

PATENT SPECIFICATION

(11) 1378252

1378252

- (21) Application No. 1463/72 (22) Filed 12 Jan. 1972
 (31) Convention Application No. 107200 (32) Filed 18 Jan. 1971 in
 (33) United States of America (US)
 (44) Complete Specification published 27 Dec. 1974
 (51) International Classification H04N 3/16 5/36 5/86//H03B 3/08
 (52) Index at acceptance

H4F D12K1 D27E D53C D54 D57 D60 D62M1 D65
 D70G2 D70P D82S2 D83X
 H3A C11X C16 L2DX LX P

- (72) Inventors CARL NELSON SCHAUFFELE and
 LENARD M. METZGER



(54) APPARATUS FOR SCANNING INFORMATION BEARING MEDIA

(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 apparatus for scanning the frames of continuously moving information bearing media in a television field pattern consisting of a plurality of spaced horizontal line scans, and more particularly, to generating a horizontal sweep signal in response to the rate of movement of the continuously moving information bearing media.

In telecine transmission systems, flying spot scanners have been used to scan the frames of 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 a photosensor. The transmitted video signal representative of the image frames of the motion picture film controls the electron beam of the television receiver tuned to the transmitting station to reproduce the motion picture film frame on the television screen.

Currently standardized television broadcast systems in the United States all employ 2:1 interlace; that is, each frame of video information is displayed in two successive fields. The first field in each frame consists of 262½ odd horizontal scanning lines, and the second field in each frame consists of the remaining 262½ even horizontal scanning lines. The fields are repeated at a rate of 60 per second for black and white transmission and 59.94 per second for colour transmission. To generate and maintain 2:1 interlace, the field rate (vertical sweep frequency) must be phase

locked to the odd integral submultiple of twice the horizontal line sweep frequency. In practice, phase-locked vertical and horizontal synchronization signals are usually generated by frequency division from the same oscillator.

In telcine transmission systems wherein flying spot scanners have been employed to scan the frames of a continuously moving motion picture film with a beam of light in the standard interlaced scanning raster pattern described above, it has been found necessary to deflect the scanning beam a variable amount in the direction of movement of the film at the beginning of each frame in synchronism with the rate of movement of the film. In our copending Application 36407/71 (Serial No. 1,322,615), it is proposed to detect the television field rate from indicia disposed on a disc adapted to rotate with the sprocket wheel of the motion picture film drive. Since the television field rate and raster deflection rate are derived from the actual rate of movement of the motion picture film, there may be difficulty in using an oscillator to generate the horizontal synchronization signals that are employed to trigger the horizontal sweep circuitry of the flying spot scanner.

As the standard horizontal sweep frequency employed in television is 15,750 Hz, it may be difficult to provide the number of indicia on a track of the disc rotating with the sprocket wheel of the motion picture film drive that are necessary to generate horizontal sync signals at the horizontal sweep frequency. Such a method of sync signal generation would require a relatively large and/or high speed disc in order to produce horizontal sync signals of sufficient accuracy.

Accordingly, it is an object of the present invention to provide an apparatus for scanning frames of a continuously moving information bearing media wherein accurate horizontal sweep signals for the flying spot scanner are provided from the rate of movement of the motion picture film.

In accordance with the present invention

there is provided apparatus for scanning continuously moving information bearing media with repeating line scansions, the apparatus comprising means driven in synchronism with the movement of the media for generating a first signal having a frequency substantially equal to an integral submultiple of a predetermined sweep frequency, means for producing a sweep signal of substantially the predetermined sweep frequency, and frequency control means responsive to the first signal and to the sweep signal for controlling the predetermined sweep frequency.

