

PATENT SPECIFICATION (11)

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- (21) Application No. 26615/72 (22) Filed 7 June 1972 (19)
 (31) Convention Application No. 150 698 (32) Filed 7 June 1971 in
 (33) United States of America (US)
 (44) Complete Specification published 18 June 1975
 (51) INT. CL.³ G11B 25/04 21/08 23/18 5/54 5/55 5/56 5/80
 (52) Index at acceptance

G5R B185 B208 B223 B264 B333 B345 B36Y B38Y B435
 B443 B451 B471 B513 B550 B55X B55Y B583 B58Y
 B60X B612 B613 B614 B61Y B701 B72Y B784
 B788

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(54) REPRODUCING 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:—

The present invention relates to reproducing apparatus and, more particularly, to a device for selectively positioning a transducer head with respect to a selected one of a plurality of tracks on either of two opposed planar surfaces of a record medium and for rendering operative the transducer head associated with the selected track for reproducing information thereon.

The prior art discloses that it is well-known to utilize visual and/or audio information on a transparent or an opaque record medium that can be readily inserted and used in conjunction with a device, such as a programmed film projector. In many instances, the record medium is provided with only a single sound track and, in some instances, the transducer head is moved relative to the medium. In such disclosures, quite complex mechanisms are required to disengage the transducer head from the record medium at the end of the run relative to the sound track so as to return the head to its original position for operation with respect to the sound track on the next medium that might be inserted in the apparatus. The prior art also discloses a form of record medium having information-bearing tracks on opposite surfaces thereof and in which a transducer head associated with each surface or side is selectively operable to reproduce with respect to the track on a respective surface. As pointed out hereinabove, the mechanisms required are quite

complex for controlling the movement of the transducer head, particularly when a zig-zag (continuous) track is used, or when the sound track is one that requires continuous movement of the head with respect to the medium in both directions and in synchronism with movement of the medium so as to position each respective sound track relative to the head.

In accordance with the present invention there is provided reproducing apparatus including a pair of spaced and generally aligned transducer heads for selectively reproducing information in a plurality of spaced, parallel tracks extending longitudinally on the opposed surfaces of a record medium, the tracks on one surface being generally aligned with those on the other surface in accordance with the alignment of the transducer heads, comprising a carrier which is movable in a rectilinear path and is adapted to support the record medium between the transducer heads, first moving means for moving the transducer heads transversely of the record medium to engage simultaneously a selected track on one of the said opposed surfaces and the track aligned therewith on the other of said opposed surfaces, second moving means for moving the record medium in a direction parallel to the tracks and relative to the transducer heads, and means for rendering the transducer head engaging the selected track operative to reproduce information thereon.

The present invention will now be described by way of example with reference to the accompanying drawings in which:—

Fig. 1 is a perspective view showing the format of a representative record medium;

Fig. 2 is a simplified side elevation of the apparatus of the present invention showing the mechanism by which the record medium and transducer heads are moved and show-

ing the relation of the mechanism to the horizontal plane for utilizing gravity as means for moving the record medium in one direction;

Fig. 3 is a plan showing the relation of the record medium to one of the transducer heads and the drive mechanism for moving the record medium and transducer heads;

Fig. 4 is an end view showing the drive mechanism for moving the transducer heads transversely of the record medium;

Fig. 5 is a side elevation of the supporting and guiding means for the transducer heads;

Fig. 6 is a side elevation showing the mechanism, slightly modified with respect to Fig. 2, by which the drive means for the record medium is actuated; and

Fig. 7 is a schematic diagram of an electrical circuit for controlling the selection of the transducer head and sound track to be rendered operable and for controlling the operation of the drive means for the record medium and transducer heads.

With reference particularly to Fig. 1, a record medium 10 is shown as comprising a support, for example a sheet of paper, cardboard, film, glass, plastic, or a similar material on which a plurality of sound tracks 11 can be formed by providing a coating of magnetic material or the like. In the present invention, the sound tracks 11 are formed on both surfaces 12 and 13 of the medium 10, the tracks on one surface being generally aligned with those on the other surface so that a set of transducer heads 14 and 15 can be arranged relative to the sound tracks on each surface and movable as a unit so as to be aligned with a respective track on each surface. While the present invention is described herein as directed to the reproduction of sound recorded on the tracks 11, digital data or other information can be reproduced in each track, the heads 14 and 15 then being used in conjunction with suitable information decoding circuitry. The term "reproducing" as used herein and in the appended claims is meant to include recording as well as play back as used in this art.

