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(54) TELECINE APPARATUS

(71) We, EASTMAN KODAK COMPANY, a Company organized under the Laws of the State of New Jersey, United States of America, of 343 State Street, Rochester, New York 14650, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to telecine apparatus, that is to apparatus for scanning continuously moving information bearing media to produce an image signal and, more particularly, to apparatus for scanning continuously moving or stationary motion picture film frames to produce television signals therefrom, the scanning rate being responsive to the rate of movement of the motion picture film.

In telecine transmission systems, flying spot scanning devices have often been used to scan the frames of a motion picture film in a scanning raster pattern to produce interlaced television fields representative of the scanned image frames. The scanning raster pattern light beam is modulated by the image pattern of the film frame, and the modulated light is detected and transformed into a video signal by photoresponsive devices. The transmitted video signal controls the electron beam of the television receiver turned to the transmitting station to reproduce the motion picture film frame on the television screen. Since it is desirable that the motion picture film be moved continuously and transversely to the beam of light produced by the flying spot scanning device at its normally projected frame rate, it is also desirable to deflect the scanning light beam in the direction of movement of the film at the frame rate frequency. Therefore the frame area of the film scanned remains constant for each scanning field, and each film frame is scanned by an integral number of scanning fields.

Prior art systems have used optical image

splitting apparatus or mechanical light directing apparatus to produce the desired scanning beam movement during each scanning field. These systems are relatively cumbersome and subject to mechanical failure.

Further prior art systems such as shown in U.S. Patent 2,261,848 to Goldmark, contemplate the use of apparatus for applying a signal having an irregular amplitude, sawtooth wave form to the vertical deflecting coils of the flying spot scanning device to deflect the scanning light beam in the direction of film movement. Such systems may be relatively expensive, and in many instances, are not directly synchronized to the actual rate of movement of the film frames.

Accordingly, it is an object of the present invention to provide an improved telecine apparatus.

According to the present invention, there is provided a telecine apparatus, for repetitively scanning an information bearing medium having a plurality of successive image frames thereon, at a scanning station, by means of a raster comprising a plurality of lines, the apparatus comprising means for moving the information bearing medium through the station at a fixed film frame rate, in a direction transverse to the lines, means for deriving from the means for moving, a signal indicative of the scanning rate and indicative of the rate of movement of the medium the signal also being dependent on a predetermined ratio of said rates, and means for controlling the raster, as a function of the signal in a direction transverse to the lines and for spacing the lines so that, on operation of the moving means, the raster is initiated at a transverse edge of an image frame and the dimension of the raster in the direction transverse to the lines is made equal to the effective dimension of an image frame in the same direction.

The invention will be described further, by



way of example, with reference to the accompanying drawings, in which:—

Fig. 1 is a schematic illustration of one embodiment of a film scanning system for a telecine apparatus in accordance with the invention;

Fig. 2 shows wave forms for scanning a continuously moving film in the apparatus shown in Fig. 1;

Fig. 3 is a schematic illustration of an alternative disc for use in the apparatus of Fig. 1;

Fig. 4 is a schematic illustration of a sensor mask for use in conjunction with the disc of Fig. 3;

Fig. 5 is a schematic illustration in partial perspective of another embodiment of a film scanning system in accordance with the invention;

Fig. 6 shows wave forms for scanning a continuously moving film in accordance with the system shown in Fig. 5;

Fig. 7 is a schematic representation of an alternative vertical deflection circuit that may be used in the apparatus shown in Fig. 1; and

Fig. 8 is a schematic illustration in partial perspective of an alternative array of photo-sensors to those shown in Fig. 5 for use in conjunction with the circuit shown in Fig. 7.

Referring now to the drawings and firstly to Fig. 1, there is shown a flying spot scanning system according to a preferred embodiment of the invention for converting images on a motion picture film into video signals suitable or television transmission or direct application to a television receiver. The motion picture film is scanned at the 60 field per second video scanning rate that is commonly employed in the United States, while the film is moving at the frame rate at which it was exposed and would normally be projected. In order to scan each film frame by an integral number of television fields in an interlaced pattern of line scans, it is necessary to synchronize the vertical deflection of the scanning beam of the flying spot scanning device with the film frame rate. In the embodiment shown in Fig. 1, this synchronization is accomplished with the timing disc and vertical deflection circuit described hereafter.