The invention also provides apparatus for scanning the frames of a continuously moving motion picture film in a television field pattern including a plurality of spaced horizontal line scansions, the apparatus comprising a disc adapted to rotate at a rate related to the rate of movement of the motion picture film and having indicia disposed thereon in a track, means located adjacent the track for detecting the movement of the indicia and generating a first signal having a frequency substantially equal to an integral submultiple of a predetermined horizontal sweep frequency, and means for producing a horizontal sweep signal having the predetermined horizontal sweep frequency comprising means for changing the predetermined horizontal sweep frequency of the horizontal sweep signal to produce a second signal, phase detector means having a first input terminal adapted to receive the first signal and a second input terminal adapted to receive the second signal, the phase detector means being responsive to a phase difference between the frequencies of the first signal and the second signal for producing a phase difference signal at an output terminal thereof, integrating means adapted to receive the phase difference signal from the output terminal of the phase detector means for integrating the phase difference signal to produce a third signal having a variable DC voltage amplitude, and voltage controlled oscillator means having an input terminal adapted to receive the third signal, the oscillator means being responsive to the third signal for generating the horizontal sweep signal at a horizontal sweep frequency dependent upon the DC voltage amplitude of the third signal.

The invention will be described further, by way of example, with reference to the accompanying drawings in which:

Figure 1 is a schematic illustration of one embodiment of a circuit for generating a horizontal sweep signal from the detected rate of movement of a motion picture film drive;

Figure 2 is a schematic illustration of a further embodiment of a circuit for generating a horizontal sweep signal from the detected rate of movement of a motion picture film drive; and

Figures 3a-3d are views showing the wave

forms of various signals developed at particular points in the circuit diagram of Figure 2.

Referring now to the drawings and firstly to Figure 1, as one preferred embodiment of the invention, there is shown a circuit responsive to indicia on a disc adapted to rotate with the drive means of a moving motion picture film in the manner shown, for example in the aforementioned copending patent application No. 36407/71 (Serial No. 1,322,615), for producing a horizontal sweep signal that is related in phase to a vertical sweep signal so that successive television fields produced by the horizontal and vertical sweep signals are interlaced. In the aforementioned copending patent application, there is shown a flying spot scanning system for converting images on a motion picture film into video signals suitable for 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 identical to the black and white television field rate and within allowable tolerances of the standard colour television field rate that are commonly employed in the United States. The film is moved continuously 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 horizontal line scans, there is shown therein a timing disc and vertical deflection circuit that is operative to synchronize the vertical deflection of a scanning beam of the flying spot scanner with the film frame rate.

Referring now to Figure 1 of the present invention, there is shown a timing disc 10 similar to that employed in the aforementioned copending Application No. 36407/71 (Serial No. 1,322,615). The timing disc 10 is mounted on the sprocket wheel 12 of the motion picture film drive (not shown) and is adapted to rotate at the rate of movement of the motion picture film image frames through the scanning station of the flying spot scanner (not shown). The sprocket wheel 12 has four equally displaced projections 14 which engage the sprocket holes of the motion picture film. Since motion picture film with sound is projected at a rate of 24 frames per second and there are four projections 14, the disc 10 is adapted rotate at the rate of

$$\frac{24}{4} = 6$$

revolutions per second. The disc 10 has thereon, in two concentric tracks 16 and 18, indicia spaced apart in the identical manner as disclosed in the aforementioned copending patent application, that are effective in cooperation with photosensors 20 and 22, respectively, sensitive to a light source (not shown) modulated by the indicia to produce

raster deflection rate signals and television field rate signals at the terminals 24 and 26, respectively. At a rate of rotation of six revolutions per second, the television field rate signal has a frequency equal to 60 Hz, and the raster deflection rate signal has an irregular period related to the rate of movement of the motion picture film. The employment of the raster deflection rate signal and the television field rate signal to produce a vertical deflection signal for the flying spot scanner that has a complex wave form sufficient to track the continuously moving image frames of the motion picture film is shown in detail in the aforementioned copending Application No. 36407/71 (Serial No. 1,322,615) and forms no part of the present invention, and further reference thereto is considered unnecessary to the understanding of the present invention.