As shown in Fig. 3, the record medium 10 is insertable in a frame member 18. The frame member 18 is generally U-shape in form and is provided with brackets 19 on one side thereof and a bracket 20 on the other side by which the frame member 18 is supported on rods 21 and 22 for a purpose to be described hereinafter. When the record medium 10 is in the frame 18, one end of the record medium 10 extends beyond the frame member 18, and the other end is spaced inward from a cross bar 23 of the frame member 18 to permit the full length of the medium 10 to be moved relative to the transducer heads 14 and 15. The frame

member 18 is provided with grooves 24 in which the record medium 10 can be inserted and withdrawn.

The rods 21 and 22 are mounted in spaced extensions 25 on a plate member 26 and spaced extensions 27 which are mounted on a plate 28. As can be seen in Fig. 2, the plate member 26 is mounted on the plate 28.

The means for supporting each of the transducer heads 14 and 15 in a position relative to the record medium 10 comprises a rod 30 on which the head 14 is movably mounted and a rod 31 on which the head 15 is movably mounted. The rods 30 and 31 are mounted in spaced, parallel relationship on side walls 32 and 33 that are formed integral with the plate member 26. Heads 14 and 15 are mounted in substantially the same way on their respective rod 30 or 31 and such mounting will therefore be described only with respect to the head 14.

A slide member 35 is provided with spaced bearings 36 for operably and slideably engaging the rod 30. A tongue portion 37 (Fig. 5) extends between the bearings 36 and is provided with a slot 38 through which an actuating rod 39 extends for a purpose to be described hereinafter. A yoke member 40 is pivotally mounted on the slide member 35 at 41 and at the opposite end carries a bracket 42 on which a head bracket 47 is mounted. The tongue portion 37 carries an eccentric screw 43, the head of which engages the under surface of yoke member 40, as shown in detail in Fig. 5. A leaf spring 44 is mounted on the slide member 35 and the free end thereof engages the yoke member 40 near the overhanging end thereof. By turning the screw 43, the override of the slide member 35 relative to the yoke member 40 can be adjusted, thereby ensuring proper clearance between the head 14 and the record medium 10 in a disengaged position. The bracket 42 is pivotally mounted on the yoke member 40 at 45 and an eccentric stud 46 carried thereby engages the yoke member 40 for adjusting the position of the bracket 42 in a generally horizontal direction, as viewed in Fig. 5, so as to accurately position the head 14 relative to the sound tracks on the medium 10. The bracket 47, on which the head 14 is mounted, is pivotally mounted on the bracket 42 at 48. By means of an eccentric stud 49 the angular position of the head 14 in a vertical plane, as viewed in Fig. 5, can be adjusted so as to position the head 14 normal to the plane of the record medium 10.

Means for intermittently moving the heads 14 and 15 transversely of the record medium 10 comprises a stepping motor 51 and a cable drive 52 associated therewith. The side walls 32 and 33 of the plate member 26 carry a number of extensions or bearing

members 53, each of which rotatably supports one of pulleys 54, 55, 56, and 57, as shown in Fig. 4. The stepping motor 51 is provided with a pulley 58. In order to more clearly understand the cable drive 52, reference should be made to Figs. 2 and 4. The pulleys 54-57 are each provided with two grooves to form a path of movement for a cable 59 which is as follows: Starting at the lower end (as viewed in Fig. 4) of a spring 60, to which it is attached, the cable 59 passes around the upper groove of the pulley 54, through a slot 61 (see Fig. 5) in the lower slide member 35 by means of which the cable 59 is secured to the lower member 35, around the upper groove of the pulley 57 and then wraps around the pulley 58 on the stepping motor 51. From the pulley 58, the cable 59 extends around the lower groove of the pulley 54, the upper groove of the pulley 55, through the slot 61 in the upper slide member 35, and then around the upper groove of the pulley 56 and the lower groove in the pulley 57 to the other end of the spring 60. With this arrangement, if the pulley 58 is rotated by the motor 51 in an anticlockwise direction (as viewed in Fig. 4), then the heads 14 and 15 will be moved as a unit in an upward direction (as viewed in Fig. 4) which is transversely of the record medium 10. During such movement, the heads 14 and 15 are disengaged from the respective surfaces 12 and 13 of the record medium 10.

