United States Patent [19]

Britz

[11] **3,749,410**

[45] **July 31, 1973**

[54] **AUTOMATED CHANGER-PLAYER FOR MAGNETIC TAPE CARTRIDGE RECORDINGS**

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[21] Appl. No.: **27,886**

[52] **U.S. Cl.** ..... **274/4 F**
[51] **Int. Cl.** **G11b 5/00**
[58] **Field of Search** ..... 274/4 E, 4 F; 242/197-200

[56] **References Cited**

UNITED STATES PATENTS

3,408,139	10/1968	Schwartz et al.	274/4 F
3,484,055	12/1969	Raine	274/4 F
3,617,066	11/1971	Foelkel	274/4 F
3,512,785	5/1970	Ban	274/4 F

FOREIGN PATENTS OR APPLICATIONS

1,299,127	7/1969	Germany	274/4 F

Primary Examiner—Harry N. Haroian
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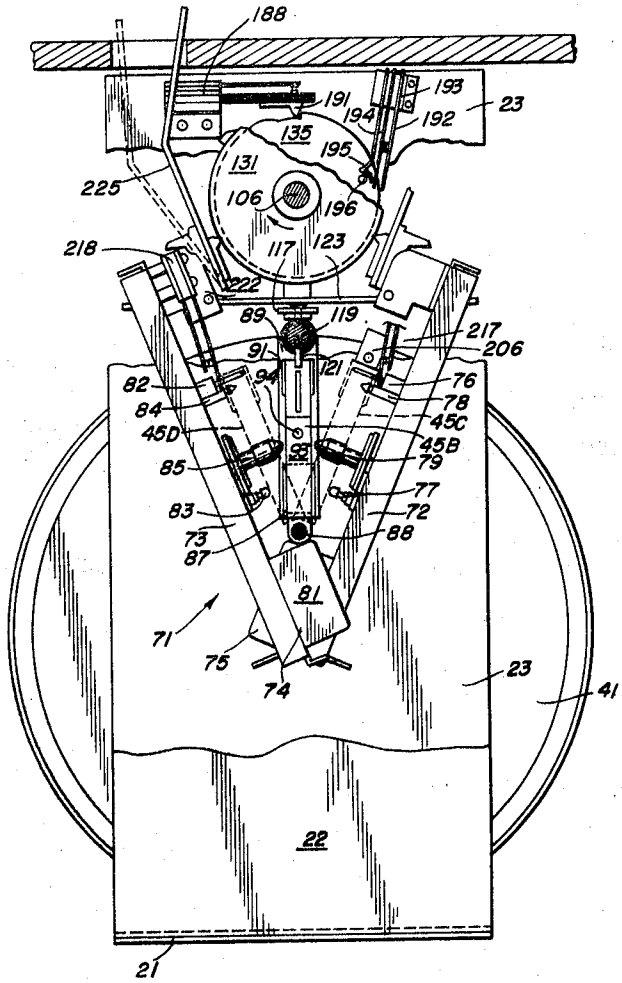
[57] **ABSTRACT**

An automated changer-player for magnetic tape cartridge recordings in which a plurality of cartridges are stored in a rotary drum storage magazine having a stepping drive to advance the cartridges, one-by-one, to a transfer position. A transfer mechanism transfers a cartridge along a path parallel to the drum axis to an intermediate position in a tape play mechanism that includes two tape decks arranged in V-shaped configuration on opposite sides of the intermediate position. The cartridge is shifted angularly, first to one tape deck and then to the other, to play both sides of the tape, and then is returned to the intermediate position and transferred back to the storage drum. A sequential electrical control for the changer-player includes a selector to select tapes for playing on an individual basis, with provision for skipping empty tape positions in the drum.

