

PATENT SPECIFICATION

(11)

1 429 882

1 429 882

- (21) Application No. 14453/73 (22) Filed 26 March 1973
 (31) Convention Application No. 7 204 205 (32) Filed 29 March 1972 in
 (33) Netherlands (NL)
 (44) Complete Specification published 31 March 1976
 (51) INT. CL.² G02F 1/29
 (52) Index at acceptance
 G3R 2A1 31F 4 69 72N 72Y 7Q
 G3N 251 287 A



(54) APPARATUS FOR READING A DISC-SHAPED RECORD CARRIER CONTAINING SIGNALS CODED IN OPTICAL FORM

- (71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2., a British Company, 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:—
- 10 THE INVENTION relates to apparatus for reading a disc-shaped record on which signals, in particular video signals, are recorded in parallel information tracks. (The term "parallel tracks" is herein defined to
- 15 means a number of tracks constituting the successive turns of a spiral or a number of separate circular concentric tracks). Such apparatus includes an optical read unit comprising a source of optical radiation, an
- 20 optical system and a read detector, which source emits a beam of radiation which by means of the optical system transfers the information present on the record to the read detector. Such apparatus also includes
- 25 a measuring detector for measuring the radial position of the beam relative to a desired track, and a control system for controlling this radial position of the beam to maintain it on the desired track. This control
- 30 system comprises a coarse tracking feedback loop enabling the radial position of the read unit to be controlled, and a fine tracking feedback loop which includes the measuring detector and fine drive means
- 35 enabling the position of beam deflection means, included in the optical system, relative to the incident beam of radiation and hence the radial position of the beam relative to the read unit to be controlled.
- 40 Such apparatus is described in United States Patent Specification No. 3,381,086. In the apparatus described in this specification the read detector and the measuring detector are combined. The beam of radiation
- 45 which passes through the information

carrier is imaged by an optical system on the beam deflection means, which in this known apparatus is a rotatable element which has two reflecting surfaces which reflect the beam of radiation to two 50 detector elements. The difference signal from these detector elements is used as a control signal for both driving devices, whilst the sum signal becomes available as a video output signal. The coarse drive 55 means comprises a coarse control loop including the measuring detector.

The two control loops ensure that the scanning point always accurately follows an information track on the carrier. In general, 60 this information track is one turn of a spiral, so that the read beam is to be displaced in a radial direction at an approximately uniform speed. This uniform motion in general is effected by the coarse driving device, 65 whilst the fine driving device must in general be capable, by small rotation or tilting of the rotatable element, of following rapid variations of the radial position of the information track, for example due 70 to eccentricity of the pivot point relative to the centre of the record carrier, in order to ensure continuous reading of the information track.

It is an object of the present invention 75 to provide an apparatus of the aforementioned type which permits the information, in particular the video information, recorded on the record carrier to be displayed at a speed different from the recording speed 80 by simple means. More particularly slow-motion pictures, or still pictures or quick-motion pictures or even reverse motion pictures may be desired.

The invention provides apparatus for 85 reading a disc-shaped record in which video signals are recorded in optically readable form in parallel information tracks (as herein defined) and comprising:

- (a) an optical read unit comprising an op- 90

- tical system for directing a beam of optical radiation from a source onto the record and for imaging the information from the record onto a read detector for converting the optical image into a video signal,
- 5 (b) a measuring detector for measuring the radial position of a desired track relative to said optical read unit,
- 10 (c) a coarse tracking feedback loop including a coarse driving device for driving said optical read unit in the radial direction,
- (d) a fine tracking feedback loop comprising tiltable beam deflection means mounted in the path of said beam and actuated by
- 15 fine drive means coupled to receive a drive signal derived from the output of said measuring detector so as to maintain a desired track imaged on said read detector, and
- 20 (e) switching means responsive to a switching cycle starting pulse comprising means for opening said fine loop, means for applying a track jump signal to said beam deflection means so as to image another track onto
- 25 said read detector and means for reclosing said fine loop.