Drive means for moving the record medium 10 between a first position in which one end of the sound tracks 11 is positioned relative to the heads 14 and 15 and a second position in which the other end of the sound tracks 11 is positioned relative to the heads 14 and 15 comprises a motor 65 that is continuously energized when the apparatus is operative, so that the movement of the record medium 10 can be accomplished at any time. The motor 65 is mounted on the underside of the plate 28 and drives a pulley 66 secured to its shaft 67. The pulley 66 is coupled to a pulley 68 by a belt 69. Rotation of the pulley 66 causes rotation of a small roller 70 which is associated with the pulley 68 and frictionally engages a rubber roller 71. The roller 71 engages a fly wheel 72 which is secured to a rotatable, axially movable shaft 73. A clutch means 74 is provided for imparting rotation of the shaft 73 to a shaft 75 to which a pulley 76 is secured.

In a manner to be described in more detail hereinafter, a solenoid 78 is energized when the heads 14 and 15 are positioned relative to the selected sound track. With energization of the solenoid 78, the armature 79 moves inward to allow a lever 80 to be moved by a spring 83 in an anticlockwise direction about a pivot 81 on a post 82 that

extends from the underside of the plate 20 (see Fig. 6). This movement of the lever 80 causes the shaft 73 to be moved axially and the clutch means 74 is then engaged, thereby imparting rotation of the shaft 73 to the shaft 75 and hence rotating the pulley 76. A cable 84 is connected to a bracket 19 of the frame member 18 and encircles the pulley 76 and a pulley 85. The pulley 85 is mounted on the plate member 26 and is biased by a spring 86, as shown in Fig. 2. The frame member 18, is, therefore, moved along the rods 21 and 22 at a uniform rate and relative to the transducer heads 14 and 15. During such movement, the spring 86 that is connected between the pulley 85 and the plate 26 is wound up to bias the pulley 85.

The solenoid 78 is capable of providing rotary movement of the armature 79 as well as axial movement. The armature 79 carries a lever 88 that is pivotally connected at 89 to an extension 90 of a lever 91. The lever 91 is pivotally mounted at 92 on the plate 28 and is pivotally connected via an extension 93 thereof to the respective ends 94 of the actuating rods 39 (see Fig. 4). This linkage of levers can be best seen in Figs. 3 and 4. The pivot at 89 comprises a pin and slot connection, a pin 95 being carried by the lever 88 and the extension 90 having a slot 96. The lever 91 is moved in an anticlockwise direction (as viewed in Fig. 2) about the pivot 92, to move the heads 14 and 15 into an engaging position with respect to the record medium 10. Similarly, movement of the lever 91 in a clockwise direction disengages the heads 14 and 15 from the record medium 10. It will be evident from Figs. 2, 3 and 4 that movement of the lever 91 actuates the rods 39 simultaneously so that, upon energization of the solenoid 78, the heads 14 and 15 are moved into position for engaging the record medium 10 simultaneously with the movement of the record medium 10 relative to the heads 14 and 15. The heads 14 and 15 also serve to support the record medium 10 during its movement relative thereto and with such support improved reproduction is attained.

The operation of the device of the present invention will now be described with reference to the schematic diagram shown in Fig. 7. It is assumed that a record medium 10 has been inserted in the frame member 18. With a switch 100 closed, the motor 65 is continuously energized by a power supply 101, so that the device is then operative merely upon selection of the track and associated transducer head to be made operative. When selection of any track 11 is made in accordance with the actuation of one of a plurality of buttons 102 on a controller 103, a signal is presented which energizes