The scanning system includes a cathode ray tube 10 having a cathode 12 that emits an electron beam 14, the strength of which is controlled by an intensity control circuit 16. A horizontal deflection yoke operates in the well known manner under the influence of a horizontal deflection circuit 18 to direct the beam 14 horizontally across the screen of the cathode ray tube 10 at a scanning frequency of 15,750 Hz. A vertical deflection yoke operates to deflect the electron beam 14 vertically in response to a complex vertical deflection wave form signal generated by vertical deflection circuit 20.

The screen of the cathode ray tube 10 preferably comprises a wide band spectral emis-

sion fluorescent material such as zinc oxide (P_{24}) phosphor which, when excited by the electron beam 14, will produce a light spot on the screen. The (P_{24}) phosphor is described on page 5—26 of Television Engineering Handbook, by Fink, published by McGraw Hill, 1957. Under the control of the horizontal and vertical deflection signals, the electron beam 14 is swept across the screen in a raster pattern of discrete spaced apart line scans to generate a scanning light beam 22.

The light beam 22 is condensed by a lens 24 and thereafter focused by lens 26 onto an image bearing medium 28 located with respect to a scanning station 30. Scanning station 30 may consist of, in the preferred embodiment of the invention an opaque film gate having an aperture therein. The aperture of the film gate has a dimension in the longitudinal direction of the film 28 which is related to the rate of movement of the film and the height of the film frames. In order to accommodate the maximum vertical deflection of the scanning light beam that can be expected, the dimension is equal to twice the longitudinal dimension of a film frame.

The image bearing medium may take the form, for example, of Super 8 color motion picture film which has been exposed in a motion picture camera and processed using known techniques. As is well known in the art, such film is manufactured with sprocket holes along one side to enable the film to be advanced a predetermined rate in the camera and exposed to record images thereon in spaced discrete frames. The standard film exposure frame rate of the prior art is nominally 18 or 24 frames per second.

The motion picture film 28 is advanced through the scanning station 30 in a downward direction by sprocket wheel 32 that is mechanically coupled in a manner well known in the art as indicated by a dotted line in Fig. 1, to an electric motor 34 and driven in the clockwise direction. Preferably the electric motor 34 is synchronized to the 60 Hz alternating current source and rotates in the clockwise direction at a constant rate. The motion picture film 28 is also engaged by a capstan 38 and a tensioning wheel 40 which cooperate to keep the film taut between themselves and the sprocket wheel 32. The supply reel 44 is braked to maintain the film taut in the scanning station. The electric motor 34 is also coupled as indicated by dotted lines to rotate take-up reel 42 in the clockwise direction to wind the film 28 from the supply reel 44 onto the take-up reel 42.

The scanning light beam 22 passes through the frame within the scanning station 30 in the raster pattern described and is modulated by the color image thereon. The modulated light beam is focused by a lens 46 and is intercepted by dichroic mirrors 48 and 50 which are effective to separate and pass the

blue, red, and green color components of the modulated light to respective photoresponsive devices 52, 54 and 56. The dichroic mirror 48 is effective to reflect the blue color component to the surface of the photoresponsive device 52 and pass the green and red color components to the surface of dichroic mirror 50. Dichroic mirror 50 is effective to transmit the green color component to photoresponsive device 56 and reflect the red color component to photoresponsive device 54. The photoresponsive devices 52, 54 and 56 translate the intensity of their respective color components into electrical signals which are applied to the video color signal processor 58 of the television transmitter or receiver.

The film 28 may also have a sound track which may be detected by an audio reproduction transducer 60 and translated into an audio signal for the audio signal processor 62 of the television transmitter or receiver.

The system hereinbefore described with respect to Fig. 1 is known in the prior art of telecine reproduction. In the past, practitioners of the art have either employed optical image deflecting apparatus interposed between the flying spot scanner and the scanning station, or inflexible vertical deflection apparatus for producing a vertical deflection signal which compensates for movement of the film frames. These prior art approaches have required the employment of highly accurate film moving mechanisms to ensure that the scanning raster is properly registered with each moving film frame. In neither approach, have the prior art practitioners provided a vertical deflection apparatus wherein the television field rate and the raster deflection rate are detected from the movement of the motion picture film and synchronized thereby. In accordance with the present invention, vertical deflection circuitry is provided that combines detected pulse trains representative of the television field rate and the raster deflection rate to produce a vertical deflection signal having a complex sawtooth wave form.