It is a feature of the invention that the starting pulse causes the read beam providing a scanning point on the record to

30 jump in a radial direction. The result achieved depends upon the repetition frequency of the starting pulse and the magnitude and the direction of the jump or displacement of the scanning point. If the

35 record contains spiral information tracks which start at the outer circumference, a still picture is obtainable by displacing the scanning point outwards through one track spacing after each revolution of the record

40 carrier, so that always the same portion of the information track is scanned. If the record is to be displayed at one half of the recording speed, the scanning point will be displaced outwards through one track spacing

45 after each two revolutions. It will be clear that thus many modifications of the display speed are possible.

The records used in the apparatus in accordance with the invention usually contain

50 an integral number of pictures, usually one, per revolution, in which case a given location in all recorded frames is stored at the same angular position on all tracks and hence forms a radial line on the record.

55 Because the video information changes very little from picture to picture in the case of motion pictures, this means that the difference between information stored in radially corresponding points of adjacent tracks is small, so that the likelihood of interference due to crosstalk between adjacent tracks is greatly reduced.

The input signal for said coarse driving device may be derived from the output of

65 said measuring detector as a signal repre-

senting the mean position of said beam deflection means.

Preferred embodiments of the invention utilize the above mentioned choice of recording pattern having an integral number

70 of pictures per revolution by ensuring that a jump of the scanning point from one track to another is commenced at an instant which at least substantially corresponds to a frame flyback pulse in the recorded video

75 signal, for in this recording pattern the portions of the information track which correspond to the frame flyback periods will be radially adjacent in successive tracks. By starting the jump of the scanning point at

80 the beginning of such a frame flyback period of a track the scanning point after the jump, provided that the jump is fast enough, falls in a frame flyback period recorded in the new track. This means that the

85 jump of the scanning point takes place entirely in a period in which the image is suppressed, so that this jump does not introduce disturbances in the visible picture. Obviously, the starting pulses for the switching

90 cycle may be caused to lag behind the frame flyback pulses to enable the old track to be followed during part of this frame flyback period in order to read certain information, for example information relating

95 to the desired repetition frequencies and the like of the switching cycles.

A programming unit may be provided which can accept detected frame pulses and, by making a selection between them

100 as to which of them will be used as track jump signals, can implement any of the previously mentioned modifications of display speed.

As has been mentioned above, instead of

105 a record provided with spiral information tracks a record provided with concentric tracks may be used in apparatus in accordance with the invention. If, for example, one picture is recorded in each concentric

110 track, in the case of display at the normal speed the scanning point will have to jump one track spacing after each revolution of the record. The use of such concentric tracks, however, may be of particular im-

115 portance when the apparatus is used to display the same picture for a prolonged period of time accompanied by a continuous spoken text. By causing the scanning point to follow the same track for a given

120 period, which mode of operation does not require any switching cycle in the case of concentric tracks, the picture may be retained for any desired time. The sound assigned to this period may also be re-

125 corded in this concentric track by several methods, but obviously provision must be made to produce a continuous audio signal. As an example the sound may be recorded in frequency multiplex, the sound

130

carrier being changed after each revolution. In this case the read apparatus also must be switched to this changed carrier frequency after each revolution. Obviously, care should be taken to ensure that there is a regular sequence of carrier frequencies or that an additional indicating signal is provided on the record which, each time gives an indication with respect to the carrier frequency.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings in which:

Figures 1 and 2 show two embodiments of read apparatus according to the invention.

Figure 3 shows a simple design of an alternative tiltable reflecting element with associated drive means, for use with the apparatus of Figures 1-2.

Figure 4 shows an example of the fine control loop including a switching unit.

Figure 5 shows an example of a unit for supplying the voltages for controlling the switching units shown in Figure 4, and

Figure 6 shows voltage wave-forms which occur in this unit.

Referring now to Figure 1, a disc-shaped record 1 is driven in rotation by a motor M_1 via a spindle 2 which passes through a centre hole in the record. The record may be either a disc made of a rigid material or of thin foil. The record 1 is provided with information tracks which in general are spiral and in which video and maybe also audio signals are recorded in optically readable form. These signals may be stored in frequency-modulated or amplitude-modulated form. The signals are read by means of a beam of radiation which, depending on the physical structure on the record used to record the information is amplitude-modulated or phase-modulated by this information. For the control means described hereinafter the method of modulation and the mode of recording on the record are of minor importance, so that they will not be described further.