The frequency of the horizontal sweep signal F_h applied to the horizontal deflection circuits of the flying spot scanner is selected to be 15,750 Hz which is identical to the standard horizontal sweep signal employed in the United States for transmission of black and white video signals. The 15,750 Hz horizontal sweep signal reduces to $262\frac{1}{2}$ cycles of the horizontal sweep signal for each occurrence of the 60 Hz vertical sweep signal. A conceptually straightforward procedure for providing the 15,750 Hz horizontal sweep signal F_h in synchronism with a disc produced 60 Hz vertical sweep signal would be to provide in the track 28 of disc 10,

$$\frac{15,750}{6}$$

or 2625 indicia. However, the production of such a large number of indicia on a relative small disc may be difficult and expensive, and the finely spaced indicia may be difficult to detect by the photosensors.

In accordance with the teachings of the present invention, a third track 28 of indicia is added to the disc 10. Track 28 includes 125 equally spaced indicia, $12\frac{1}{2}$ indicia being disposed between each successive indicia in track 18. These indicia are detected by photosensor 30 which is effective, in cooperation with the light source and with the rotation of the disc 10 at 6 revolutions per second, to produce a 750 Hz sync signal

$$\frac{F_h}{N}$$

(where N is an integer, in this case equal to

$$\frac{F_h}{750}$$

or 21) at output terminal 32.

The requirement of the large number of finely spaced indicia is avoided by the provision, in accordance with the embodiment of the present invention shown in Figure 1, of a voltage controlled horizontal oscillator with automatic frequency control similar to the automatic frequency control circuits of modern television receiver horizontal oscillators. As shown in Figure 1, the 750 Hz sync signal

$$\frac{F_h}{N}$$

is applied at one input terminal 34 of a phase detector circuit 36. The phase detector circuit 36 is connected at its output terminal by conductor 38 to the input terminal of a low pass filter 40. The phase detector 36 is operative as described hereinafter to produce a variable DC voltage having an amplitude dependent upon the phase relationship of the signals applied at its input terminals, and the low pass filter 40 is operative to integrate the variable DC voltage over a suitable time period to provide at its output terminal a fairly stable DC voltage control signal. The DC voltage control signal is applied by conductor 42 to the input terminal of a voltage controlled horizontal oscillator 44. The frequency of oscillation of the voltage controlled horizontal oscillator 44 is dependent upon the DC voltage level of the voltage control signal applied at its input terminal. As stated hereinbefore, the desired frequency of oscillation of the horizontal oscillator 44 is 15,750 Hz, the standard horizontal sweep signal frequency.

Advantage is taken of the "fly wheel" effect of automatic frequency control to regulate the frequency of the horizontal sweep signal F_h produced at the output terminal 46 of the voltage controlled horizontal oscillator 44. The automatic frequency control consists of the frequency division circuit 48, the phase detector 36 and the low pass filter 40. The horizontal sweep signal F_h is applied to the input terminal of the frequency division circuit 48 which is operative to divide the frequency of the horizontal sweep signal by N, which in this instance equals 21, to produce a 750 Hz AFC signal

$$\frac{F_h'}{N}$$

which is applied to a second input terminal 50 of the phase detector 36. The phase detector circuit 36 is operative to produce the variable DC voltage level signal at its output terminal in accordance with the degree of phase coincidence of the 750 Hz sync signal

$$\frac{F_h}{N}$$

and a 750 Hz AFC signal

$$\frac{F_h'}{N}$$

Thus, for example, if the signals

$$\frac{F_h}{N}$$

and

$$\frac{F_h'}{N}$$

are in phase or in exact coincidence, the DC voltage level of the output signal of the phase detector 36 is selected to be equal to the voltage level sufficient, when applied by low pass filter 40 to the input terminal of a horizontal oscillator 44, to establish a frequency of oscillation of 15,750 Hz. If, however, the 750 Hz AFC signal

$$\frac{F_h'}{N}$$

lags or leads the 750 Hz sync signal

$$\frac{F_h}{N}$$

the DC voltage level of the output signal of the phase detector 36 will change from the level sufficient to control the oscillation of the voltage controlled horizontal oscillator 44 at 15,750 Hz. Thus, if the signal