5 Claims, 10 Drawing Figures



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SHEET 1 OF 6

FIG. 1

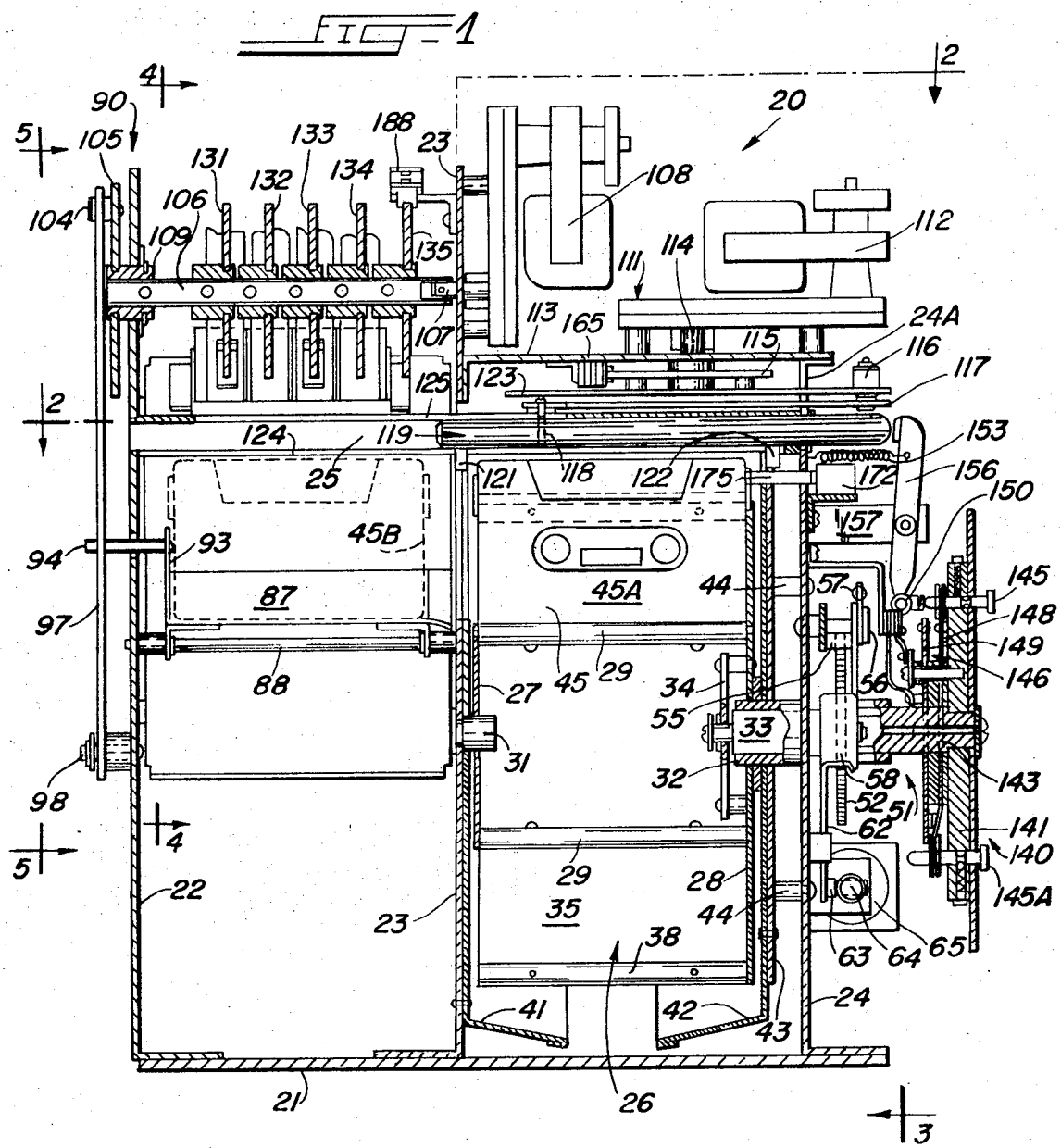

