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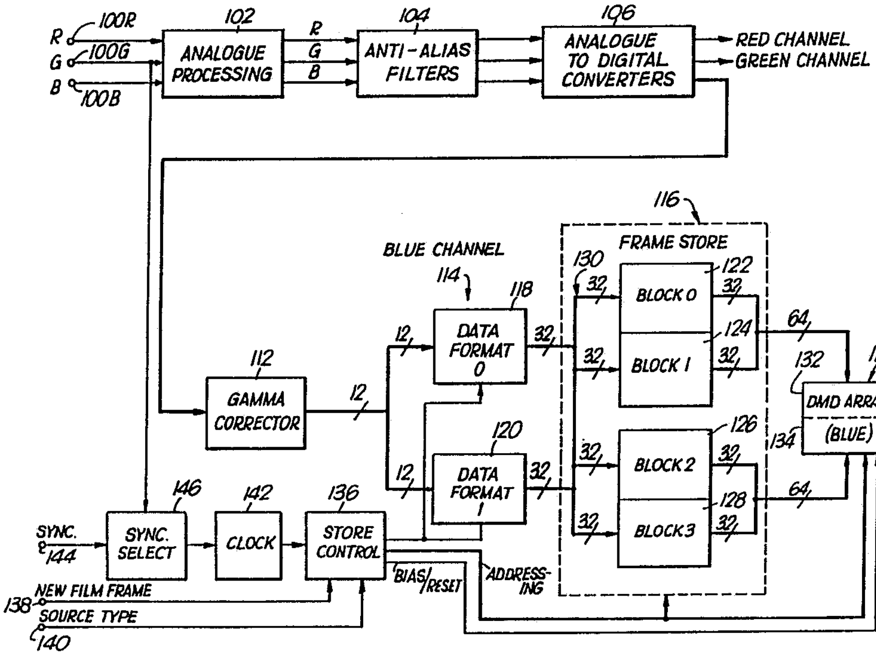

(57) Abstract

A video signal has a data location which indicates whether the signal is originally derived from an optical image by a camera source or a telecine. This data is used (140, 136) in a projection display which received an interlaced video signal and which comprises a spatial light modulator (110) in the form of a deformable mirror device (DMD) so as to selectively vary both the interpolation mode and the updating mode used in the DMD. In one interpolation mode, a complete frame of image data is interpolated from one of the interlaced input video fields, so as to reduce motion artefacts (Fig. 12). In one updating mode, (mode B) odd lines are updated at the commencement of one field and even lines are updated at the commencement of the next, and so on (Fig. 9).

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VIDEO SYSTEMS

This invention relates to video systems, and more particularly to such systems in which a processed or transmitted signal can be derived from a camera source or from a film source.

Present day television systems operate on the interlaced scan principle. This means that for the 625 line system used in Europe, the odd numbered lines are scanned first, followed by the even numbered lines. Therefore a complete television picture consists of an "odd field" of 312.5 lines and an "even field" of 312.5 lines, the period of each television field on the 625 line system being 1/50th of a second, hence it is described as "625/50". A complete picture has a period of 1/25th of a second. The other main TV system to be discussed, 525/60 as used in North America and Japan, is exactly the same except that there are 525 lines and the field period is 1/60th of a second. It is described as "525/60".

When an electronic camera scans a moving image, since the even lines are scanned 1/50th of a second after the odd lines, there is image displacement between the odd and even fields.

When scanning film on the 625/50 line system, it is usual to operate the telecine at a film speed of 25 film frames per second, to provide a simple 2:1 relationship between television fields and film frames. This means that one odd and one even television field are obtained from each film frame. Since the odd and even fields are obtained from the same film frame, in this case there will be no image displacement between these particular odd and even fields, even if there is displacement of images between film frames.

The situation is similar but slightly different on the 525/60 system, since film is then operated at a speed of 24 frames per second to give a 3:2 relationship with television fields. This means that three television fields are obtained from one film frame and two from the next, and so on, repeating. It has been known to operate at a film speed of 30 frames per second on the 525/60 system, in which case we will have the simpler 2:1 relationship described for the 625/50 system, but this is normally less satisfactory.

We have appreciated that the receiver display can be improved if the receiver or the intermediate processing equipment is told whether the transmitted signal came originally from a camera source or a telecine (i.e. film scanning equipment).

In accordance with this invention in a first aspect we propose a video signal having a data location which indicates whether the signal is originally derived from an optical image by a camera source or a telecine. This data location may conveniently form part of a teletext multiplex or may be carried in any convenient data location in the signal. Typically this data location will be in the frame blanking.

The invention also provides a video transmitter for transmitting such a signal, processing circuitry for processing such a signal, and a receiver for receiving such a signal. The receiver includes means responsive to the data in the data location to command signal processing means operative on the received video signal to operate in different respective modes.

The invention in its first aspect is particularly suited for use with video display systems based on the use of a spatial light modulator, and especially though not exclusively to the type of spatial light modulator which has become known as a deformable mirror device or DMD.

For a background description of several types of spatial light modulator reference may be made to HUIGNARD, J.P., "Spatial Light Modulators and their Applications, J. Optics (Paris), 1987, Vol. 18, No. 4, pp 181-186. By way of example another type of spatial light modulator is described in THOMAS, R.N. et. al. "The Mirror-Matrix Tube : A Novel Light Valve for Projection Displays", IEEE Transactions on Electron Devices, Vol. ED-22, No. 9, September 1975, pp 765-775.

The deformable mirror device is a particular type of spatial light modulator and comprises a micro-mechanical array of electronically addressable mirror elements, the elements corresponding to pixels. Each pixel mirror element is capable of mechanical movement in response to an electical input. Such movement is in practice more often a deflection rather than a deformation but the term deformable mirror device has now become accepted as the description of this class of devices. They may be digitally addressed in which case they can be referred to as digital mirror devices. The expression DMD covers all of these.

For a description of current DMD technology reference is made to HORNBECK, L.J., "Deformable-Mirror Spatial Light Modulators" Proc. SPIE Critical Reviews Series, Vol. 1150, 6-11 August 1989, San Diego, California, U.S.A., pp 86-102. This paper contains many references to earlier work and attention is drawn particularly to references 3, 9, 14 and 23 of that paper. Further details of the construction of the devices is found in BOYSEL, R.M., "A 128 x 128 frame-addressed deformable mirror spatial light modulator" Optical Engineering, Vol. 30, No. 9, September 1991, pages 1422-1427. Attention is also drawn to reference 1 in that paper which is an earlier publication by Boysel et al. It has been proposed that DMDs should be usable as projection displays, see e.g. HORNBECK, L.J., et al., "Deformable Mirror Projection Display", SID 80 Digest, pp 228-229 (Abstract of presentation delivered July 20, 1980 at SID Symposium), and United States Patent US-A-4,680,579.

The construction and manufacture of DMDs is further described in United States Patents US-A-4,615,595 and US-A-4,566,935 and European Patent Application EP-A-0 391 529, all of Texas Instruments Incorporated.

The following description assumes a knowledge of the above-noted prior documents, all of which are hereby incorporated by reference.

The DMD is an example of a class of display devices, generally including spatial light modulators, having a simultaneous "scan". That is to say all the pixels are simultaneously illuminated, as opposed to being successively illuminated by way of a raster scan as with a conventional cathode ray tube display device. Such systems will be referred to as "simultaneous-scan image displays", in which all elements are active at the same time. This property can create problems when displaying material produced by interlaced sources, such as video cameras.

Most video signals are interlaced - i.e. they consist of a sequence of frames, each frame made up of two fields. One field contains the even numbered lines, the other the odd numbered lines.

The fields are arranged in succession, which means that adjacent lines are time displaced. This is not normally a major problem, as they are displayed in the same time sequence. However, due to the "simultaneous" nature of the DMD, all lines are displayed at the same time. Therefore if there is any movement between fields, unacceptable motion artefacts will be introduced when attempting to display an interlaced video signal.

The simultaneous scan (which is not realy a scan at all) is to be distinguished from a progressive or non-interlaced scan, in which the lines are still refreshed sequentially, though without the conventional interlace.

In order to overcome the problem of movement between fields, we propose in accordance with a second aspect of this invention, to interpolate each field as it is received to create a new frame, and display this instead of the interlaced frame.

Although this implies some form of storage to allow the interpolation to be performed, this is in any event required to assemble the frame from the two fields. In order to reduce storage requirements, the new lines can be interpolated from the old ones as they arrive. This implies at least a two-line delay in the system. While one field is being interpolated the other (already interpolated) field will be displayed on the mirrors. Thus every pixel will be refreshed at the field rate, and not just alternate lines as in a conventional display.