The detection apparatus of Fig. 1 comprises a disc 64 mounted to rotate with the sprocket wheel 32 (shown displaced for convenience of illustration) and having thereon, in two concentric tracks 66 and 68, indicia spaced apart at an angular spacing related to the frequency of the television field rate and the raster deflection rate, respectively, so that a predetermined ratio exists between the numbers of indicia in the two tracks. Photoresponsive devices 70 and 72 are disposed to detect and translate light transmitted from a suitable light source and mask (not shown) through transparent indicia or reflected by opaque indicia, into respective television field rate frequency and raster deflection rate pulse trains respectively.

As stated hereinbefore, the television field rate frequency is the rate at which the scan-

ning raster pattern is repeated and is 60 per second in the United States.

In order to translate the information appearing in each motion picture film frame into signals suitable for television reproduction of the image frame, it is necessary, as stated hereinbefore, to scan each film frame by an integral number of television fields in an interlaced pattern of line scans. To accomplish this objective in accordance with the preferred embodiments of the present invention, apparatus is provided to determine, in accordance with the rate of movement of the film, the proper number of television fields to scan each image frame. Referring to Fig. 2a there are shown the relative periods of 24 frames per second, motion picture film and the 60 field per second, television scanning rate. The common denominator of the $1/60$ second period and the $1/24$ second period is $1/12$ second and, as illustrated, five field scans occur in a time of two film frames ($5 \times 1/60 = 2 \times 1/24 = 1/12$). An examination of the disc 64 reveals that in the interval including two successive sprockets teeth indicated at 74 (180°), there appear two raster deflection indicia and five field rate indicia.

The raster deflection that will correctly scan the moving film consists of alternate frames of the film being scanned twice in $1/30$ second and three times in $1/20$ second for a total of five field scans in two film frames. The detected raster deflection rate pulses shown in Fig. 2c are therefore spaced apart at alternate $1/30$ and $1/20$ second periods and are in phase with the field rate pulses.

The vertical deflection circuitry 20 includes two monostable multivibrators 76 and 78 to which are applied, at their respective input terminals, the detected field rate pulse train of Fig. 2a, as derived from the photoresponsive device 70 and the detected raster deflection rate pulse train of Fig. 2a, as derived from the photoresponsive device 72. An integrator circuit including operational amplifier 80 and condenser 82 is connected at the output terminals of the monostable multivibrator circuits and is effective to produce a vertical deflection signal having the complex sawtooth wave form necessary to register the scanning raster pattern upon the moving motion picture film frames.

The representative block diagrams of the multivibrator circuits 76 and 78 have trigger

T inputs and Y and $\bar{Y}$ outputs in accordance with symbology employed by Millman and Taub in the textbook, Pulse, Digital and Switching Wave Forms published by McGraw-Hill Book Co., and in which suitable practical circuits may be found to employ the practice of the present invention. The

symbols Y and $\bar{Y}$ simply mean that an out-

put signal on Y is the complement of an output signal on $\bar{Y}$.

The monostable multivibrator circuits 76 and 78 are responsive to the positive going transistors of the detected pulse trains to produce the pulse trains of Figs. 2b and 2d, at the Y output of multivibrator 76 and at the

$\bar{Y}$ output of multivibrator 78 respectively each pulse having a constant duration t_1 equal to the retrace time between field scans of the cathode ray beam 14. The signals depicted by the wave forms of Figs. 2b and 2d are transmitted by diodes 84, 86, 88 and 90 and variable resistors R_1 , R_2 , R_3 and R_4 to the summing input terminal 100 of operational amplifier 80. Capacitor 82, connected between the summing input terminal 100 and the output terminal 102 of the operational amplifier, is effective, in cooperation with the operational amplifier, to operate as a Miller integrator to integrate the summed pulse trains.