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FIG. 2

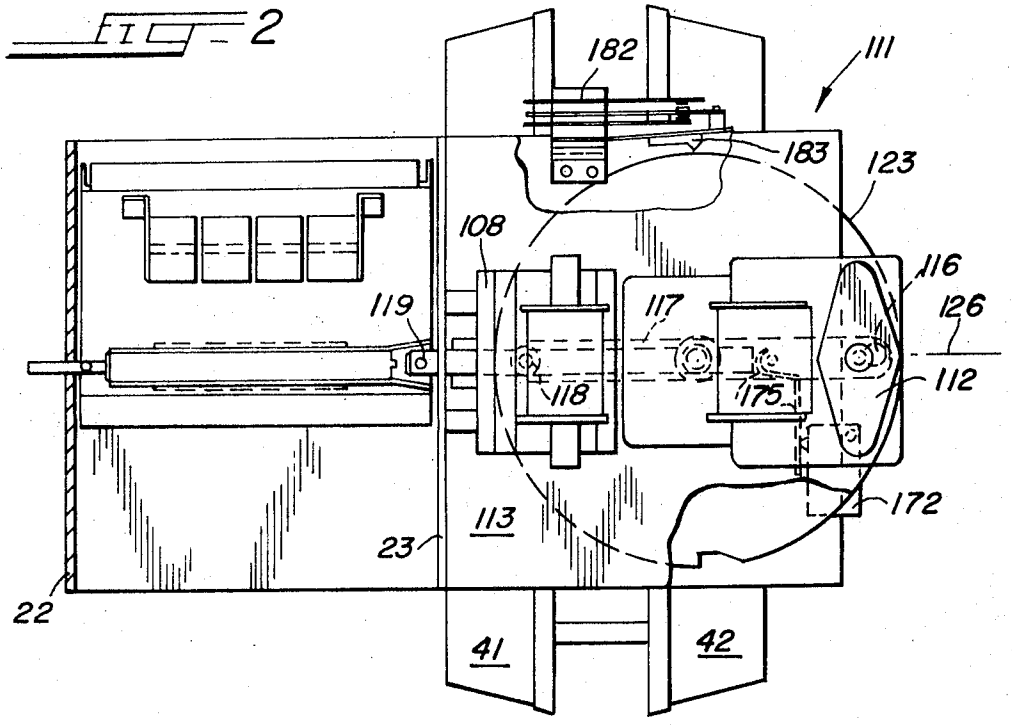

FIG. 3

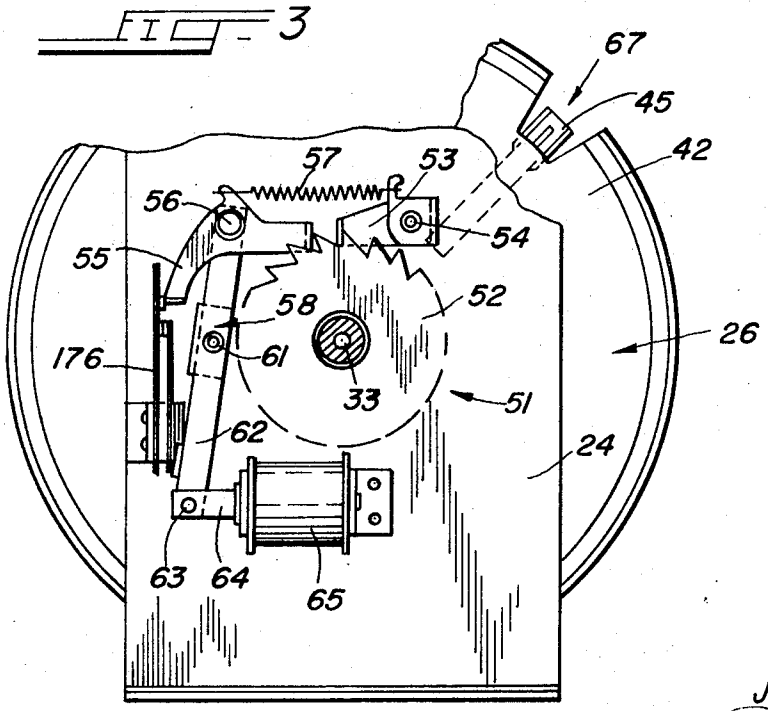

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FIG. 4