As the interpolated lines will be replaced one field later by the correct information, the interpolating algorithm does not need to be too critical. A simple bilinear interpolation employing the lines on either side of the new line is therefore suitable. This requires one addition and a division by two.

Such a system has the disadvantage that it reduces the vertical resolution of the display by half, and may introduce unwanted noise in stationary scenes, as lines change from interpolated to original and back. Furthermore, although the incoming signal may be interlaced, if it was produced on say a telecine then both fields will come from the same film frame and will have no motion between them.

It would be possible to provide that interpolation should only take place where there is movement, and in stationary areas the information from the previous field should be maintained.

This aspect of the invention is particularly suited for use with the first aspect. When the input signal was derived from telecine, a different display mode can be used than when the input signal was originally derived from a camera. A camera is an interlaced scanning source with successive fields relating to slightly different instants of time. With a telecine this is not the case. When a simple 2:1 scan is used in the telecine, the two interlaced fields relate to the identical instant of time.

In accordance with a third aspect of the invention a simultaneous scan device displays an image represented by an incoming interlaced video signal by updating the display at the field rate, odd lines being changed at the commencement of one field and even lines being changed at the commencement of the next. Thus each field is displayed, after it has arrived, with the previously-received field.

This mode is normally preferred, but in the presence of an input signal derived from a telecine, the display can revert to updating at the commencement of each picture consisting of two interlaced fields, making use of the first aspect of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in more detail, by way of example, with reference to the drawings, in which:

Figure 1 shows schematically the general arrangement of a projection system including a spatial light modulator of the DMD type;

Figure 2 is a view of the DMD device indicating the pixel mirror elements;

Figure 3 shows schematically the arrangement of a colour projection system;

Figure 4 shows schematically a portion of Figure 1 in greater detail;

Figure 5 shows a detail of the mirror array device of Figure 2;

Figure 6 is a schematic side view of a light modulator mirror element used in one embodiment of the invention;

Figure 7 is a schematic block diagram showing the driver circuitry for a DMD array;

Figure 8 illustrates a video transmission claim showing how signals from a camera source or a telecine can reach a projection display of the type shown in Figure 7;

Figure 9 is a timing diagram showing how incoming fields of an interlaced video signal can be applied to a simultaneous-scan display such as a DMD, when the signal comes from a camera source;

Figure 10 is a diagram similar to Figure 9 for use when the signal comes from a telecine operating at 525/60/30 or 625/50/25;

Figure 11 is a diagram similar to Figure 9 for use when the signal comes from a telecine operating at 525/60/24; and

Figure 12 is a block diagram showing how interpolated lines can be generated for application to the DMD device.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, a projection system comprises a reflective screen (for example a cinema screen) B and a projector A, positioned and aligned relative to the screen so as to generate a focused image on the screen.

The projector A comprises a lamp A1, typically rated at several kilowatts for a cinema application, generating a light beam which is directed onto a reflective planar spatial light modulator A2 comprising, for example, a DMD array of 512 x 512 individual pixel mirrors. Each mirror of the display device A2 is individually connected to be addressed by an addressing circuit A3 which receives at an input A5 a video signal in any convenient format (for example, a serial raster scanned interlaced field format) and controls each individual mirror in accordance with the corresponding pixel signal value within the video signal.

The modulated reflected beam from the active matrix device A2 (or rather, from those pixel mirrors of the device which have been selectively activated by the address circuit A3) is directed to a projector lens system A4 which, in a conventional manner, focuses, magnifies and directs the beam onto the screen B as shown schematically in Figure 2.

As shown in Figure 3, in a three colour system, three separate active matrix devices A2a-A2c are provided, one driven by each of three separate colour video signals from the address circuit A3, with separate illumination arrangements A1a-A1c producing beams of the different colours. The arrangement may be as disclosed in United States Patent US-A-4,680,579, for example. The light reflected from the three devices A2a-A2c is combined (not shown) and supplied to the lens system A4.

Referring to Figure 4, one type of display device comprises a plurality of row enable lines A2d and a plurality of column enable lines A2e. The address circuit A3 comprises an input port receiving a digital video signal in an input format (for example, a conventional line scanned interlaced field format), a scan convertor circuit A3a for converting the input video signal format into one suitable for display on the device A2, and an addressing circuit A3b arranged to selectively activate corresponding pixel mirrors of the device A2 in accordance with a signal from the scan convertor circuit A3a. In a colour system of the type shown in Figure 3, the scan convertor circuit receives a composite colour video signal, for example, and generates therefrom three separate colour component video signals supplied to three separate addressing circuits A3b, one for each display device A2. A clock circuit A3c controls the timing of the address circuit A3b; in one preferred mode of operation, as discussed above, the intensity displayed by each pixel mirror is controlled by controlling the time for which that pixel mirror is deflected, and corresponding timing signals are derived from the clock A3c.

Referring to Figure 5, associated with each crossing point where a particular row line and column line meet, there is provided a semiconductor switch A2f the control terminal of which is connected to, for example, a row enable line A2d. For example, as shown, the switch may comprise a field effect transistor, the gate of which is connected to a row enable line A2d. The source of the field effect transistor is connected to one of the column enable lines A2e and the drain to the deflection terminal of a deflectable mirror device. Thus, each mirror device A2g will, when addressed by a row enable signal, deflect in response to the signal applied to its corresponding column enable line A2e. Each mirror device A2g and switch A2f combination is arranged to latch the display state of the mirror device A2g until the next time the mirror device is addressed.

An individual mirror element is shown in Figure 6. The element comprises a torsion beam 20 in the form of a plate, supported by a torsion rod 34 which in turn is supported at its ends (not shown). A substrate 28 carries a pair of control terminals 38, 40 (address electrodes) symmetrically disposed around the axis of the torsion beam defined by the torsion bar 34. The control terminals 38, 40 are connected to addressing lines (not shown) and a voltage is supplied to one or other. Also provided on the substrate 28 are a pair of landing electrodes 42, 44 disposed under the edges of the torsion beam mirror element 20. On the outer surface of the torsion beam is a reflective coating 36. The landing electrodes 42, 44 are electrically connected to the torsion beam 20, which is conductive, and is connected to a bias voltage source V_B.

Each modulator has individual control terminal lines V_{ON}, V_{OFF} connected to the control terminals 38, 40.

In use, generally speaking, the application of a voltage to one control terminal 40 will set up an electric field between the control terminal 40 and the torsion beam 20; the voltage supplied to the control terminal 40 is generally such that the field is attractive. The beam 20 therefore tends to rotate through an angle α towards the control terminal 40 depending upon the magnitude of the field, thus changing the orientation of the torsion beam. The torsion bar 34 tends to resist any such rotation. If the field is sufficiently strong the beam 20 will be drawn to make physical contact with the landing electrode 44; to avoid unwanted discharge the two are connected in common. The magnitude of the attractive field is controlled therefore by the bias voltage V_B applied to the beam 20 and by the voltage applied to the control electrode 40. It would be possible to simultaneously apply a voltage to the other control electrode 38, but in practice this is avoided. Depending on the magnitude of the bias voltage, the torsion beam 20 may have two or three stable positions.

At any instant during a display, certain mirror elements 20 will be in their ON position and the other mirror elements will be in their OFF position, so that the instantaneous picture seen on the display will comprise a black and white picture. In practice, in use the mirrors are flipped back and forth between their ON and OFF positions. Shades of grey can be displayed by varying the mark-space ratio or effective proportion of the time for which a mirror is ON. The mark-space ratio may typically vary from black to white in steps of about 0.05% (some 2000 steps) to provide a high quality display.

For further description reference should be made to the documents cited in the introduction of this application.

The manner in which the DMD device is driven will now be described with reference to Figure 7. The system receives red, green and blue signals at inputs 100R, 100G and 100B. Alternatively the signals may be received in Y, U, V or Y, I, Q form. The input video signals are processed in analogue processing circuits 102 which control gain and lift, and provide for matrixing of the signals to control saturation, or when required to convert the signals to R, G, B form.

The signals are then passed to anti-alias filters 104. such filters are well-known and serve to remove frequency components that could give rise to problems in the subsequent analogue-to-digital converters (ADCs) 106. When the signals are sampled, high signal frequencies above half the sample frequency can be reflected back by the sampling operation into the low frequency part of the signal. The filters 104 remove such components. The filters are switchable in dependence upon the signal format, e.g. 525 or 625 lines, and conventional or enhanced aperture ratio (4:3 or 16:9).