The integrator circuit operates in the well known manner, as described, for example, at pages 458 and 462 in the book entitled Reference Data for Radio Engineers, Fourth Edition, published by International Telephone and Telegraph Co., to integrate a square wave input signal into a triangular wave output signal by means of a series RC circuit.

The sawtooth wave forms of Figs. 2e, 2f and 2g represent respectively, the response of the integrator circuit to the field rate pulse wave form of Fig. 2b, the raster deflection rate pulse wave form of Fig. 2d, and the combination of the wave forms of Figs. 2b and 2d. The wave form of Fig. 2g represents the mathematical summation of the wave forms of Figs. 2e and 2f and constitute the requisite wave form of the vertical deflection signal necessary to scan continuously moving film at 24 frames per second.

The wave form of Fig. 2e must have a maximum amplitude equal to the voltage necessary to deflect vertically the scanning raster pattern of the flying spot scanning device 10 upon a stationary film frame. The slope of the wave form of Fig. 2e is governed by the relative values of resistors R_1 and R_3 and capacitor 82. The time constant of resistor R_1 and capacitor 82 is adjusted to be equal to the retrace time t_1 . The occurrence of each pulse of the wave form of Fig. 2b charges the capacitor 82 to the maximum amplitude potential through diode 90 and resistor R_4 . The positive potential at the input terminal 100 is inverted by operational amplifier 80, and the output signal at the output terminal 102 decreases during the interval of time t_1 to a reference potential depicted as 0 in Fig. 2e. Thereafter, in the interval t_2 the capacitor 82 is discharged to the reference potential 0 of Fig. 2b through resistor R_4 and

diode 88. The operational amplifier 80 inverts the discharge signal of the capacitor 82 and the output signal at the output terminal 102 increases in voltage at a linear rate as shown in Fig. 2e. The linear rate and the maximum amplitude of the wave form of Fig. 2e is determined by adjusting the resistance R_3 to be equal to the product of

$$R_4 \times \frac{t_2}{t_1}$$

Therefore, in the absence of any raster deflection pulse signal, the integrator circuit would operate to produce a signal having the wave form of Fig. 2e.

In like manner, the time constant of resistor R_1 and capacitor 82 is adjusted, by varying the resistance of resistor R_1 , to be equal to the retrace time t_1 . However, the resistor R_2 must be adjusted to be equal to the product of

$$R_3 \frac{K}{M}$$

where K is the field rate frequency and M is the frame rate of movement. In the same manner as described above, the resistors R_2 and R_1 , the diodes 84 and 86, and the capacitor 82 cooperate to produce from the raster deflection signal having the wave form of Fig. 2d an output signal at terminal 102 having the wave form of Fig. 2f. At each occurrence of the raster deflection signal, the wave form of Fig. 2f undergoes a transition having a maximum value equal to the maximum amplitude of the wave form of Fig. 2e.

The resulting complex sawtooth wave form of Fig. 2g represents the mathematical summation by the integrator of the wave forms of Figs. 2e and 2f. The slope of the resultant wave form of Fig. 2g is automatically adjusted to compress the scanning raster pattern, i.e., to reduce the spacing between adjacent lines of each television field by an amount equal to 24/60's of the vertical dimension of a film frame. Due to its movement the film frame has an effective dimension in the direction of movement of 36/60 of the corresponding actual dimension. The movement of the film in the downward direction cooperates with the compressed scanning raster pattern to expand the pattern to scan the entire image frame during each television field.

In the event that a stationary film frame is selected for viewing by the operator, a single frame control 33, which may take the form of a mechanical clutch, is interposed between the motor 34, the sprocket wheel 32, the capstan 40, and the take-up reel 42, to withdraw the sprocket wheel from engagement with the film, whilst maintaining drive thereto

and to the disc 64, and halt the movement of the film. Furthermore, a switch 35 is provided in the output conductor of multivibrator 78 that is operated in conjunction with the control 33 to open the conductive path

between the $\bar{Y}$ terminal of multivibrator 78 and the diodes 84 and 86. The resultant vertical deflection signal would have the wave form of Fig. 2e.