$$\frac{F_h'}{N}$$

lags the signal

$$\frac{F_h}{N}$$

the DC voltage of the output signal of the phase detector 36 changes in the direction sufficient to increase the frequency of oscillation of the horizontal oscillator 44. Conversely, if the signal

$$\frac{F_h'}{N}$$

leads the signal

$$\frac{F_h}{N}$$

in phase, the DC voltage level of the output signal of the phase detector 36 changes in a direction sufficient to decrease the frequency of the voltage controlled horizontal oscillator 44. The low pass filter 40 interposed between the phase detector 36 and the voltage controlled horizontal oscillator 44 is operative to integrate the DC voltage levels of the output signals of the phase detector 36 over several cycles of the 750 Hz signals

$$\frac{F_h}{N}$$

and

$$\frac{F_h'}{N}$$

to reduce transient in the input circuit of the voltage controlled horizontal oscillator 44 and to prevent continual changes in the frequency of oscillation of the voltage controlled horizontal oscillator 44 in response to minute differences in the DC levels of the output signal of the phase detector 36.

The phase detector 36, low pass filter 40, and voltage controlled horizontal oscillator 44 all operate in the well-known manner, as described, for example, in the book entitled *Television Engineering Handbook*, by Fink, published by McGraw-Hill Inc.

Advantageously a low pass filter may be included in the frequency division circuit 48, to remove all harmonics of the sweep frequency.

If the frequency of the sync signal

$$\frac{F_h}{N}$$

detected from the disc 10 is greater than about 1/10th the frequency of the horizontal sweep signal F_h , i.e., if N is less than 10, the circuit may be designed to phase lock the horizontal oscillator 44 to the sync signal

$$\frac{F_h}{N}$$

with no frequency division interposed between the output terminal of the horizontal oscillator 44 and the input terminal 50 of the phase detector 36. This system is shown schematically in the circuit diagram of Figure 2.

The disc 10 of Figure 2 rotates at 6 revolutions per second and is identical to the disc 10 of Figure 1, except for the provision of

37.5 indicia in the track 28' between each indicia of track 18, for a total number of 375 indicia in track 28'. The photosensor 30 detects the indicia and produces a 2250 Hz sync signal

$$\frac{F_h}{N}$$

at output terminal 32. It will be noted that the frequency of the sync signal

$$\frac{F_h}{N}$$

10 is 1/7th the frequency of the horizontal sweep signal F_h i.e., $N=7$.

The wave form diagram of Figure 3a depicts the successive occurrences of each pulse of the sync signal

$$\frac{F_h}{N}$$

15

applied at the input terminal 34 of the phase detector 36. The wave form diagram of Figure 3b depicts the horizontal sweep signal F_h in the desired phase relationship with respect to the sync signal to maintain the desired frequency of 15,750 Hz. It will be noted that the sync signal

$$\frac{F_h}{N}$$

25 is depicted in Figure 3a as a square wave form having abrupt rise and fall times and that the horizontal sweep signal F_h is depicted in Figure 3b as a sawtooth wave form having a relatively long rise time and an abrupt fall time. The waveforms of Figures 3a and 3b are depicted in the aforementioned desired phase relationship, but it should be understood that the relative magnitudes and durations of the wave forms may not be in scale.

35 The phase detector 36 may be designed to produce a DC voltage signal at its output terminal having an amplitude equal to the amplitude of the horizontal sweep signal F_h at the instantaneous occurrence of the sync signal

$$\frac{F_h}{N}$$

40

As illustrated by the dotted lines between the wave forms of Figures 3a and 3b, the sync signal

$$\frac{F_h}{N}$$

45 samples the amplitude of the horizontal sweep signal F_h at point 52 during the fall time of each respective signal. When the output signal of the phase detector 36 remains at a predetermined voltage amplitude, e.g. point 52 on the wave form of the horizontal sweep signal F_h , the voltage controlled horizontal oscillator oscillates at the desired frequency of 15,750 Hz and produces the horizontal sweep signal F_h in the phase relationship depicted in Figures 3a and 3b.