The R, G and B signals are then applied to separate red, green and blue channels, each of which has a DMD array 110. Only the blue channel is shown; the others are similar.

The digital blue colour component signal is first applied to a gamma corrector 112. The gamma corrector takes the form of a read-only memory configured as an 8-bit input to 11-bit or 12-bit output look-up table. The output of the gamma corrector is applied through a data formatting stage 114 to a frame store stage 116 and thence to the DMD 110.

The data formatting stage comprises two data format circuits 118 and 120. Each of these holds half a line of data, and they are arranged so that while data is being written into one, data is being transfered out of the other into the frame store 116. The frame store stage is divided into four blocks 122, 124, 126, 128, each of which can accommodate half a frame of data. The frame store can thus hold two complete frames (or pictures) of data. This corresponds to four fields of an interlaced signal. Each of the two data format circuits has access by a bus 130 to each of the four blocks of the frame store. The outputs of the frame store blocks are then applied to the DMD 110. The DMD is divided into upper and lower halves 132 and 134 which are separately addressed, so as to reduce the required data rate. The upper half 132 receives the output of frame store blocks 122 and 124, and the lower half 134 receives the output of frame store blocks 126 and 128.

The system is controlled by a store controller 136 which supplies appropriate addresses to the frame store 116, and the DMD 110, provides bias and reset pulses to the DMD 110, and controls the data format stage 114. The store control receives a signal from an input 138 indicating the start of a new film frame, a signal at an input 140 indicating whether the picture was originally derived from an image by a camera or by a telecine, and clock signals from a clock circuit 142. The clock circuit is driven from synchronising pulses in the video input, e.g. the green signal, or by external sync. pulses received at an input 144, as selected by a sync. select circuit 146. The inputs 138, 140 may in fact be merged into a single input, as will be apparent from the following.

The display system of Figure 7 is part of an overall video system as schematically shown in Figure 8. Practically all image signals will have originally been converted from an optical image either by a camera 150 viewing a scene or by a telecine 152 viewing a cinematograph film 154. Computer-generated images would be an exception to this. In the diagrammatic system shown in Figure 8, the camera and telecine produce digital video outputs in accordance with CCIR Recommendation 601. One or other of the video signals is selected at any instant by a selector switch 156 and applied to a teletext encoder 158 which receives text at an input 160. Other conventional processing stages are omitted in this figure.

The telecine has a further output line 162 to the teletext encoder 158 which is high when the telecine output is being passed through the encoder 158. In response to line 162 being high, the teletext encoder adds a special flag or code to the video signal to indicate that the signal was originally derived from a telecine and not from a camera. The flag may, furthermore, comprise a code indicating the mode in which the telecine is operating, that is whether it is converting from 24 frames to 60 fields or from 25 frames to 50 fields, and whether the aperture ratio of the image is 4:3 or 16:9.

The flag or code is preferably included in one of the unallocated control code locations in the teletext multiplex, see "Broadcast Teletext Specification" published by British Broadcasting Corporation, Independent Broadcasting Authority, and British Radio Equipment Manufacturers Association, September 1976. The flag may be inserted by the telecine itself rather than by the teletext encoder. The flag may comprise the presence of a code when the signal has come from a telecine, and the absence of it when it comes from a camera. The flag may for example comprise a 3-bit code which takes the value 000 (or is undefined) with a camera source, and other values up to 111 to indicate a telecine and its current operating paramaters.

Illustratively the signal may then be applied to adaptive processing circuitry 164 in the studio where it is processed in any one of many possible ways. Some types of processing, e.g. to remove blemishes, can usefully be modified if the source of the signal is known. Thus different processing can be applied dependent upon whether the signal was derived from a camera source or a telecine source. In particular, where the processing involves interpolation, the interpolation algorithm can be modified in dependence upon the type of signal source.

The signal may then be transmitted for example to a receiver station comprising a videotape recorder 166. The signal can be recorded in conventional fashion. Those parts of the video signal which were originally derived from the telecine will continue to carry the source type flag, those that were derived from a camera will not. The interpolation of the videotape recorder has no effect on the situation.

The signal is passed from the videotape recorder 166 to the display unit which can be based on the system of Figure 7, using DMD devices to project an image on a screen 170. A teletext decoder 172 extracts the teletext signals and either discards them or uses them as required. However, the source type codes are passed to a code separator 174 which separates out the source type code and applies it to the input 140 of the system of Figure 7. This may furthermore indicate the nature of the telecine operation as indicated above. The codes may also indicate the point in the field cycle when a new film frame started to be scanned by the telecine and this information is applied to input 138 of Figure 7.

The source type codes may be used in other display devices, for example an enhanced broadcast receiver which upconverts the received standard to a higher standard. The upconversion algorithm could be adaptive in dependence upon whether the original signal was generated by a camera source or by a telecine.

In any event it will be seen that since the source type flag has been carried by the signal itself, it will survive processing and editing by any equipment which retains proper integrity of the signal. As an alternative to putting the code in the teletext multiplex, i.e. in the frame blanking interval, the code could be constituted by data in the active picture area. The degree of corruption of the picture can be arranged to be insignificant.

The manner in which the fields of the interlaced video signal are applied to the DMD devices will now be described. Figure 9 is a timing diagram showing input television fields and two possible modes A and B which can be used in the updating of the DMD display. The input TV fields are numbered as they appear in time, 1 followed by 2 followed by 3 and so on. "O" means "odd" and "E" even.

It is first assumed that the signal came originally from a camera source. Although the incoming signal conforms to the interlaced standard, it is very advantageous to activate all the lines of mirrors in the DMD display in one television field period, instead of only half the number of rows in the interlaced mode. The two main advantages of activating all the lines in the DMD display apply particularly to projection on large screens. The first advantage is the increased brightness by a factor of two, and secondly is the elimination of "interlace twitter", a common problem with interlaced scans, especially when magnified on a large screen. "Interlace twitter" is a combination of vertical movement and flicker, caused by the vertical displacement between the two interlaced scans and the repetition rate of 25Hz. The human eye is increasingly more sensitive to flicker at frequencies below 50Hz, therefore the minimum display frequency is 50Hz.

The DMD display requires the picture store 116 of Figure 7 between the incoming interlaced signal and the DMD. Referring again to Figure 9, the DMD, in modes A and B, displays both odd and even fields in the time required for one input field to arrive. For example, in mode A, fields 01 and E2 are displayed while field 03 is arriving. Also in mode A, 01 and E2 are repeated during the arrival of E4. When 03 and E4 have arrived, these two fields are also repeated for the next two incoming field periods. The principle of mode A is to update the display only after the arrival of a complete picture of an odd and even field. The problem with this mode is that E2 is displayed before 01, E4 before 03 and so on, therefore there will be motion errors, because the fields are displayed in the wrong sequence.

In mode B each field is displayed, after it has arrived, with the previously-received field. Thus we have a different type of motion error where in each displayed picture, only the odd or even lines are updated alternately. Mode B is preferred since updating is more frequent.

There are complex interpolation solutions to the above motion errors. For example when displaying 03, instead of displaying E4 in mode A, E3, which does not exist, could be interpolated from 03, or from E2 and E4.

Let us now consider the situation when we have a film source by referring to Figure 10. Fields 01 and E1 are derived from the same film frame, therefore there is no motion between these fields. Thus if we operate in mode A, and wait for 01 and E1 to arrive before displaying, we have no motion errors, since the fields are displayed in the correct sequence. We have appreciated that if the DMD receiver or projector can be instructed to switch to mode A (if it was in mode B or an interpolation mode for an electronic camera source) improved display will result. As shown in Figure 10, the flag indicates the start of each film frame, and occurs every 1/25 (or 1/30) of a second.

Figure 10 refers to film sources operating on 525/60/30 film frames per second and 625/50/25 film frames per second. Film sources operating on 525/60/24 film frames per second require a modification to mode A as can be seen by referring to Figure 11. On this standard, five television fields are produced for every two film frames. Thus in the modified mode A, at the display, three consecutive pictures are produced from one film frame and two consecutive pictures from the next film frame alternately, the sequence being repeated every four film frames. The flag occurs only at the beginning of each sequence, i.e. every four film frames or ten video fields. Therefore, there are no motion errors due to incorrect display sequence, but there remains a problem with uneven motion due to the 3:2 picture display, but all television receivers suffer from this problem when operating on this standard.