In like manner a disc 64 may be prepared for any integral frame scanning rate, and the resistors R_1 — R_4 may be adjusted in the manner described to produce a vertical deflection signal having the requisite complex sawtooth wave form to scan the motion picture film moving at that frame rate. The number N of equally spaced indicia on the field rate track of the scanning disc is governed by the 60 field per second frequency K, the variable frame rate of movement M, and the number of sprocket teeth P, in the following relationship:

$$\frac{K}{M} = \frac{N}{P}$$

The number of indicia on the raster deflection track is always equal to the number of sprocket teeth since one film frame corresponds to each sprocket hole in the film. The spacing of the raster deflection indicia is governed by the requirement that the scanning raster of the flying spot scanning device 10 must be deflected in a repetitive pattern at the field rate frequency to scan each film frame an integral number of times. Therefore, the raster deflection indicia are in phase with the field rate indicia and spaced apart by integral multiples of the field rate indicia. For all film frame rates between 20 and 30 frames per second, the raster deflection indicia are spaced apart by either two or three field rate indicia. For all frame rates between 10 and 20 frames per second, the raster deflection indicia are spaced apart by an appropriate combination of three or four or five or six field rate indicia. Thus for example at the 20 frames per second rate, the raster deflection indicia are in phase with, and spaced apart by, three field rate indicia.

Referring now to Fig. 3 there is shown an alternative disc 104 suitable for use with both 24 frame per second motion picture film and 18 frame per second motion picture film. As shown, the sprocket wheel 32 has six sprocket teeth 74 thereon. Therefore, the number of field frequency indicia in track 106 and for 24 frames per second film speed is equal to:

$$\frac{60 \times 6}{24} = 15.$$

The number of raster deflection indicia in row 110 at 24 frames per second is equal to 6,

and they are spaced apart by two and three successive field rate indicia.

The number of field rate indicia in row 108 for 18 frames per second is equal to:

$$\frac{60 \times 6}{18} = 20.$$

The number of raster deflection indicia in row 112, at 18 frames per second, is equal to 6, and they are spaced apart in a pattern of three, three and four field rate indicia. Therefore, three successive image frames are scanned by three, three and four television fields, respectively.

Two pairs of photosensors, 114 and 116, are arranged to detect light emitted by a source (not shown) that passes through or is reflected by the field rate indicia of tracks 106 and 108 and the raster deflection indicia of tracks 110 and 112, respectively. The pair of photosensors 114 is electrically connected in parallel to a voltage source +V and the input terminal T of multivibrator 76. In like manner, the pair of photosensors 116 is electrically connected in parallel to the voltage source +V and the input terminal T of multivibrator 78.

The mask 117 of Fig. 4 is provided in order to allow, in accordance with the rate of film movement, the modulated light to strike one photosensor of each pair of photosensors 114, 116. Although not illustrated, the light mask is intended to be supported between, and in close proximity to, the photosensor pairs 114 and 116 and the disc 104. The mask 117 is intended to be movable, in the direction of the arrows, to mask one or the other photosensor of each pair in accordance with the desired rate of movement of the film.

Obviously, any number of tracks of raster deflection and field rate indicia, with associated masks and photocells, could be provided on such a disc.

In Figs. 5 and 6, there is shown an alternative apparatus for generating the raster deflection television field rate pulse signals from the movement of the sprocket holes of the motion picture film. At 20 frames per second, or any other rate of movement that is an integral submultiple of the 60 per second television field rate, a plurality of photosensors equal in number to the aforementioned integer are arranged equally spaced apart in the distance between the leading edges of two sprocket holes. As depicted in Fig. 5, at 20 frames per second, three photosensors 118a, 118b and 118c are arranged on a suitable substrate 120 equally spaced apart in the distance between two successive sprocket holes 122. Light source 124 and mask 126 cooperate with each sprocket hole 122 as it advances in the direction of movement of the film, indicated by the arrow, to direct light succes-

sively upon the photosensors 118a, 118b and 118c. The detection of the light by the photosensors produces the pulse signals depicted by the wave forms of Figs. 6a, 6b and 6c.

5 The pulse signals of wave forms 6a, 6b and 6c are added by OR gate 128 and applied to the input terminal T of the monostable multivibrator 76 of Fig. 1. The output signal of multivibrator 76 is shown by wave form 60d and has a frequency equal to the 60 per second television field rate.