45

50

55

The phase detector 36 responds to a change in the phase relationship between the horizontal sweep signal F_h and the sync signal

$$\frac{F_h}{N}$$

to increase or decrease the frequency of oscillation of the voltage controlled horizontal oscillator 44 to return the respective signals to the proper phase relationship. For example, if the horizontal sweep signal F_h lags the sync signal

60

65

$$\frac{F_h}{N}$$

by less than one half cycle, the wave form of the horizontal sweep signal F_h is sampled at a point, e.g. point 54, that is greater in amplitude than the point 52, and the amplitude of the output signal tends to increase. As the voltage level applied to the input terminal 42 of the voltage controlled horizontal oscillator 44 increases over a number of cycles, the oscillator is designed to respond by increasing its frequency of oscillation. Conversely, if the horizontal sweep signal F_h leads the sync signal

70

75

$$\frac{F_h}{N}$$

by less than one half cycle, the voltage amplitude of the output signal applied to the input terminal 42 tends to decrease, and the voltage controlled horizontal oscillator 44 responds thereto to decrease its frequency of oscillation.

80

85

A problem that may arise from the operation of the circuit of Figure 2 as described so far resides in the fact that the phase detector 36 may produce an output signal of the predetermined amplitude of point 52 when the horizontal sweep signal F_h lags or leads the sync signal

90

$$\frac{F_h}{N}$$

by one or more integral cycles. Stated another way, the phase detector may lock into the sixth or eighth multiple of the sync signal

$$\frac{F_h}{N}$$

- 5 i.e., N may become 6 or 8, respectively, instead of 7. To prevent such erroneous lock-in of the phase detector 36, the operating range of the voltage controlled horizontal oscillator 44 may be limited to

$$10 \quad \frac{N - \frac{1}{2}}{N} \times 15,750 \text{ Hz}$$

and

$$\frac{N + \frac{1}{2}}{N} \times 15,750 \text{ Hz}$$

- 15 where N is, in this illustrated example, equal to 7. This may be accomplished by limiting the control voltage applied to the input terminal 42 to a predetermined range or by designing the oscillator to respond to a limited range of the control voltage.

- 20 Even with the range of the horizontal oscillator 44 so limited, harmonics present in the horizontal sweep signal can still cause improper phase lock of the phase detector 36. Integral harmonics of the sync signal

$$\frac{F_h}{N}$$

- 25 and integral or non-integral harmonics of the frequencies within the range

$$\frac{N - \frac{1}{2}}{N} \times F_h$$

to

$$\frac{N + \frac{1}{2}}{N} \times F_h$$

- 30 may cause erroneous lock-in Figure 3c is illustrative of the example wherein the circuit stabilizes at $N = 6\frac{1}{2}$, and the frequency of oscillation of the horizontal sweep signal F_h stabilizes at $6\frac{1}{2} \times 2250$ or 14,625. This stabilization occurs because the second harmonic of the 14,625 Hz signal depicted as 56 in the wave form of Figure 3c has a peak voltage that is nearly equal to the predetermined voltage amplitude of point 52 of Figure 3b.
- 40 The wave form of Figure 3c sampled by the sync signal

$$\frac{F_h}{N}$$

results in an output signal of the phase detector 36 having a DC voltage amplitude that is within the operating range of the voltage controlled horizontal oscillator 44 as limited hereinbefore.

In order to prevent such erroneous lock-in of the phase detector 36 to harmonics of the sync signal

$$\frac{F_h}{N}$$

and the horizontal sweep signal F_h , a low pass filter 58 is inserted into the feedback circuit between the output terminal 46 of the voltage controlled horizontal oscillator 44 and the input terminal 50 of the phase detector 36 that is tuned to filter out frequencies above the 15,750 Hz desired frequency, thus eliminating harmonics of any frequencies within the limited operating range of the voltage controlled horizontal oscillator 44. The resulting filtered signal F_h' is depicted in Figure 3d, and as shown it contains no ambiguous voltage peaks which may be locked in by the phase detector 36.