The flag carried by the transmitted video signal, indicates whether a conventional source is involved, with the interlaced fields representing time-displaced information, or whether the signal has been derived from a telecine, in which case certain fields are derived from information obtained at the same time. The flag enables the receiver to switch between these modes. As described above, to this end the transmitter is adapted to introduce into the signal the flag in response to the signal source. The receiver comprises a signal processing circuit in the video path which includes at least a field store and which can be operated selectively in the two modes A and B. The flag is extracted from the incoming signal and used to switch the receiver between its two modes.

In Figure 11 the flag fulfils three purposes, (1) the presence of the flag denotes a film source, (2) the period of the flag, which is now 1/6th of a second instead of 1/25th or 1/30th as in Figure 10, denotes the standard 525/60/24, and (3) the position of the flag denotes the fact that the start of an odd field coincides with the start of a film frame, which only occurs every four film frames. There are two identical odd fields from every fourth film frame, and it is necessary to know which is which, so as to obtain the correct display sequence. The format of the standard television synchronising pulses provides the necessary means to detect the start of an odd or even field.

Thus it is seen that the presence of a flag denotes a film source and therefore the display sequence can be altered to suit a film transmission, being different from that used for an electronic camera source. Also, the period of the flag identifies the standard of the film transmission, and its phase indicates the sequence of the incoming television fields.

As was noted in the introduction, the DMD device is an example of the class of 'simultaneous-scan' display devices, in which motion artefacts will arise when attempting to display an interlaced video signal. As previously mentioned, the fields can therefore be generated in the display system at least in part by interpolation.

Such an arrangement may be implemented as follows. The first field is read in and interpolated. The next field is sent to another block of the picture store and also interpolated. At the same time the incoming data is subtracted from the corresponding interpolated pixels in the first 'frame'. These differences are summed over the whole image and the total normalised to run between 0 and 1.0. If the total is greater than a predetermined threshold, this implies that there is a lot of movement between fields. A more sophisticated motion detector could of course be used. The interpolated lines are used with each field to create whole frames, and the two frames displayed one after the other. If the total is less than the threshold, it implies that there is little or no movement between fields. In this case both original fields can be displayed together (the interpolated fields are ignored). To maintain the frame rate, the fields are displayed twice.

An example of suitable apparatus is illustrated in Figure 12. The first field, field 1, is read into to store block 122. It is also applied to a line delay 200, and an interpolator 202 receives both the delayed and undelayed signal. The interpolator supplies interpolated lines to the store block 122. the next field, field 2, is sent to block 124 of the store and also interpolated by line delay 204 and interpolator 206. At the same time a differencing circuit 208 subtracts the incoming data from the corresponding interpolated pixels in the first 'frame'. A summing circuit 210 sums the differences over the whole image. The total is compared with a threshold set in a circuit 212, to determine whether there is a lot of movement between the fields. If the total error is small, a switcher 214 selects only non-interpolated lines and displays the two frames together.

If the total error exceeds the threshold, the interpolated lines are used.

To reduce the complexity of the system, a simple bilinear interpolation is again used. The threshold can be set to guard against wrong decisions. If the average difference is normalised between 0 and 1.0, then if displaying the interpolated fields at the wrong time is less obtrusive than displaying interlaced fields with movement, the threshold should be set below 0.5 If the converse is the case it should be set at greater than 0.5 The actual value can be determined empirically with a suitable set of test sequences.

If a scene consists of a static background with some movement in a small area of the image, then the system may not be sensitive to detect this. A way to deal with this problem would be to test individual blocks of the picture, e.g. separate lines, against a threshold rather than the whole image. A count of blocks or lines greater than the threshold would be used to determine what action is to be taken. The threshold could also change with each block or line, allowing more weighting to be given to central areas for instance.

Further features that may be used in conjunction with the present embodiemnt are described in International Patent Applications Nos. PCT/GB91/02032, PCT/GB91/02033 and PCT/GB91/02034 (Agents Refs: 31678, 31974, 31975) the disclosure of which is hereby incorporated by reference.

CLAIMS

1. A video signal having a data location which indicates whether the signal is originally derived from an optical image by a camera source or a telecine.

2. A video signal according to claim 1, in which the data location comprises a data item which is present when the signal was originally derived by a telecine and absent when the signal was originally derived from a camera.

3. A video signal according to claim 1, in which the data location is in the frame blanking interval.

4. A video signal according to claim 1, in which the data location is in a teletext multiplex.

5. A video signal according to claim 1, in which the data location is in the active picture area.

6. A video signal according to claim 1, in which the data location comprises a data item indicating when the signal was originally derived from a telecine which can take a plurality of values depending upon the telecine operating parameters.

7. A video signal according to claim 1, in which the data location is arranged when the signal was originally derived from a telecine to indicate the instant at which the telecine starts to scan a new film frame.

8. A video signal according to claim 1, in which the data location is arranged when the signal was originally derived from a telecine to indicate the instant at which the telecone starts to scan selected periodic ones only of the film frames.

9. A video encoder having a video input for receiving a video signal and a supplementary input for receiving a signal indicating whether the associated video signal is originally derived from an optical image by a camera source or a telecine, and including means for inserting in a data location in a video output signal a data item responsive to the signal at the supplementary input.

10. A telecine, comprising means for generating a video output signal representative of a film, and means for inserting in a data location in the video output signal a data item representative of the fact that the video output signal is serived by the telecine.

11. A telecine according to claim 10, in which the telecine is operable with variable operating parameters, and in whic hthe data item can take a plurality of values depending upon the said telecine operating parameters.

12. A telecine according to claim 10, in which the data item is arranged to indicate the instant at which the telecine starts to scan selected periodic ones only of the film frames.

13. Video signal processing apparatus having a video signal input for receiving an input video signal, signal processing means connected to the input and operative on the input signal selectively in a plurality of different modes, and means connected to the input for extracting from the input signal a data item indicating whether the signal is originally derived from an optical image by a camera source of a telecine and for commanding the signal processing means to operate in a selected one of its modes in dependence thereon.

14. Apparatus according to claim 13, in which the signal processing means comprises interpolation means for generating a video output signal by combinations of portions of the input signal, the extracting and commanding means being operative to alter the interpolation function used in the interpolation means.

15. Apparatus according to claim 14, in which the interpolation means is responsive to the timing or the periodicity of the data item.

16. Apparatus according to claim 13, in which said apparatus comprises a display device.

17. Apparatus according to claim 16, in which the display device comprises a spatial light modulator.

18. Apparatus according to claim 17, in which the spatial light modulator is a deformable mirrowr device.

19. Apparatus according to claim 17, in which the spatial light modulator is updated periodically, in which the updating rate is varied in dependence upon the data item.

20. Apparatus according to claim 16, including interpolation means for interpolating selected lines of the display, in which the interpolation means is selectively operable in dependence upon the data item.

21. A method for displaying an image having at least two interlaced fields of image data on a simultaneous-scan display device, comprising the steps of receiving a field of image data, interpolating a complete frame of imgae data from the received field, displaying the complete frame of image data on the simultaneous display device, and repeating the steps for each subsequent field of image data.

22. A method according to claim 21, including the steps of detecting where motion has taken place between successive fields and, in areas of the image where substantially no motion has taken place, displaying the original fields together without interpolation.

23. A method according to claim 22, in which the motion detecting step comprises subtracting image data in a received field from image data interpolated from a previously received field, summing the differences betewen the two fields over a predetermined area of the image, and interpolating new image data in dependence on the result of the summation.

24. A method according to claim 23, in which new image data is interpolated in the predetermined area if the result of the summation exceeeds a predetermined level.

25. A simultaneous-scan display for displaying an image having at least two interlaced fields of image data, comprising input means for receiving fields of image data, means for interpolating complete frames of image data from the received fields and a simultaneous-scan display device for displaying the interpolated frames of image data.

26. A display according to claim 25, including means for detecting when motion has taken place between successive fields, and means for displaying the original fields together in areas of the image where substantially no motion has taken place.

27. A display according to claim 26, in which the motion detecting means comprises means for subtracting image data in a received field from image data interpolated from a previously received field, means for summing the differences between the two fields over a predetermined area of the image, and means for switching between image data from the original fields and new image data interpolated from the most recently received field in dependence on the result of the summation.

28. A display according to claim 27, in which new image data is interpolated in the predetermined area if the result of the summation exceeds a predetermined level.