either a switch 104 or a switch 105 associated with the stepping motor 51, to rotate the motor 51 in accordance with the necessary direction to locate the selected track 11. The motor 51 imparts small increments of movement to the pulley 58 and, via the cable 59, the upper and lower slide members 35 are moved as a unit transversely of the record medium 10. When the heads 14 and 15 are properly aligned with the selected track, a signal is generated which causes the solenoid 78 to be energized via a switch 121. As a result, the lever 88 causes the lever 91 to rotate the rods 39 and move the heads 14 and 15 into engagement with the record medium 10. At the same time, the armature 79 permits the lever 80 to be moved by the spring 83 into a position in which the clutch means 74 is engaged, thereby causing the pulley 76 to rotate and move the frame member 18 along the rods 21 and 22 at a uniform rate. When the other end of the tracks on the record medium 10 are adjacent the heads 14 and 15, the forward bracket 19 engages the arm of a limit switch 107 which signals the controller 103 that the end of a track has been reached. Then the controller 103 opens the switch 121 which breaks the circuit to the solenoid 78. When this occurs, the lever 91 returns the heads 14 and 15 to their disengaged positions and the lever 80 releases the clutch means 74. The frame member 18 is now free to be moved by the spring 86 and the force of gravity due to the inclination of the entire device to a "home" or first position wherein the forward end of the tracks 11 on the record medium 10 are adjacent the heads 14 and 15.

The record medium 10 can be removed from or inserted into the grooves 24 in the frame member 18 as follows. Upon a "load" command from the controller 103, the solenoid 78 is energized by the closing of the switch 121, which initiates a regular "reproduce" cycle. However, the controller 103 does not select either head 14 or 15, so as to maintain silence. The signal derived from the limit switch 107 as it is actuated by the bracket 19 is also disregarded. A casing 126 is provided with a throat 127 which is generally aligned with the grooves 24 in the frame member 18. The record medium 10 can be moved to a position in which it extends outside the casing 126 and is, therefore, available for removal by an operator. Previous to this operation the limit switch 107 indicated to the controller 103 that the record medium 10 is within the casing 126 and, hence, is inaccessible to the operator. The record medium 10 is moved out of the casing 126 to a point at which the bracket 20 is latched by a latching cam 122 associated with a plunger 123 of a solenoid 120. The solenoid 120 is mounted on a bracket

member 125 which, in turn, is fixed to the plate 28. The end of the solenoid plunger 123 that is opposite the latching cam 122 actuates a switch 130. A spring 124 normally urges the solenoid plunger 123 toward the bracket 20. When the bracket 20 is driven past the latching cam 122, the record medium 10 extends beyond the throat 127 a sufficient distance so that it can be grasped by the operator. The bracket 20 forces the latching cam 122 toward the switch 130 to actuate the switch 130. The signal generated by the switch 130 indicates to the controller 103 that the latching cam 122 is in its lower position (as viewed in Fig. 3) and driving of the frame member 18 continues until the latching cam 122 is urged behind the right leg of the bracket 20. When this occurs, the switch 130 opens and provides a signal to the controller 103 that the plunger 123 has returned to its latching position; and with this signal, the switch 121 is opened, thereby de-energizing the solenoid 78. The record medium 10 is now in its extended position with respect to the casing 126 so it can be removed by the operator and a new record medium inserted therein. When a new record medium 10 is inserted, the controller 103 momentarily energizes a switch 131 which, in turn, energizes the solenoid 120 so the latching cam 122 is withdrawn from the bracket 20 and the frame member 18 is then moved by gravity and the biasing force of the spring 86 to the "home" position.

The controller 103 includes circuitry for associating one of the heads 14 and 15 with the selected track 11 and renders the head operative for reproduction when it is positioned in engagement with the record medium 10. The controller 103 can also include circuitry for remembering the position of the heads 14 and 15 so that the direction of movement of the heads 14 and 15 can be immediately ascertained with the next selection that is made. In another version of such a controller, the heads 14 and 15 can always be returned to a designated track upon completion of a run along a selected track so the movement of the heads 14 and 15 is always in the same direction for locating relative to a newly selected track. In any event, the controller 103 serves as means for locating the heads 14 and 15 relative to any selected track.