The read beam of radiation is produced, and the information contained in it after interaction with the record is detected by means of an optical system accommodated in the optical read unit within casing 4. This optical system comprises a source of light 7 and a mirror 8 by which the light from the source is collimated into a beam of radiation b_1 . This beam of radiation is reflected towards the record by means of a plane mirror 9 and focussed by a lens 10 on the surface of the record 1 on which the information is recorded, in this embodiment on the lower surface. The beam of radiation which after being modulated by this information emerges from the record is directed

via a lens 11 and a plane mirror 12 to a detector unit 13 as a collimated beam of radiation b_2 . A scanned point or desired track of the record thus is imaged on a read detector 14 which detects the information contained in the beam, the detected information appearing at an output terminal 16.

To ensure continuous reading of the information the scanning point imaged on the read detector 14 must always follow the information track provided on the record 1 and a tracking controller is used for this purpose. If this information track is spiral, the scanning point a must firstly be displaced in a radial direction by coarse drive means at a speed which corresponds to the pitch of this spiral information track. Furthermore the scanning point must be capable of following any rapid radial displacements of the information track due, for example, to eccentricity of the centre hole in the record.

This necessary control of the radial position of the scanning point a is effected by cooperation of two tracking controls, a coarse drive means capable only of producing a slow radial displacement of the scanning point and a fine tracking control capable of producing a comparatively small but fast displacement of the scanning point. In the embodiment shown the coarse drive is provided by a motor M_2 which via a servo amplifier V_2 receives a control signal and is capable of displacing the casing 4 in a radial direction by means of a geared drive, for example a wormwheel 5 and a rack 6. The fine tracking control is effected by pivoting the plane mirror 12 about a pivot 18 so as to act as the beam deflection means. It is assumed that the area of the record illuminated by the beam of radiation comprises several tracks. Pivotal movement of the mirror 12 causes the scanning point imaged by this mirror on the read detector 14 to be radially displaced. The pivotal movement of the mirror 12 is produced by a driving element 19, which may be any suitable element. This driving element 19 receives a control signal from a servo amplifier V_1 . The element 19 may, for example, be a piezo-electric element. Such an element in general comprises a stack of a plurality of slices of a piezo-electric material with inter-leaved electrodes. To enlarge the deflection produced by such an element, for example, a suitable lever system may be used by which the movements of the piezo-electric element are transmitted to the reflecting element. Also, a liquid amplifier may be used in which the piezoelectric element is secured to a first diaphragm which forms a wall of a liquid-filled closed space. The movements of this first diaphragm are transmitted via the liquid to a second dia-

phragm, this movement being amplified by a factor determined by the ratio between the surface areas of the two diaphragms.

Alternatively a piezoelectric torsion element may be used to advantage by causing this element to act as the pivot of the reflecting element.

Instead of a reflecting element it is also possible to use a tiltable light transmitting element to deflect the beam of radiation.

The information about the position of the scanning point a relative to the information track, which information is required for this fine tracking control, is obtained by means of a measuring detector 15 which forms part of the detector unit 13. This measuring detector 15 also may be constructed in various ways, for example as described in the aforementioned United States Patent Specification No. 3,381,086 in which the measuring and read detectors are combined, or as described in Patent Specification No. 1,391,335. The measuring detector 15 shown schematically in the Figure consists, according to an embodiment of the latter specification, of a grating made up of radiation-transmitting and radiation-absorbing strips. This grating is shown greatly enlarged in the Figure and actually will lie within the radiation beam b_1 . Since the beam of radiation illuminates a plurality of tracks, for example 50 tracks, of a record, there will be formed on the measuring detector an image which corresponds to the track pattern and hence also the pattern of a grating. By means of suitable pick-up elements the position of this grating-shaped image of the track pattern relative to the grating-shaped detector produces a signal which is representative of the position of the scanning point a relative to the desired track, which signal may be derived from an output terminal 17. This signal is used as the control signal for driving device 19 and for this purpose is applied to the servo amplifier V_1 via a switch S_1 .