29. A display according to claim 27, in which the summation is performed over the whole area of the image.

30. A display according to claim 27, in which the summation is performed for each of a plurality of blocks of the image.

31. A display according to claim 25, in which the input image data comprises video image data.

32. A display according to claim 25, in which the simultaneous-scan display device comprises a spatial light modulator.

33. A display according to claim 32, in which the spatial light modulator comprises a deformable mirror device.

34. A display according to claim 25, including means connected to the input means for extracting from the input signal a data item indicating whether the signal is originally derived from an optical image by a camera source or a telecine and for commanding the interpolation means to vary its interpolation function in dependence thereon.

35. A simultaneous-scan display for displaying an image having at least two interlaced fields of image data, coprising input means for receiving fields of image data, a simultaneous-scan display device for displaying the image data, and means coupled between the imgae means and the display device for updating the displayed image data, the updating means being operable in a mode in which the displayed lines of alternate interlaced fields are updated between successive displayed fields.

36. A display according to claim 35, in which odd lines are updated at the commencement of one field and even lines are updated at the commencement of the next, and so on.

37. A display according to claim 35, in which the updating means is operable in a plurality of modes, and including means connected to the input means for extracting from the input signal a data item indicating whether the signal is originally derived from an optical image by a camera source or a telecine and for commanding the updating means to vary its mode of operation in dependence thereon.

1/7

Fig.1.

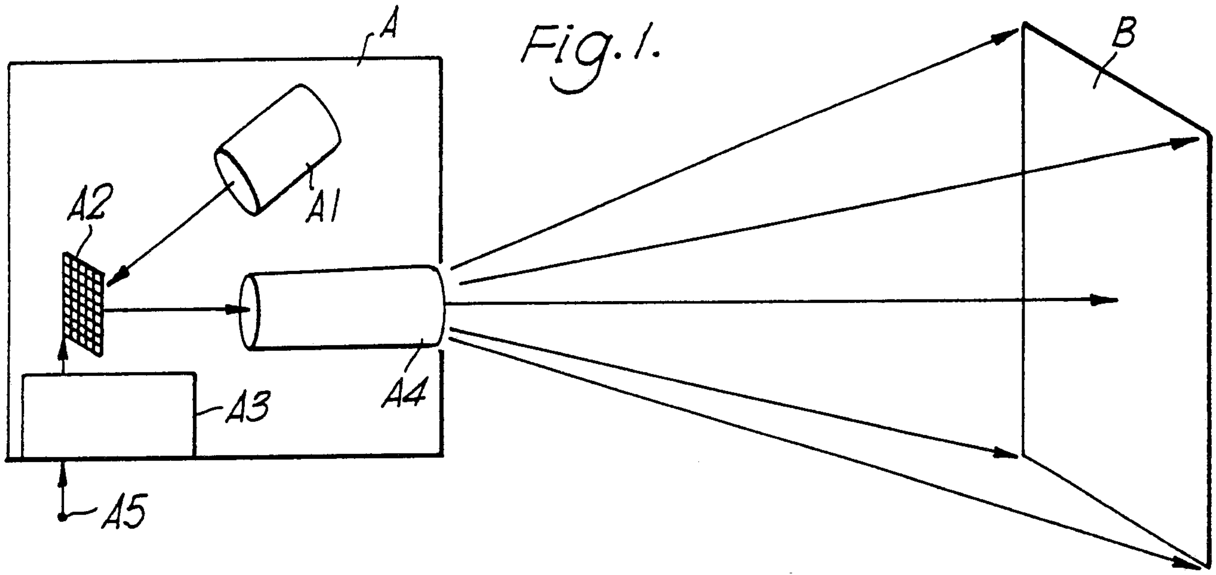


Fig.2.

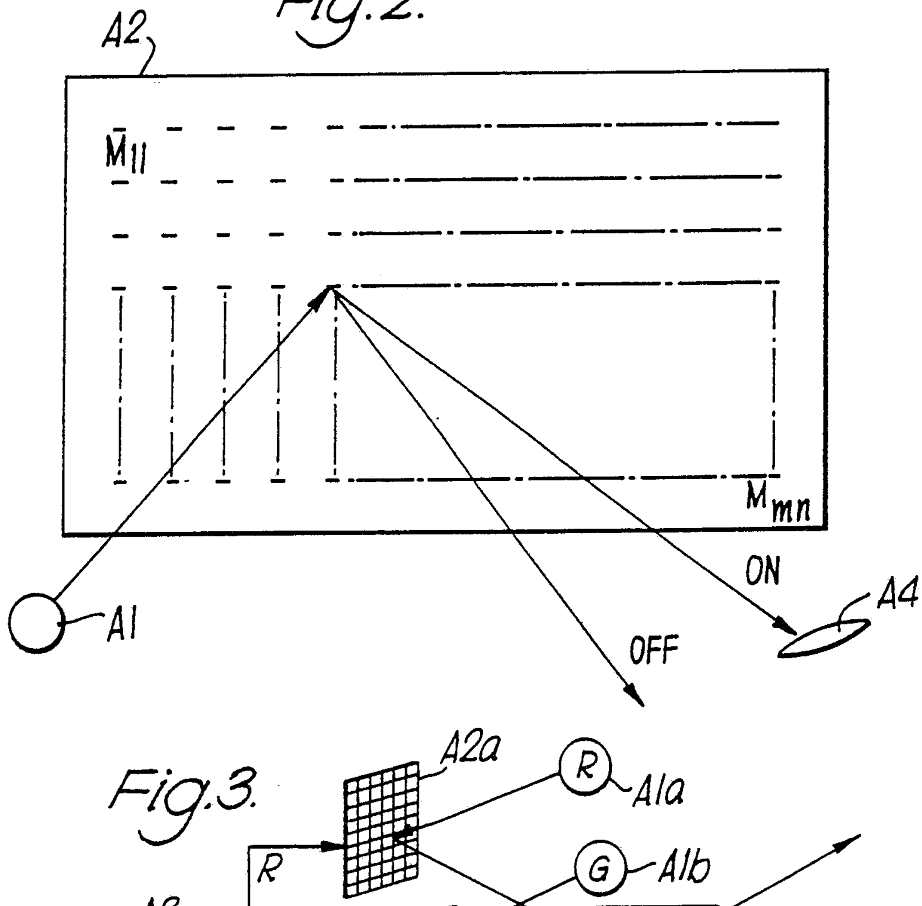
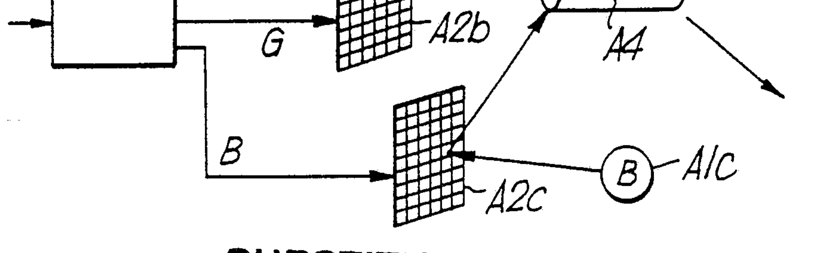


Fig.3.