It is apparent that proper limitation on the operating range of the voltage controlled horizontal oscillator 44, and the addition of a low pass filter 58 is effective to regulate the frequency of the horizontal sweep signal without requiring a frequency dividing circuit. It is also apparent from the teachings of the present invention that a circuit may be designed to translate any sync signal

$$\frac{F_h}{N}$$

detected from the rate of movement of the motion picture film, and having a frequency less than the desired frequency of the horizontal sweep signal F_h , into a frequency regulated horizontal sweep signal. Furthermore, it is apparent that the circuits disclosed may be made compatible to alternatively designed phase detectors that are well known in the art.

From the description of the preferred embodiment set forth above, it is apparent that the invention can be practiced in many alternative ways. The invention may be practiced in substantially the same manner as disclosed in the preferred embodiments at the European 50 Hz television field rate frequency or any other standard field rate frequency.

Also, it is apparent that the number and spacing of the indicia on the rotating disc may be varied in accordance with the teachings of

the present invention to accommodate any rate of disc rotation necessitated by different film frame rates and/or sprocket wheels rotating at different rates.

- 5 Furthermore, it is apparent that the indicia located on the tracks on the rotating disc may be opaque or transparent to light and may consist of slits in an opaque disc or light absorbing or reflecting ink on an opaque
10 or transparent disc, or indicia may be embossed on the tracks and electromechanically sensed. It is also apparent also that many other means of generating a sync signal

$$\frac{F_h}{N}$$

$$N$$

- 15 from the rate of movement of the motion picture film may be contemplated.

As may be seen a system has been disclosed for producing a horizontal sweep signal for controlling the horizontal deflection of
20 each line scan of a flying spot scanner employed in the transformation of images of an ordinary inexpensive motion picture film into video signals for television transmission or direct connection to the antenna terminals of
25 a conventional television receiver. The number and spacing of the indicia that are detected to produce the sync signal with respect to the number and spacing of the indicia that are detected to produce the vertical sync
30 signal automatically provides for 2:1 interlace of successive scanning fields of the flying spot scanner.

In summary, it will be readily apparent by virtue of the arrangement disclosed whereby
35 the vertical deflection signal, the horizontal sweep signal and the raster deflection signal are all detected in synchronism from the moving motion picture film, the deflection of the scanning beam of the flying spot scanner is
40 readily effected in exact synchronism with the film movement.

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

WHAT WE CLAIM IS:—

- 50 1. Apparatus for scanning continuously moving information bearing media with repeating line scansions, the apparatus comprising means driven in synchronism with the movement of the media for generating a first
55 signal having a frequency substantially equal to an integral submultiple of a predetermined sweep frequency, means for producing a sweep signal of substantially the predetermined sweep frequency, and frequency control means responsive to the first signal and to the sweep

signal for controlling the predetermined sweep frequency. 60

2. An apparatus as claimed in Claim 1 wherein the first signal generating means comprises a disc adapted to rotate at a predetermined rate related to the rate of movement of
65 the information bearing media and having indicia disposed thereon in a track, and means located adjacent to the track for detecting the movement of the indicia and for generating the first signal in response thereto. 70

3. An apparatus as claimed in Claim 1 or 2 further including means for changing the frequency of the sweep signal to produce a second signal having a second frequency, the frequency control means being adapted to receive the first signal and the second
75 signal and being responsive to a predetermined relationship in the frequencies of the first signal and second signal for producing a third signal having a parameter dependent upon the relationship, and oscillator means responsive to the third
80 signal for generating the sweep signal and for controlling the sweep frequency thereof.