10 The pulse signal of wave form 6a is also applied to the input terminal T of the multivibrator 78 of Fig. 1. The output signal of multivibrator 78 is shown by wave form 6e and has a frequency equal to both the 20 frame per second rate of movement and the raster deflection rate.

15 In accordance with the practice set forth hereinbefore, resistors R₁ and R₂ are adjusted to reflect the period t₁; resistor R₃ is adjusted to reflect the period t₂; and resistor R₄ is adjusted to reflect the period equal to:

$$\frac{Kt_2}{M} = \frac{60t_2}{20} = 3t_2$$

25 The resulting sawtooth wave forms a, b and c are depicted in superimposition in Fig. 6f. The raster deflection signal having the wave form c is the sum of the detected raster deflection sawtooth wave form signal b and the detected television field rate sawtooth wave form signal a.

30 Referring now to Fig. 7 there is shown an alternative embodiment of the vertical deflection circuit 20 of Fig. 1. In Fig. 1 monostable multivibrators are responsive to the positive transitions of the detected pulse signals to produce further pulse signals having a duration t₁ equal to the vertical retrace time of the flying spot scanning device. The circuit of Fig. 7, however, employs bistable multivibrators 76' and 78' having set S and reset R input terminals. The positive transitions of a signal applied to either input terminal will determine the bistable state of the multivibrators 76' and 78'. The use of bistable multivibrators therefor necessitates the employment of a pair of photosensors in place of each single photosensor of Figs. 1, 3 and 5. The photosensors of a pair furthermore must be spaced apart by a distance, with respect to the frame rate of movement of the film, that will provide a time period between the respective pair of impulses generated thereby equal to the vertical retrace time t₁ of the flying spot scanning device.

55 Referring to Fig. 8, there is shown an array of photosensor pairs 130, 132, and 134 arranged on a substrate 120' in the manner described with reference to the embodiment of Fig. 5. The photosensor pair 130, for example, replaces photosensor 118a of Fig. 5

and consists of a leading (in the direction of film movement depicted in Fig. 5) and a lagging photosensor. The leading and lagging photosensors of each pair are spaced apart by a distance that, when traversed by a sprocket hole or indicia 122 of the film 28 at 20 frames per second, results in the production of a pair of impulses spaced apart in time by the retrace time period t₁. The leading impulses generated by the leading photosensors of the pairs are added by OR gate 136 and passed to the set S input terminal of bistable multivibrator 76'. The lagging impulses generated by the lagging photosensors of the pairs are added by OR gate 138 and passed to the reset R input terminal of the bistable multivibrator 76'. The leading and lagging impulses generated by the leading and lagging photosensors of the photosensor pair 130 are applied to the reset R and set S input terminals of bistable multivibrator 78'. The resulting wave forms and operation of the circuit of Fig. 7 is identical to those described with respect to Figs. 5 and 6.

With respect to Fig. 1, the photosensors 70 and 72 would have to be replaced by pairs 70' and 72' of photosensors each pair being physically arranged in parallel along its associated track on the disc 64. The output signal of the leading (in the direction of rotation of the disc) photosensor of each pair would be applied to the set S input of multivibrator 76'. The output signal of the lagging photosensor of each pair would be applied to the reset R input of the multivibrators 76'.

From the description set forth above, it will be apparent that the invention can be practised in many alternative ways. For example, the invention may be practised in many alternative ways. For example, the invention may be practised in substantially the same manner as disclosed in the preferred, embodiments at the European, 50 per second, television field rate or any other standard field rate.

Also, it will be apparent that the rate of movement of the motion picture film or other image bearing media may be detected from indicia, instead of the sprocket holes, recorded on the media.

Furthermore, it will be apparent that the indicia on the rotating disk may be opaque or transparent to light and may consist of slits in an opaque disk.

As may be seen, a system has been disclosed for transforming the images and sound track of an ordinary, inexpensive motion picture film into respective video and audio signals for television transmission or direct connection to the antenna terminals of the conventional television receiver. The system is compatible with professional and amateur motion picture films, both black and white and color, and with and without sound tracks.

In summary it will be readily apparent that by virtue of the novel arrangements disclosed whereby the vertical deflection circuit is directly controlled by the detected film frame rate and raster deflection rate, the deflection of the scanning beam is readily effected in exact synchronism with the film movement. The vertical deflection disclosed is adaptable to a wide range of film frame rates and compensates for minor fluctuations in the spacing between film frames or the frame rate itself since the television field rate is detected from the actual rate of movement of the film.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the scope of the invention as defined in the appended claims.