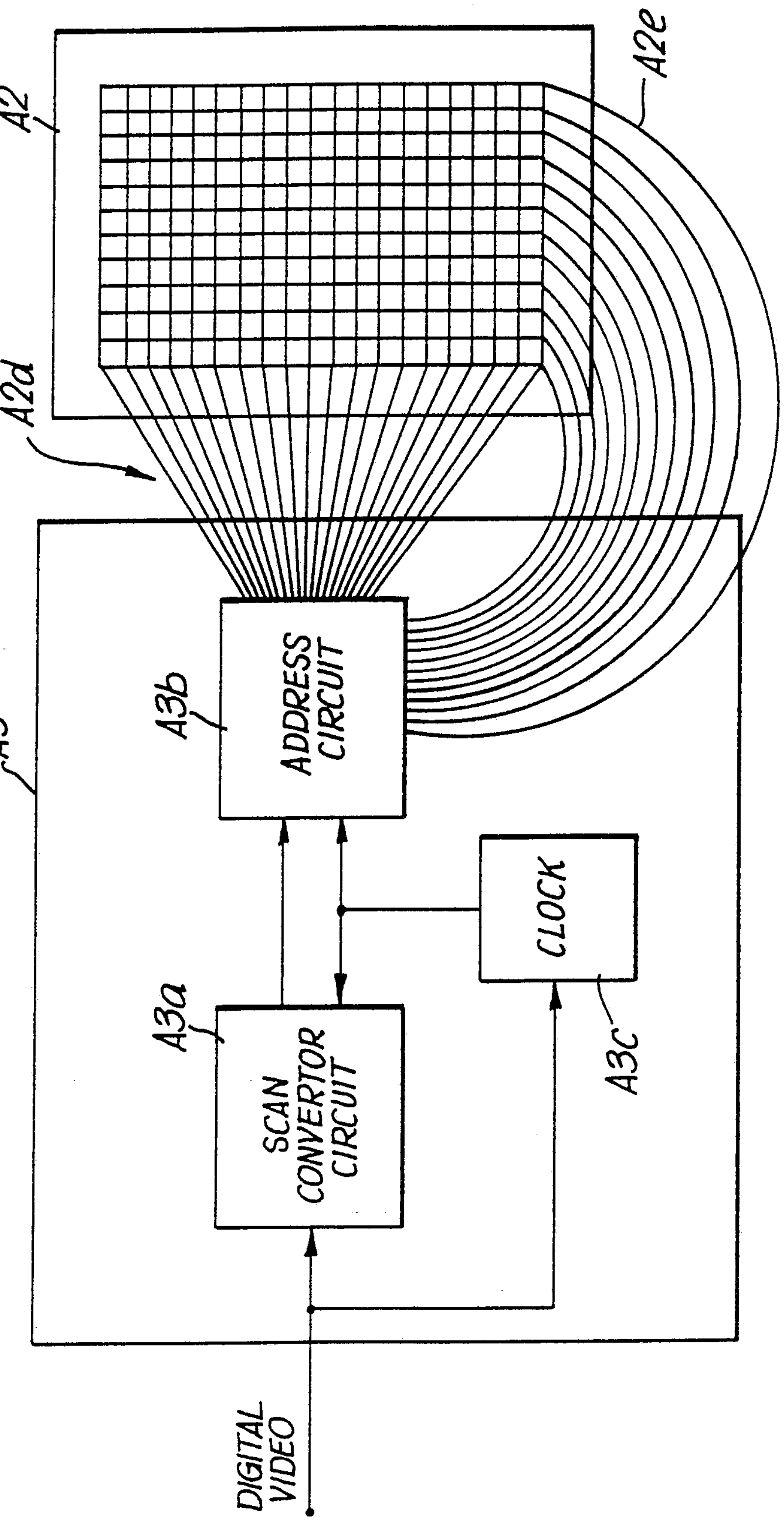

A2
A2e
A2d
A3
A3b
ADDRESS CIRCUIT
CLOCK
A3a
SCAN CONVERTOR CIRCUIT
A3c
DIGITAL VIDEO

Fig.4.

Fig.5.

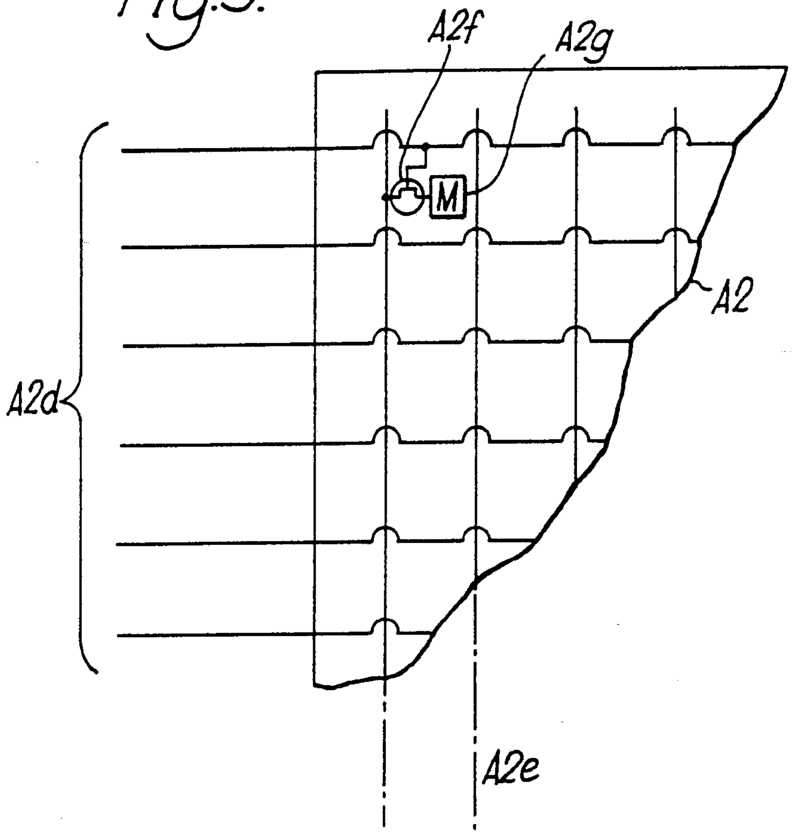
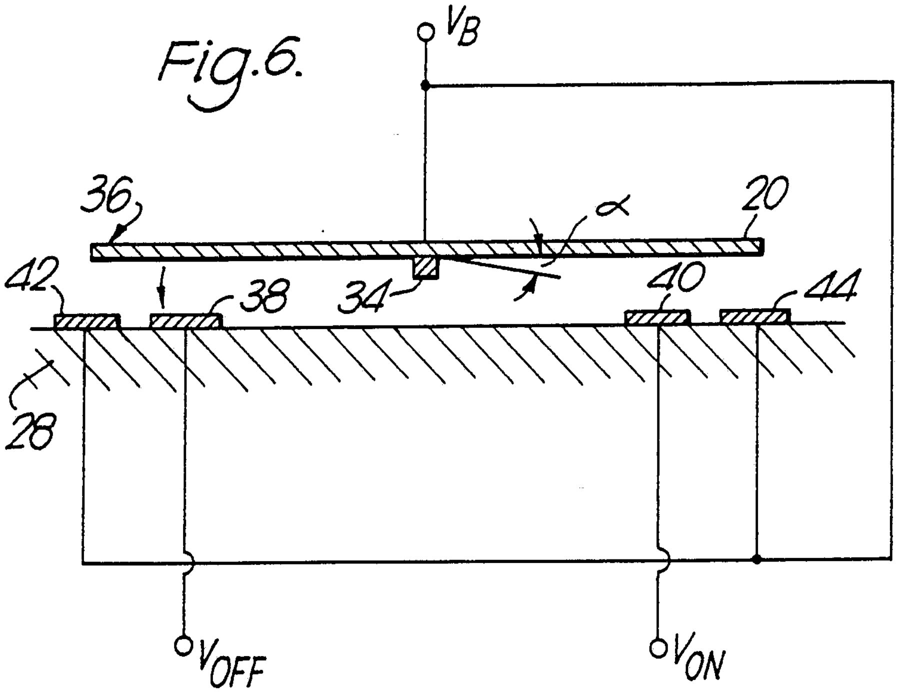
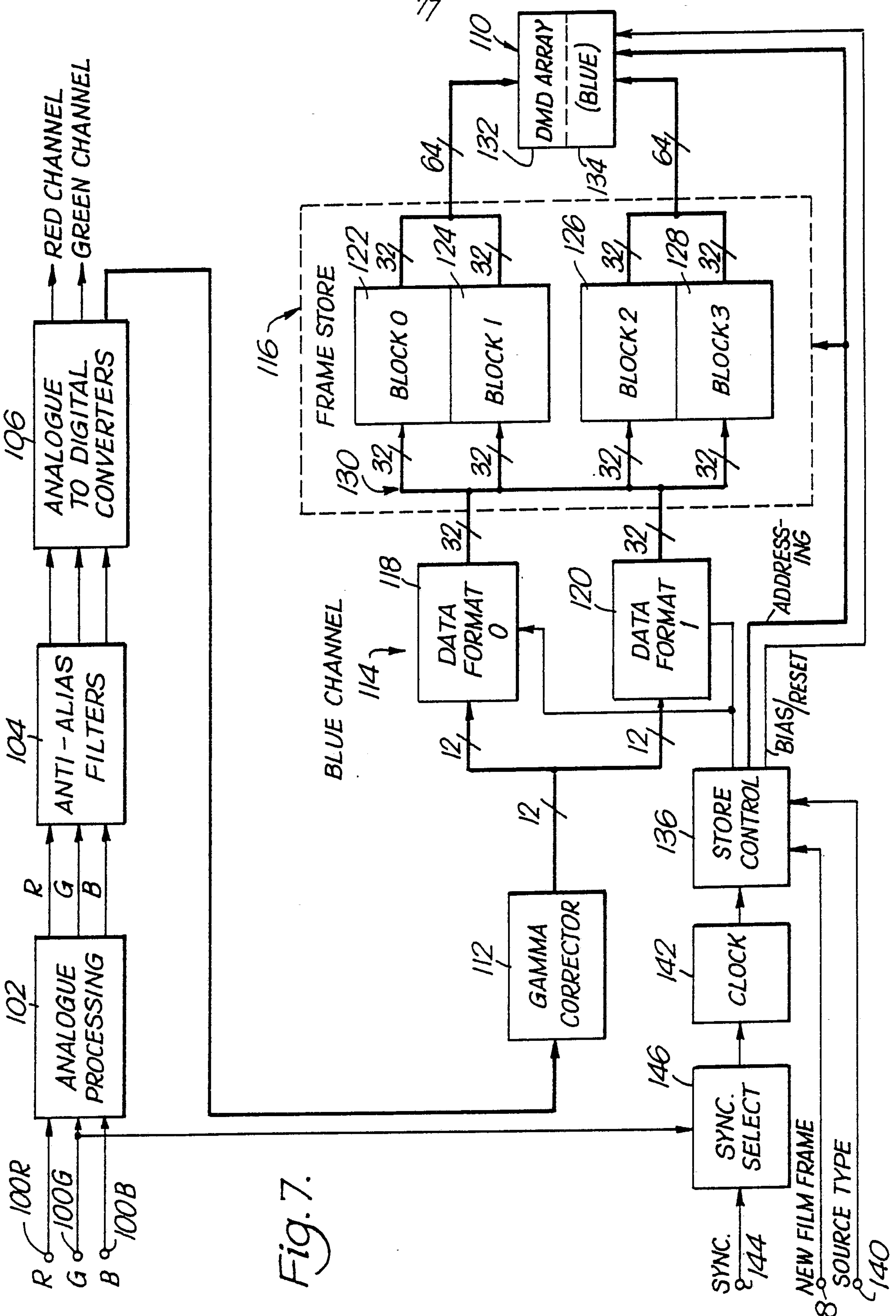