The control signal for the coarse control to be applied to the servo amplifier V_2 can be taken from the output terminal 17 via a suitable signal processing network thus coupling the output of the measuring detector into the coarse tracking loop. However, as is shown in the Figure, this coupling can also be achieved by deriving the control signal for the amplifier V_2 from the mean deflection of the mirror 12 relative to a central position. Such a signal may be obtained in a variety of ways which will be obvious to one skilled in the art, for example by means of capacitive or inductive transducers, and therefore the Figure shows only schematically the manner in which the desired signal is derived from the driving element 19. Naturally, the coarse control may alternatively be used inter-

mittently, i.e. only when the deflection of the mirror 12 with respect to its centre position exceeds a given limit. In the case of a spiral information track on the record carrier, however, the firstmentioned configuration in which the mean deflection of the mirror provides the control signal for the coarse control, will produce a smoother servo behaviour.

Thus, it is ensured by means of the said control systems that the scanning point a continuously follows the information track. If, for example, a still picture is to be displayed, the scanning point, after having followed the information track for a time sufficient for one picture, for example for at least one period of revolution of the record, will have to jump back at least one track spacing to enable that picture to be repeated. This jump is then repeated for as long as the still picture is required. For this purpose a switching unit A is provided which is capable of operating a switch S . If this switching unit A at its control input c receives a starting signal, a switching cycle is started during which first the switch S is changed over from the position S_1 to the position S_2 . This opens the fine control loop for the radial position of the scanning point. After the switch S has been switched to the position S_2 , the switching unit via this switch S and the servo amplifier V_1 applies to the driving unit 19 a signal such that the mirror 12 is pivoted through an angle such that the scanning point a jumps approximately one track spacing. Subsequently the switching cycle is terminated in that the switching unit A returns the switch to the position S_1 , so that the control loop is closed again and the scanning point a locks on to the new track.

It will be appreciated that the aforescribed switching cycle should be performed as fast as possible. This imposes certain requirements on the servo system, the design of the mirror 12 and the switching signal to be applied by the switching unit to the servo system, which requirements will be discussed hereinafter.

However, first a second embodiment of the optical system will be described with reference to Figure 2. In this embodiment the transmitted beam of radiation is replaced by a beam of radiation reflected by the record. Elements corresponding to those of Figure 1 are denoted by the same reference symbols.

The required radiation beam b_1 is again obtained by means of a source of light 7 and is converged by a lens 20. Via a half-silvered mirror 21 the converged beam falls on a plane mirror 12 which reflects it towards the record 1. This reflected beam is focussed on the record by a lens 10. The radiation beam reflected by the record 1 is

reflected by the plane mirror 12 to the half-silvered mirror 21. The part of the beam which is reflected by the mirror 21 falls on a detector unit 13 which includes a signal detector 14 on which the scanned point *a* is imaged.

The mirror 12 is pivotable and the casing 4 is radially displaceable by means of a control system which may be constructed identically with that shown in Figure 1. With respect to the size of the area on the record illuminated by the radiation there are two possibilities. If this area contains a plurality of tracks, the said radiation beam may again be used to obtain the desired information about the radial position of the scanning point *a*, for these illuminated tracks can be imaged on a measuring detector 15 adjacent to the signal detector 14 and having, for example, a grating-shaped pattern. In this case either the signal detector 14 must have a width which substantially corresponds to the width of the image of one information track provided on the record, or only a small part of the image must be transmitted to the detector.

As an alternative, however, the area of the record carrier illuminated by the radiation beam may comprise only a single track. Since in this case this track only is imaged on the signal detector, there is no objection to the detector 14 being larger. Obtaining a signal which is representative of the radial position of the scanning point *a* can now be achieved by a second radiation beam, not shown, which forms an image of a plurality of tracks on the measuring detector 15. The switch *S* and the switching unit *A* may be provided in a manner identical to that shown in Figure 1.

Figure 3 shows a simple and advantageous embodiment of the plane mirror 12 together with the driving element 19. The mirror 12 is adapted to pivot about a pivot 24 which passes through the centre of gravity of the mirror and is journaled in bearings 25. The driving element 19 is constituted by windings 22 which are wound around the circumference of the mirror and are arranged in a magnetic field produced by pole pieces 26. By supplying a control current to terminals 23 which form the ends of the windings 22, the mirror is pivoted against the force of a spring, not shown, the pivoting angle being determined by the magnitude of the current. The advantage of the embodiment of the mirror and its drive shown are the simplicity and lightweight construction, enabling very fast changes in the radial position of the scanning point *a* to be obtained. In another related embodiment a permanent magnet is mounted on the mirror and the mirror is arranged in a variable magnetic field.