20 WHAT WE CLAIM IS:—

1. A telecine apparatus, for repetitively scanning an information bearing medium having a plurality of successive image frames thereon, at a scanning station, by means of a raster comprising a plurality of lines, the apparatus comprising means for moving the information bearing medium through the station at a fixed film frame rate, in a direction transverse to the lines, means for deriving from the means for moving, a signal indicative of the scanning rate and indicative of the rate of movement of the medium the signal also being dependent on a predetermined ratio of said rates, and means for controlling the raster, as a function of the signal in a direction transverse to the lines and for spacing the lines so that, on operation of the moving means, the raster is initiated at a transverse edge of an image frame and the dimension of the raster in the direction transverse to the lines is made equal to the effective dimension of an image frame in the same direction.

2. An apparatus as claimed in Claim 1 wherein the controlling means is arranged to deflect the raster such that predetermined sequential image frames are each scanned an integral number of times.

3. An apparatus as claimed in Claim 1 or 2 wherein the information bearing medium comprises motion picture film.

4. An apparatus as claimed in Claim 3 wherein the motion picture film has a sprocket hole associated with each image frame, there being means for directing radiation in a path intercepted by the sprocket holes, and photoresponsive means positioned with respect to the sprocket holes to detect the radiation modulated by the sprocket holes, whereby a signal indicative of the rate of movement of the medium is generated.

5. An apparatus as claimed in Claim 4 wherein the photoresponsive means comprises a plurality of photosensors equally spaced one from the other at a distance not greater

than the distance between adjacent sprocket holes of the motion picture film. 65

6. An apparatus as claimed in Claim 5 wherein the scanning rate is an integral multiple of the motion picture film frame rate and wherein the number of photosensors is equal to the quotient of the scanning rate and the motion picture film frame rate. 70

7. An apparatus as claimed in Claim 3 wherein the motion picture film has sprocket holes, and the moving means comprises a rotating sprocket wheel arranged to engage the sprocket holes of the motion picture film, first and second detecting means comprising a disc arranged to rotate with the sprocket wheel and having repetitive indicia disposed in concentric tracks on the disc, the predetermined ratio being the ratio of the indicia in the respective tracks, means for directing radiation in a path intercepted by the indicia on the disc, and photoresponsive means positioned with respect to the concentric tracks of the indicia to detect the radiation modulated by the indicia. 75 80 85

8. An apparatus as claimed in Claim 7 wherein there are P projections on the sprocket wheel arranged to engage the sprocket holes of the motion picture film, the motion picture film frame rate is M, and the scanning rate is K, and wherein the indicia are disposed in first and second concentric tracks on the surface of the disc, the indicia in the first track being equally spaced apart and of a number N equal to the produce of $P \times K/M$, and the number of indicia disposed in said second track being equal to the number P, the indicia in the second track being disposed in phase with selected indicia of the first track. 90 95 100

9. An apparatus as claimed in Claim 7 or 8 wherein the disc is opaque to the radiation and the indicia comprise slits in the disc through which the radiation is transmitted, the photoresponsive means being disposed to intercept the radiation transmitted through the slits. 105

10. An apparatus as claimed in any preceding Claim wherein the deriving means comprises an integrating circuit which has a summing input terminal and an output terminal, and a first and second pair of oppositely-directed unidirectionally conducting elements each connected to the summing input terminal, the pairs of elements receiving respectively signals indicative of the scanning and image frame rates. 110 115

11. An apparatus as claimed in any preceding Claim wherein the means for moving the information bearing medium is operative in a first mode at the image frame rate and is operative in a second mode for locating a single image frame in stationary relationship with respect to the scanning station. 120 125

12. A telecine apparatus substantially as hereinbefore described with reference to and as illustrated in Figs. 1 and 2, or Figs. 1 and 2



In summary it will be readily apparent that by virtue of the novel arrangements disclosed whereby the vertical deflection circuit is directly controlled by the detected film frame rate and raster deflection rate, the deflection of the scanning beam is readily effected in exact synchronism with the film movement. The vertical deflection disclosed is adaptable to a wide range of film frame rates and compensates for minor fluctuations in the spacing between film frames or the frame rate itself since the television field rate is detected from the actual rate of movement of the film.