4. An apparatus as claimed in Claim 3 wherein the second signal producing means comprises means for dividing the frequency of the sweep signal to produce a second signal having a frequency substantially equal to the
85 frequency of the first signal. 90

5. An apparatus as claimed in Claim 3, or 4 wherein the third signal producing means is responsive to the phase difference between the frequencies of the first signal and the second signal for producing a phase difference
95 signal, and the third signal producing means further comprises means for integrating the phase difference signal to produce the third signal. 100

6. An apparatus as claimed in Claim 3, 4, or 5 wherein the third signal is a variable DC voltage signal and the sweep signal generating means comprises a voltage controlled oscillator that oscillates at a sweep frequency dependent upon an amplitude of the DC voltage
105 signal. 110

7. Apparatus for scanning the frames of a continuously moving motion picture film in a television field pattern including a plurality of spaced horizontal line scansions, the apparatus comprising a disc adapted to rotate at a rate related to the rate of movement of the motion picture film and having indicia disposed thereon in a track, means located adjacent the track for detecting the movement of
115 the indicia and generating a first signal having a frequency substantially equal to an integral submultiple of a predetermined horizontal sweep frequency, and means for producing a horizontal sweep signal having the predetermined horizontal sweep frequency comprising
120 means for changing the predetermined horizontal sweep frequency of the horizontal sweep signal to produce a second signal, phase de-



* C L M S *

1,378,252

7

the present invention to accommodate any rate of disc rotation necessitated by different film frame rates and/or sprocket wheels rotating at different rates.

5 Furthermore, it is apparent that the indicia located on the tracks on the rotating disc may be opaque or transparent to light and may consist of slits in an opaque disc or light absorbing or reflecting ink on an opaque or transparent disc, or indicia may be embossed on the tracks and electromechanically sensed. It is also apparent also that many other means of generating a sync signal

$$F_h$$

$$N$$

15 from the rate of movement of the motion picture film may be contemplated.

As may be seen a system has been disclosed for producing a horizontal sweep signal for controlling the horizontal deflection of each line scan of a flying spot scanner employed in the transformation of images of an ordinary inexpensive motion picture film into video signals for television transmission or direct connection to the antenna terminals of a conventional television receiver. The number and spacing of the indicia that are detected to produce the sync signal with respect to the number and spacing of the indicia that are detected to produce the vertical sync signal automatically provides for 2:1 interlace of successive scanning fields of the flying spot scanner.

In summary, it will be readily apparent by virtue of the arrangement disclosed whereby the vertical deflection signal, the horizontal sweep signal and the raster deflection signal are all detected in synchronism from the moving motion picture film, the deflection of the scanning beam of the flying spot scanner is readily effected in exact synchronism with the film movement.

The invention has been described in detail with particular reference to the preferred embodiment 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. Apparatus for scanning continuously moving information bearing media with repeating line scansions, the apparatus comprising means driven in synchronism with the movement of the media for generating a first signal having a frequency substantially equal to an integral submultiple of a predetermined sweep frequency, means for producing a sweep signal of substantially the predetermined sweep frequency, and frequency control means responsive to the first signal and to the sweep

signal for controlling the predetermined sweep frequency.

2. An apparatus as claimed in Claim 1 wherein the first signal generating means comprises a disc adapted to rotate at a predetermined rate related to the rate of movement of the information bearing media and having indicia disposed thereon in a track, and means located adjacent to the track for detecting the movement of the indicia and for generating the first signal in response thereto.

3. An apparatus as claimed in Claim 1 or 2 further including means for changing the frequency of the sweep signal to produce a second signal having a second frequency, the frequency control means being adapted to receive the first signal and the second signal and being responsive to a predetermined relationship in the frequencies of the first signal and second signal for producing a third signal having a parameter dependent upon the relationship, and oscillator means responsive to the third signal for generating the sweep signal and for controlling the sweep frequency thereof.

4. An apparatus as claimed in Claim 3 wherein the second signal producing means comprises means for dividing the frequency of the sweep signal to produce a second signal having a frequency substantially equal to the frequency of the first signal.

5. An apparatus as claimed in Claim 3, or 4 wherein the third signal producing means is responsive to the phase difference between the frequencies of the first signal and the second signal for producing a phase difference signal, and the third signal producing means further comprises means for integrating the phase difference signal to produce the third signal.

6. An apparatus as claimed in Claim 3, 4, or 5 wherein the third signal is a variable DC voltage signal and the sweep signal generating means comprises a voltage controlled oscillator that oscillates at a sweep frequency dependent upon an amplitude of the DC voltage signal.