WHAT WE CLAIM IS:—

1. Reproducing apparatus including a pair of spaced and generally aligned transducer heads for selectively reproducing information in a plurality of spaced, parallel tracks extending longitudinally on the opposed surfaces of a record medium, the tracks on one surface being generally aligned



either a switch 104 or a switch 105 associated with the stepping motor 51, to rotate the motor 51 in accordance with the necessary direction to locate the selected track

5 11. The motor 51 imparts small increments of movement to the pulley 58 and, via the cable 59, the upper and lower slide members 35 are moved as a unit transversely of the record medium 10. When the heads 14 and

10 15 are properly aligned with the selected track, a signal is generated which causes the solenoid 78 to be energized via a switch 121. As a result, the lever 88 causes the lever 91 to rotate the rods 39 and move the

15 heads 14 and 15 into engagement with the record medium 10. At the same time, the armature 79 permits the lever 80 to be moved by the spring 83 into a position in which the clutch means 74 is engaged, thereby causing the pulley 76 to rotate and move

20 the frame member 18 along the rods 21 and 22 at a uniform rate. When the other end of the tracks on the record medium 10 are adjacent the heads 14 and 15, the forward bracket 19 engages the arm of a limit switch 107 which signals the controller 103 that the end of a track has been reached. Then the controller 103 opens the switch 121 which breaks the circuit to the solenoid 78. When

25 this occurs, the lever 91 returns the heads 14 and 15 to their disengaged positions and the lever 80 releases the clutch means 74. The frame member 18 is now free to be moved by the spring 86 and the force of gravity due to the inclination of the entire device to a "home" or first position wherein the forward end of the tracks 11 on the record medium 10 are adjacent the heads 14 and 15.

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55 available for removal by an operator. Previous to this operation the limit switch 107 indicated to the controller 103 that the record medium 10 is within the casing 126 and, hence, is inaccessible to the operator. The record medium 10 is moved out of the casing 126 to a point at which the bracket 20 is latched by a latching cam 122 associated with a plunger 123 of a solenoid 120.

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member 125 which, in turn, is fixed to the plate 28. The end of the solenoid plunger 123 that is opposite the latching cam 122 actuates a switch 130. A spring 124 normally urges the solenoid plunger 123 toward the bracket 20. When the bracket 20 is driven past the latching cam 122, the record medium 10 extends beyond the throat 127 a sufficient distance so that it can be grasped by the operator. The bracket 20 forces the latching cam 122 toward the switch 130 to actuate the switch 130. The signal generated by the switch 130 indicates to the controller 103 that the latching cam 122 is in its lower position (as viewed in Fig. 3) and driving of the frame member 18 continues until the latching cam 122 is urged behind the right leg of the bracket 20. When this occurs, the switch 130 opens and provides a signal to the controller 103 that the plunger 123 has returned to its latching position; and with this signal, the switch 121 is opened, thereby de-energizing the solenoid 78. The record medium 10 is now in its extended position with respect to the casing 126 so it can be removed by the operator and a new record medium inserted therein. When a new record medium 10 is inserted, the controller 103 momentarily energizes a switch 131 which, in turn, energizes the solenoid 120 so the latching cam 122 is withdrawn from the bracket 20 and the frame member 18 is then moved by gravity and the biasing force of the spring 86 to the "home" position.

The controller 103 includes circuitry for associating one of the heads 14 and 15 with the selected track 11 and renders the head operative for reproduction when it is positioned in engagement with the record medium 10. The controller 103 can also include circuitry for remembering the position of the heads 14 and 15 so that the direction of movement of the heads 14 and 15 can be immediately ascertained with the next selection that is made. In another version of such a controller, the heads 14 and 15 can always be returned to a designated track upon completion of a run along a selected track so the movement of the heads 14 and 15 is always in the same direction for locating relative to a newly selected track. In any event, the controller 103 serves as means for locating the heads 14 and 15 relative to any selected track.

WHAT WE CLAIM IS:—

1. Reproducing apparatus including a pair of spaced and generally aligned transducer heads for selectively reproducing information in a plurality of spaced, parallel tracks extending longitudinally on the opposed surfaces of a record medium, the tracks on one surface being generally aligned



with those on the other surface in accordance with the alignment of the transducer heads, comprising a carrier which is movable in a rectilinear path and is adapted to support the record medium between the transducer heads, first moving means for moving the transducer heads transversely of the record medium to engage simultaneously a selected track on one of the said opposed surfaces and the track aligned therewith on the other of said opposed surfaces, second moving means for moving the record medium in a direction parallel to the tracks and relative to the transducer heads, and means for rendering the transducer head engaging the selected track operative to reproduce information thereon.

2. Apparatus according to Claim 1 wherein the carrier is adapted to support the record medium in a plane oriented at an angle to the horizontal.

3. Apparatus according to Claim 1 or 2 wherein the carrier comprises a frame which engages opposite edges of the record medium.