Figure 4 shows schematically the manner in which the switch *S* may be constituted by electric means and incorporated in the control system. The measuring detector 15 is schematically indicated by photo-detectors *D*₁ and *D*₂ and is assumed to comprise two sub-detectors so as to obtain an indication both of the magnitude and of the direction of the deviation of the radial position of the scanning point. The signals produced across the sub-detectors *D*₁ and *D*₂ are applied via separate amplifiers 31 and 32 respectively to a differential amplifier 33 at an output terminal 17 of which the said control signal appears. This control signal is applied to a phase correction network *F* by means of which the desired stability and response of the servo loop is realized.

The output of this phase correction network *F* is connected via the main current path of a first field effect transistor *T*₁ to the positive input of an amplifier *V*₁ which, for example, supplies a control current to the terminals 23 of a mirror drive designed in the manner shown in Figure 3. The magnitude of this control current is a measure of the deflection of the mirror and hence the mean of this current may be used for the coarse control. For this purpose a resistor *R* is provided which is traversed by this control current and from a terminal 35 of which a voltage may be derived which after integration is applied to the coarse control. The voltage produced across the resistor *R* is also used as a negative-feedback voltage and applied to the negative input of the amplifier *V*₁.

The positive input of the amplifier *V*₁ is also connected, via the main current path of a second field effect transistor *T*₂, to a terminal *S*₂. If the field-effect transistors *T*₁ and *T*₂ are of opposite conductivity types, their control electrodes may be connected to one another and to one control terminal 34. At this control terminal 34 the voltage *U*₁ normally has a value such that the transistor *T*₁ is conducting and the transistor *T*₂ is non-conducting, so that the terminal *S*₁ is connected to the input of the amplifier *V*₁ and the control loop is closed. To open the control loop a square-wave change in the voltage *U*₁ is applied to the terminal 34 so that the transistor *T*₁ is rendered non-conducting. Simultaneously the transistor *T*₂ becomes conducting, so that a signal applied to the terminal *S*₂ is capable of reaching the amplifier *V*₁. To this terminal *S*₂ a voltage *U*₂ is applied during the square wave period such that the mirror 12 is pivoted through a given angle. The control voltage applied to the terminal *S*₂ preferably has a waveform which is symmetrical about zero. In this case the mirror, on termination of this con-

6
 15
 20
 25
 30
 35
 40
 45
 50
 55
 60
 65

trol voltage, becomes stationary again. This will be so because the pivoting speed may be represented as the integral of this voltage U_2 , which will be zero for such a symmetrical waveform. Instead of the square-wave voltage shown, for example, one period of a sinusoidal voltage may be used. On termination of the voltage U_2 , the voltage U_1 also returns to its normal value, so that the transistor T_2 is again rendered non-conducting and the transistor T_1 becomes conducting again, with the result that the fine control loop is closed again.

Figure 5 is a block schematic view of a circuit arrangement by means of which the voltages U_1 and U_2 shown in Figure 4 may simply be obtained, the waveforms of the voltages which are produced in this circuit arrangement being shown in Figure 6. Through an input terminal 41 the frame pulses separated from the video signal (Figure 6a) are applied to a divider stage D the divisor of which is adjustable by means of a signal at the control input C. In the embodiment shown it is assumed that the divisor is equal to 2, so that alternate frame pulses are transmitted (Figure 6b). These pulses are applied to a first monostable multivibrator F_1 , which converts them into square-wave voltages having a given fixed width (Figure 6c). The trailing edge of this square-wave voltage triggers an identical second monostable multivibrator F_2 , which as a result supplies a square-wave voltage following that of F_1 of the same width but of opposite polarity (Figure 6d). The output voltages of the two monostable multivibrators F_1 and F_2 are added and provide the desired control signal U_2 (Figure 6e). Simultaneously the output voltages of these multivibrators F_1 and F_2 are applied to a bistable multivibrator F_3 , which is set by the leading edge of the pulse from F_1 and is reset by the trailing edge of the pulse from F_2 and which as an output voltage delivers the desired switching voltage U_1 (Figure 6f).