7. Apparatus for scanning the frames of a continuously moving motion picture film in a television field pattern including a plurality of spaced horizontal line scansions, the apparatus comprising a disc adapted to rotate at a rate related to the rate of movement of the motion picture film and having indicia disposed thereon in a track, means located adjacent the track for detecting the movement of the indicia and generating a first signal having a frequency substantially equal to an integral submultiple of a predetermined horizontal sweep frequency, and means for producing a horizontal sweep signal having the predetermined horizontal sweep frequency comprising means for changing the predetermined horizontal sweep frequency of the horizontal sweep signal to produce a second signal, phase de-

5 tector means having a first input terminal adapted to receive the first signal and a second input terminal adapted to receive the second signal, the phase detector means being responsive to a phase difference between the frequencies of the first signal and the second signal for producing a phase difference signal at an output terminal thereof, integrating means adapted to receive the phase difference signal from the output terminal of the phase detector means for integrating the phase difference signal to produce a third signal having a variable DC voltage amplitude, and voltage controlled oscillator means having an input terminal adapted to receive the third signal, the oscillator means being responsive to the third signal for generating the horizontal sweep signal at a horizontal sweep frequency dependent upon the DC voltage amplitude of the third signal.

25 8. An apparatus as claimed in Claim 7 wherein the second signal producing means comprises means for dividing the frequency of the horizontal sweep signal produced by the voltage controlled oscillator mean to produce the second signal having a frequency substantially equal to the frequency of the first signal.

30 9. An apparatus as claimed in Claim 1 or 2 comprising a further signal producing means including means for filtering the sweep signal to remove all harmonics of the predetermined sweep frequency and to produce the further signal.

35 10. An apparatus as claimed in Claim 9 comprising an integrated phase difference producing means responsive to the phase difference between the frequencies of the first signal and the further signal for producing a phase difference signal, and the phase difference signal producing means further comprises means for integrating the phase difference signal to produce integrated phase difference signal.

45 11. An apparatus as claimed in Claim 10 wherein the integrated phase difference signal is a variable DC voltage signal and the sweep signal generating means comprises a voltage controlled oscillator that oscillates at a sweep frequency dependent upon an amplitude of the DC voltage signal.

50 12. Apparatus for scanning the frames of a continuously moving motion picture film in a television field pattern including a plurality

55 of spaced horizontal line scansions, the apparatus comprising a disc adapted to rotate at a rate related to the rate of movement of the motion picture film and having indicia disposed thereon in a track, means located adjacent the track for detecting the movement of the indicia and generating a first signal having a frequency substantially equal to an integral submultiple of a predetermined horizontal sweep frequency, and means for producing a horizontal sweep signal having the predetermined horizontal sweep frequency comprising filter means for filtering the predetermined horizontal sweep frequency of the horizontal sweep signal to produce a further signal, phase detector means having a first input terminal adapted to receive the first signal and a second input terminal adapted to receive the further signal, the phase detector means being responsive to a phase difference between the frequencies of the first signal and the further signal for producing a phase difference signal at an output terminal thereof, integrating means adapted to receive the phase difference signal from the output terminal of the phase detector means for integrating the phase difference signal to produce an integrated phase difference having a variable DC voltage amplitude, and voltage controlled oscillator means having an input terminal adapted to receive the third signal, the oscillator means being responsive to the integrated phase difference signal for generating the horizontal sweep signal at a horizontal sweep frequency dependent upon the DC voltage amplitude of the integrated phase difference signal.

95 13. An apparatus as claimed in Claim 12 wherein the filter means comprises means for filtering the horizontal sweep signal produced by the voltage oscillator means to remove all harmonics of the predetermined horizontal sweep frequency and to produce the further signal.

100 14. An apparatus for scanning continuously moving information bearing media with repeating line scansions substantially as hereinbefore described with reference to and as illustrated in Figure 1 or Figures 2 and 3 of the accompanying drawings.

L. A. TRANGMAR, B.Sc., C.P.A.,
Agent for the Applicants.

Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1974.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.



* C L M S *