Fig.6.





R
G
B
100R
100G
100B
ANALOGUE PROCESSING
102
ANTI-ALIAS FILTERS
104
ANALOGUE TO DIGITAL CONVERTERS
106
RED CHANNEL
GREEN CHANNEL
BLUE CHANNEL
114
GAMMA CORRECTOR
112
12
DATA FORMAT 0
118
DATA FORMAT 1
120
32
FRAME STORE
116
130
BLOCK 0
BLOCK 1
BLOCK 2
BLOCK 3
122
124
126
128
64
DMD ARRAY
(BLUE)
110
132
134
ADDRESSING
BIAS/RESET
STORE CONTROL
136
CLOCK
142
SYNC. SELECT
146
SYNC.
144
NEW FILM FRAME
138
SOURCE TYPE
140

Fig. 7.

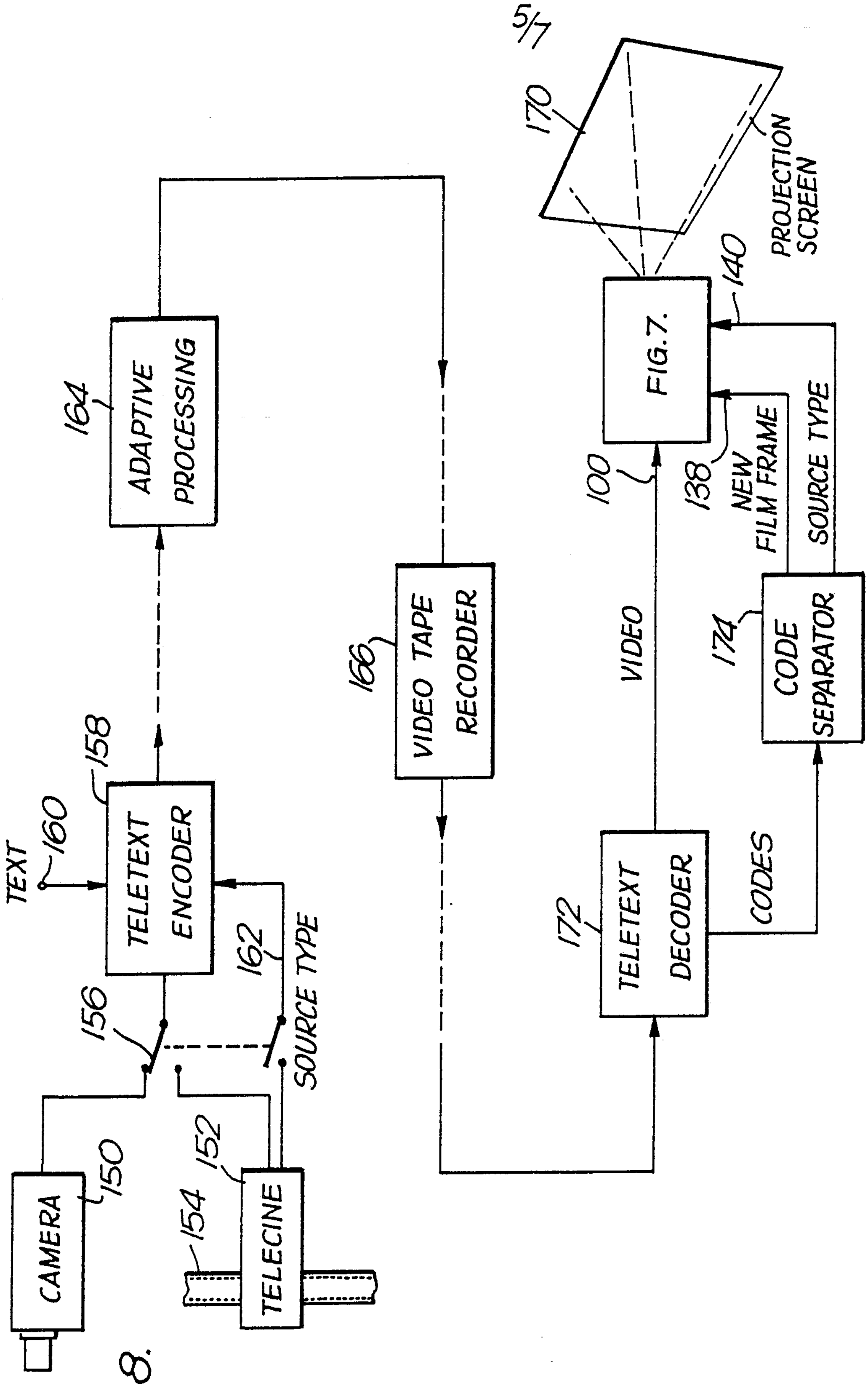

CAMERA
150
TELECINE
152
154
156
SOURCE TYPE
162
TEXT
160
TELETEXT ENCODER
158
ADAPTIVE PROCESSING
164
VIDEO TAPE RECORDER
166
TELETEXT DECODER
172
CODES
VIDEO
CODE SEPARATOR
174
100
138
NEW FILM FRAME
SOURCE TYPE
FIG.7.
140
170
PROJECTION SCREEN

Fig.8.

Fig.9

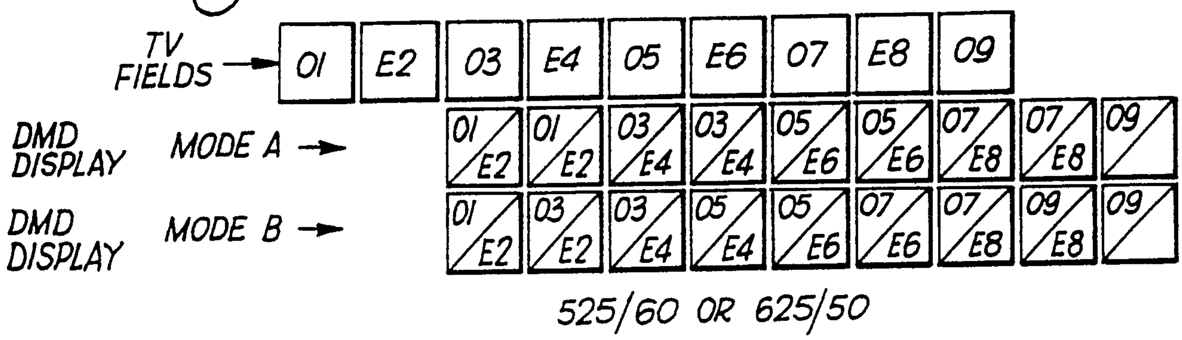

TV FIELDS
01
E2
03
E4
05
E6
07
E8
09
DMD DISPLAY MODE A
01 E2
01 E2
03 E4
03 E4
05 E6
05 E6
07 E8
07 E8
09
DMD DISPLAY MODE B
01 E2
03 E2
03 E4
05 E4
05 E6
07 E6
07 E8
09 E8
09
525/60 OR 625/50

Fig.12.