The invention enables highly advanced display modes to be realized, as on the one hand it enables a normal program to be displayed at different speeds, and on the other hand it provides the possibility of programming the video and audio reproduction by means of programming signals which also are recorded on the record. This, may, for example, be particularly useful in educational programs in which it is permissible to display the same picture for a comparatively long time. By recording an appropriate program signal on the record each picture may be retained for a fixed time while the sound proceeds continuously, for example by means of the multiplex audio techniques aforementioned. This

naturally enables the duration of the playing time to be considerably increased.

In addition to small jumps of the scanning point it may in some cases, for example when the record is used to store separate stills be useful to radially displace the scanning point through a larger distance by applying a control signal to the coarse control.

WHAT WE CLAIM IS:—

1. Apparatus for reading a disc-shaped record in which video signals are recorded in optically readable form in parallel information tracks (as herein defined) and comprising:
 (a) an optical read unit comprising an optical system for directing a beam of optical radiation from a source onto the record and for imaging the information from the record onto a read detector for converting the optical image into a video signal,
 (b) a measuring detector for measuring the radial position of a desired track relative to said optical read unit,
 (c) a coarse tracking feedback loop including a coarse driving device for driving said optical read unit in the radial direction,
 (d) a fine tracking feedback loop comprising tiltable beam deflection means mounted in the path of said beam and actuated by fine drive means coupled to receive a drive signal derived from the output of said measuring detector so as to maintain a desired track imaged on said read detector and,
 (e) switching means responsive to a switching cycle starting pulse comprising means for opening said fine loop, means for applying a track jump signal to said beam deflection means so as to image another track onto said read detector and means for reclosing said fine loop.

2. Apparatus as claimed in Claim 1 comprising means for deriving the input signal for said coarse driving device from the output of said measuring detector as a signal representing the mean position of said beam deflection means.

3. Apparatus as claimed in any preceding claim wherein the said switching means comprises means for detecting frame pulses in said video signal and a programming unit connected to the frame pulse detecting means for selecting and delivering a selected frame pulse as said starting pulse for said switching cycle.

4. Apparatus as claimed in Claim 3 comprising means for performing said selection in accordance with a programming signal read from the record.

5. Apparatus as claimed in any preceding claim wherein said fine drive means includes a winding which is rigidly secured to said tiltable optical element and is arranged in a magnetic field and to which



6
trol voltage, becomes stationary again. This will be so because the pivoting speed may be represented as the integral of this voltage U_1 , which will be zero for such a symmetrical waveform. Instead of the square-wave voltage shown, for example, one period of a sinusoidal voltage may be used. On termination of the voltage U_1 , the voltage U_2 also returns to its normal value, so that the transistor T_1 is again rendered non-conducting and the transistor T_2 becomes conducting again, with the result that the fine control loop is closed again.

15 Figure 5 is a block schematic view of a circuit arrangement by means of which the voltages U_1 and U_2 shown in Figure 4 may simply be obtained, the waveforms of the voltages which are produced in this circuit arrangement being shown in Figure 6.
20 Through an input terminal 41 the frame pulses separated from the video signal (Figure 6a) are applied to a divider stage D the divisor of which is adjustable by means of a signal at the control input C. In the embodiment shown it is assumed that the divisor is equal to 2, so that alternate frame pulses are transmitted (Figure 6b). These pulses are applied to a first monostable multivibrator F_1 which converts them into square-wave voltages having a given fixed width (Figure 6c). The trailing edge of this square-wave voltage triggers an identical second monostable multivibrator F_2 , which as a result supplies a square-wave voltage following that of F_1 of the same width but of opposite polarity (Figure 6d). The output voltages of the two monostable multivibrators F_1 and F_2 are added and provide the desired control signal U_2 (Figure 6e). Simultaneously the output voltages of these multivibrators F_1 and F_2 are applied to a bistable multivibrator F_3 which is set by the leading edge of the pulse from F_1 and is reset by the trailing edge of the pulse from F_2 , and which as an output voltage delivers the desired switching voltage U_1 (Figure 6f).

25 The invention enables highly advanced display modes to be realized, as on the one hand it enables a normal program to be displayed at different speeds, and on the other hand it provides the possibility of programming the video and audio reproduction by means of programming signals which also are recorded on the record. This, may, for example, be particularly useful in educational programs in which it is permissible to display the same picture for a comparatively long time. By recording an appropriate program signal on the record each picture may be retained for a fixed time while the sound proceeds continuously, for example by means of the multiplex
65 audio techniques aforementioned. This

naturally enables the duration of the playing time to be considerably increased.