4. Apparatus according to Claim 2 or 3 as appendant to Claim 2 wherein the second moving means comprises first drive means for positively moving the carrier in a first direction parallel to the tracks and upward in the said plane and second drive means independent of the first drive means for moving the carrier in a second direction opposed to the first direction.

5. Apparatus according to Claim 4 wherein the first drive means is coupled to the carrier by clutch means and a cable drive connected to the carrier.

6. Apparatus according to Claim 4 or 5 wherein the first drive means and the second drive means are operable to move the carrier between a first position in which the transducer heads are adjacent one end of the tracks on the respectively opposed surfaces of the record medium and a second position in which the transducer heads are adjacent the other end of the tracks.

7. Apparatus according to Claim 4, 5 or 6 wherein the second drive means comprises biasing means coupled to the carrier and wherein movement of the carrier in the said second direction by the second drive means is aided by gravity.

8. Apparatus according to any one of Claims 2, 4, 5, 6 and 7 or Claim 3 as appendant to Claim 2, comprising guide means for guiding the movement of the carrier to effect longitudinal movement of the record medium in the said plane.

9. Apparatus according to Claim 8 wherein the carrier is slidably mounted on the guide means.

10. Apparatus according to Claim 3 and either of Claims 8 and 9, wherein the guide means comprises a member for supporting

a pair of spaced, parallel rods on which the frame is slidably mounted.

11. Apparatus according to any one of Claims 2—10 comprising transducer head support means operatively associated with the first moving means and mounted each side of the carrier for supporting each of the transducer heads in a position disengaged from the record medium and transversely movable relative to the tracks on the respectively opposed surfaces of the record medium.

12. Apparatus according to Claim 11, wherein the transducer head support means comprises a cantilever member arranged with respect to each side of the carrier and slidably mounted for movement transversely of the record medium.

13. Apparatus according to Claim 12, wherein each of the cantilever members comprises a first pivotal member, a second member pivotally mounted on the first member, a transducer head supporting member pivotally mounted on the second member, and means carried by the first member and engaging the second member for controlling the pressure with which the transducer head, in use, engages the record medium.

14. Apparatus according to Claim 13 wherein the second member and the transducer head supporting member include means for adjusting its respective transducer head laterally relative to the longitudinal direction of the tracks and relative to the plane of the record medium.

15. Apparatus according to Claim 13 or 14 wherein the first moving means comprises a stepping motor and a cable drive interconnecting the motor and each of the first pivotal members.

16. Apparatus according to any one of the preceding Claims 11—15 comprising third moving means operatively associated with the transducer head support means for moving the transducer heads simultaneously into reproducing engagement with tracks on the respectively opposed surfaces of the record medium.

17. Apparatus according to Claim 16 as appendant to any one of preceding Claims 13—15, wherein the third moving means comprises a linkage engaging each of the first pivotal members.

18. Apparatus according to Claim 6 and either of Claims 16 and 17, wherein the carrier and the third moving means are moved into the second position and the engaged position, respectively, counter to spring biasing means for returning each to its respective first and disengaged positions.

19. Apparatus according to any one of the preceding Claims comprising means responsive to the selection of any track for initiating the first moving means to position the transducer heads adjacent to the selected



track and for rendering the transducer head in engagement with the selected track operative for reproducing.

5 20. Apparatus according to Claim 19 comprising means responsive to the positioning of the transducer heads by the first moving means for generating an operating signal.

10 21. Apparatus according to Claims 4, 16 and 20 comprising means responsive to the operating signal for initiating the third moving means and the first drive means, whereby the record medium is moved relative to the transducer head which is in engagement with the selected track for reproducing the in-

15 22. Apparatus according to Claim 21 wherein the means responsive to the operating signal comprises a solenoid operatively connected to the first drive means and to
20 the third moving means.

23. Apparatus according to Claims 5, 17 and 22 wherein the solenoid is operatively connected to the linkage and to the clutch means.

24. Apparatus according to Claim 6 and 25 any one of Claims 19—23 including means actuated by the carrier, when the carrier is in the second position, for decoupling the first drive means and the means responsive to the selection of any track whereby the carrier is returned to the first position by the second drive means and the transducer heads are moved to the disengaging position.

25. Apparatus according to Claim 1 constructed substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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