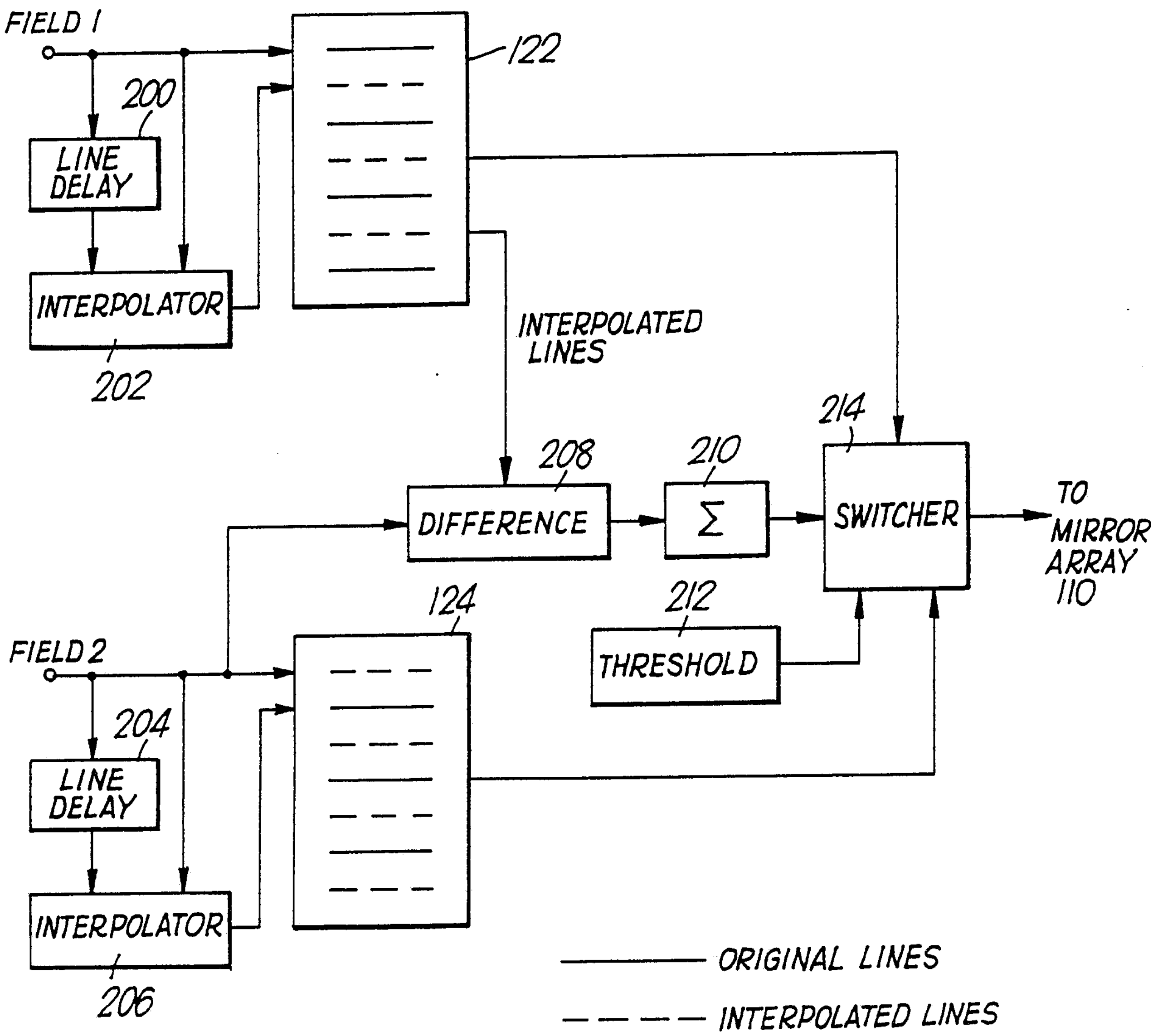

FIELD 1
200
LINE DELAY
INTERPOLATOR
202
122
INTERPOLATED LINES
208
DIFFERENCE
210
Σ
214
SWITCHER
TO MIRROR ARRAY 110
212
THRESHOLD
FIELD 2
124
204
LINE DELAY
INTERPOLATOR
206
ORIGINAL LINES
INTERPOLATED LINES

Fig.10.

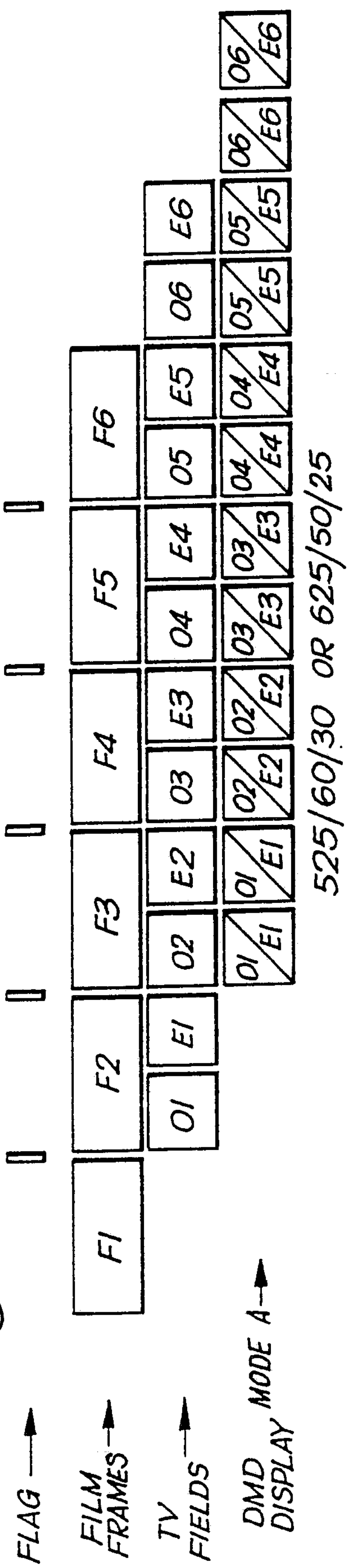
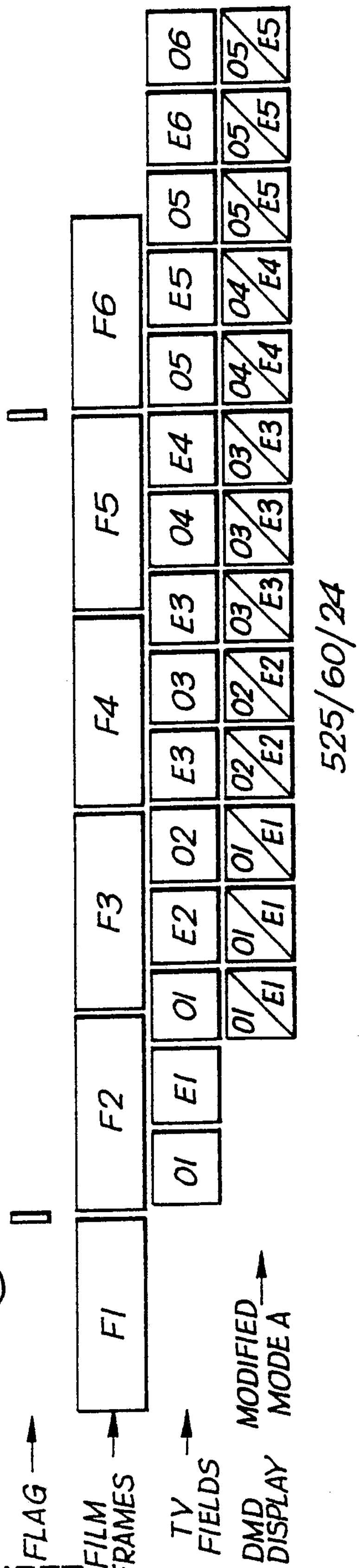

FLAG
FILM FRAMES
TV FIELDS
DMD DISPLAY MODE A
F1
F2
F3
F4
F5
F6
525/60/30 OR 625/50/25

Fig.11.


FLAG
FILM FRAMES
TV FIELDS
DMD DISPLAY MODIFIED MODE A
F1
F2
F3
F4
F5
F6
525/60/24