In addition to small jumps of the scanning point it may in some cases, for example when the record is used to store separate stills be useful to radially displace the scanning point through a larger distance by applying a control signal to the coarse control.

WHAT WE CLAIM IS:—

1. Apparatus for reading a disc-shaped record in which video signals are recorded in optically readable form in parallel information tracks (as herein defined) and comprising:

- (a) an optical read unit comprising an optical system for directing a beam of optical radiation from a source onto the record and for imaging the information from the record onto a read detector for converting the optical image into a video signal,
- (b) a measuring detector for measuring the radial position of a desired track relative to said optical read unit,
- (c) a coarse tracking feedback loop including a coarse driving device for driving said optical read unit in the radial direction,
- (d) a fine tracking feedback loop comprising tiltable beam deflection means mounted in the path of said beam and actuated by fine drive means coupled to receive a drive signal derived from the output of said measuring detector so as to maintain a desired track imaged on said read detector and,
- (e) switching means responsive to a switching cycle starting pulse comprising means for opening said fine loop, means for applying a track jump signal to said beam deflection means so as to image another track onto said read detector and means for reclosing said fine loop.

2. Apparatus as claimed in Claim 1 comprising means for deriving the input signal for said coarse driving device from the output of said measuring detector as a signal representing the mean position of said beam deflection means.

3. Apparatus as claimed in any preceding claim wherein the said switching means comprises means for detecting frame pulses in said video signal and a programming unit connected to the frame pulse detecting means for selecting and delivering a selected frame pulse as said starting pulse for said switching cycle.

4. Apparatus as claimed in Claim 3 comprising means for performing said selection in accordance with a programming signal read from the record.

5. Apparatus as claimed in any preceding claim wherein said fine drive means includes a winding which is rigidly secured to said tiltable optical element and is arranged in a magnetic field and to which



is applied said fine drive signal derived from the output signal of the measuring detector.

6. Apparatus as claimed in any of Claims 1, 2, 3 or 4 wherein said fine drive means includes a magnetic element which is rigidly secured to said tiltable optical element and is arranged in a magnetic field which is variable in accordance with said fine drive signal derived from the output signal of the measuring detector.

7. Apparatus as claimed in any of Claims 1, 2, 3 or 4 wherein said fine drive means includes a piezoelectric torsion element which serves as a pivot for said tiltable optical element and to which said fine drive signal is applied which is derived from the output signal of the measuring detector.

8. Apparatus as claimed in any of the preceding Claims wherein said switching means comprises the main current path of a first transistor included in the connection between the measuring detector and the control input of the fine drive means and the said control input being connected to a track jump signal source via a main current path of a second transistor, the control electrodes of said first and second transistors connected to receive signals such that normally the first transistor is conducting and the second transistor is cut off and such that during track jumping the first transistor is cut off and the second transistor is conducting.

9. Apparatus as claimed in any of the preceding claims, wherein the switching means includes a first monostable multivibrator to which is applied said starting pulse, a second monostable multivibrator which is controlled by the output signal of the first multivibrator, an adding circuit

arranged to add the mutually inverse polarity output signals of the first and second multivibrators and to apply the resulting sum signal to said fine drive means as said track jump signal when said fine loop is open and a third bistable multivibrator which is controlled by the output signals from the first and second multivibrators and the output signal from which effects the opening and closing of said fine loop.

10. Apparatus as claimed in any of the preceding Claims comprising means for reading video and audio information from said record, wherein the apparatus is adapted for continuous reproduction of the audio information whilst repeating the display of the same video information.

11. Apparatus as claimed in any of the preceding Claims, wherein said beam deflection means is a reflecting element.

12. Apparatus substantially as described with reference to Figure 1 or Figures 1 and 3 or Figures 1, 3, 4 and 5 of the accompanying drawings.

13. Apparatus substantially as described with reference to Figure 2 or Figures 2 and 3 or Figures 2, 3, 4 and 5 of the accompanying drawings.

C. A. CLARK,

Chartered Patent Agent,

Century House,
Shaftesbury Avenue,
London, W.C.2.

Agent for the Applicants.