The invention has been described in detail with particular reference to preferred embodiments thereof, but it will be understood that variations and modifications can be effected within the scope of the invention as defined in the appended claims.

WHAT WE CLAIM IS:—

1. A telecine apparatus, for repetitively scanning an information bearing medium having a plurality of successive image frames thereon, at a scanning station, by means of a raster comprising a plurality of lines, the apparatus comprising means for moving the information bearing medium through the station at a fixed film frame rate, in a direction transverse to the lines, means for deriving from the means for moving, a signal indicative of the scanning rate and indicative of the rate of movement of the medium the signal also being dependent on a predetermined ratio of said rates, and means for controlling the raster, as a function of the signal in a direction transverse to the lines and for spacing the lines so that, on operation of the moving means, the raster is initiated at a transverse edge of an image frame and the dimension of the raster in the direction transverse to the lines is made equal to the effective dimension of an image frame in the same direction.

2. An apparatus as claimed in Claim 1 wherein the controlling means is arranged to deflect the raster such that predetermined sequential image frames are each scanned an integral number of times.

3. An apparatus as claimed in Claim 1 or 2 wherein the information bearing medium comprises motion picture film.

4. An apparatus as claimed in Claim 3 wherein the motion picture film has a sprocket hole associated with each image frame, there being means for directing radiation in a path intercepted by the sprocket holes, and photoresponsive means positioned with respect to the sprocket holes to detect the radiation modulated by the sprocket holes, whereby a signal indicative of the rate of movement of the medium is generated.

5. An apparatus as claimed in Claim 4 wherein the photoresponsive means comprises a plurality of photosensors equally spaced one from the other at a distance not greater

than the distance between adjacent sprocket holes of the motion picture film.

6. An apparatus as claimed in Claim 5 wherein the scanning rate is an integral multiple of the motion picture film frame rate and wherein the number of photosensors is equal to the quotient of the scanning rate and the motion picture film frame rate.

7. An apparatus as claimed in Claim 3 wherein the motion picture film has sprocket holes, and the moving means comprises a rotating sprocket wheel arranged to engage the sprocket holes of the motion picture film, first and second detecting means comprising a disc arranged to rotate with the sprocket wheel and having repetitive indicia disposed in concentric tracks on the disc, the predetermined ratio being the ratio of the indicia in the respective tracks, means for directing radiation in a path intercepted by the indicia on the disc, and photoresponsive means positioned with respect to the concentric tracks of the indicia to detect the radiation modulated by the indicia.

8. An apparatus as claimed in Claim 7 wherein there are P projections on the sprocket wheel arranged to engage the sprocket holes of the motion picture film, the motion picture film frame rate is M, and the scanning rate is K, and wherein the indicia are disposed in first and second concentric tracks on the surface of the disc, the indicia in the first track being equally spaced apart and of a number N equal to the produce of $P \times K / M$, and the number of indicia disposed in said second track being equal to the number P, the indicia in the second track being disposed in phase with selected indicia of the first track.

9. An apparatus as claimed in Claim 7 or 8 wherein the disc is opaque to the radiation and the indicia comprise slits in the disc through which the radiation is transmitted, the photoresponsive means being disposed to intercept the radiation transmitted through the slits.

10. An apparatus as claimed in any preceding Claim wherein the deriving means comprises an integrating circuit which has a summing input terminal and an output terminal, and a first and second pair of oppositely-directed unidirectionally conducting elements each connected to the summing input terminal, the pairs of elements receiving respectively signals indicative of the scanning and image frame rates.

11. An apparatus as claimed in any preceding Claim wherein the means for moving the information bearing medium is operative in a first mode at the image frame rate and is operative in a second mode for locating a single image frame in stationary relationship with respect to the scanning station.

12. A telecine apparatus substantially as hereinbefore described with reference to and as illustrated in Figs. 1 and 2, or Figs. 1 and 2

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as modified by Figs. 3 and 4, or Figs. 7 and 8, or Figs. 5 and 6, of the accompanying drawings.

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