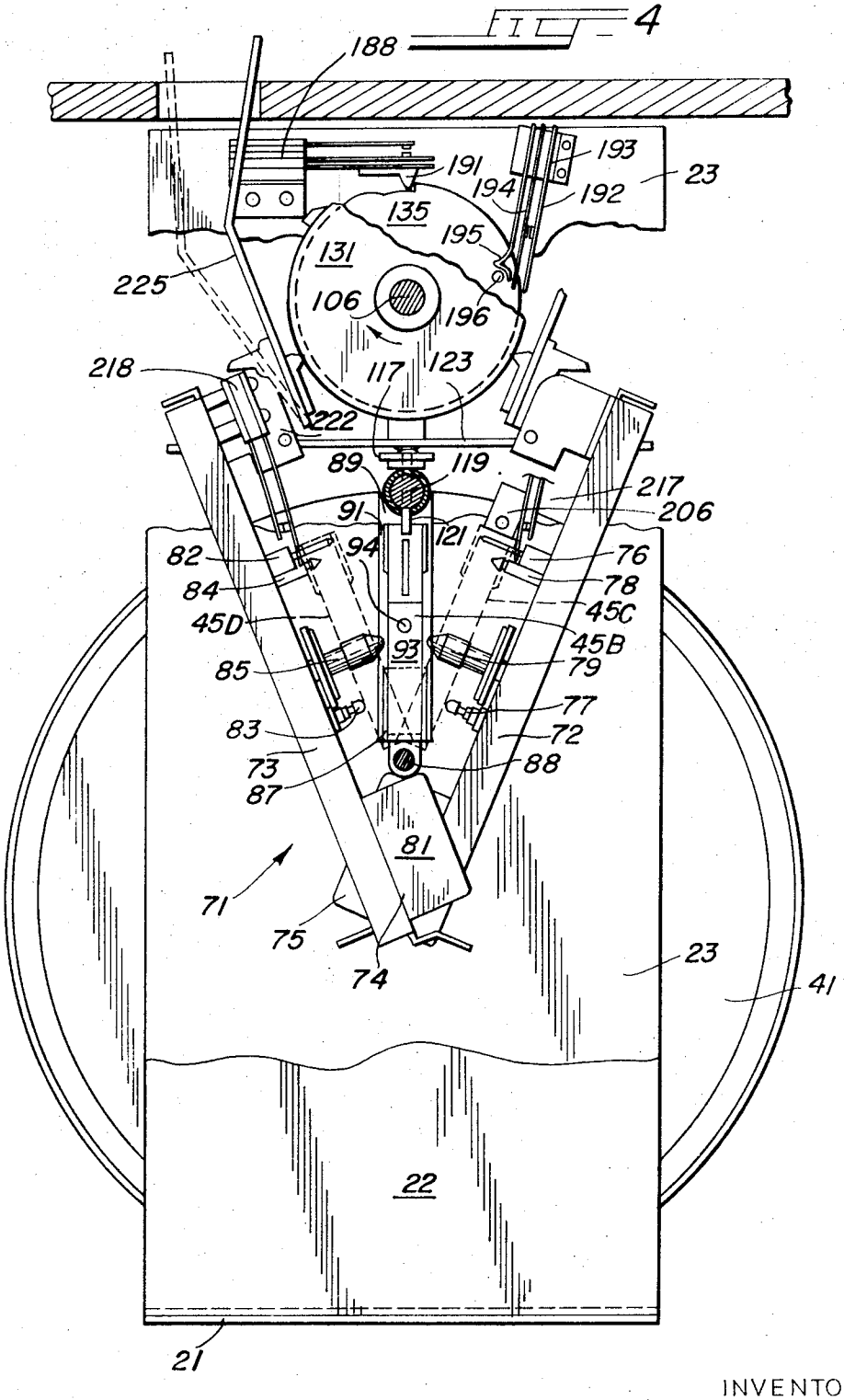

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Fig. 5

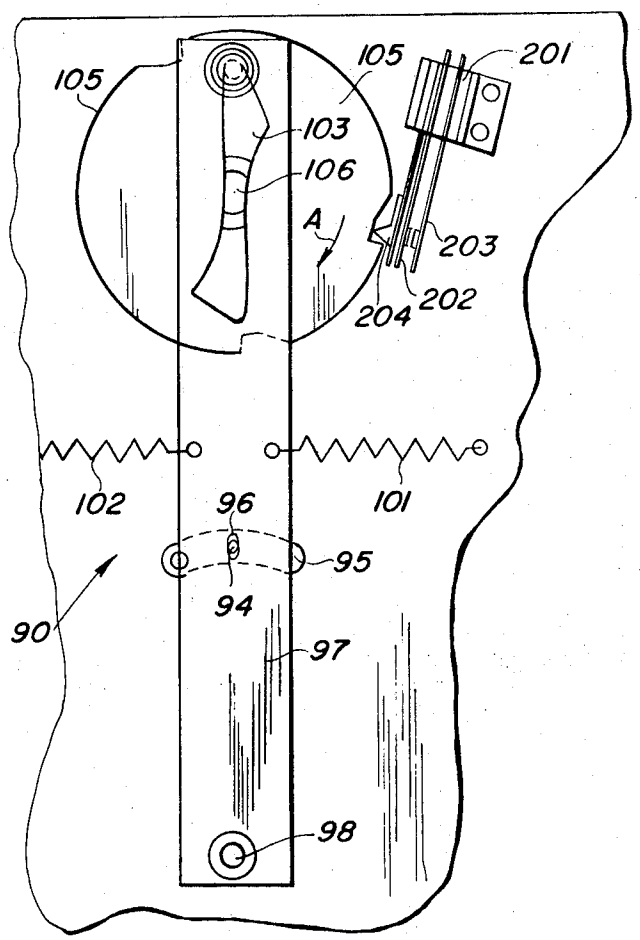

Fig. 6

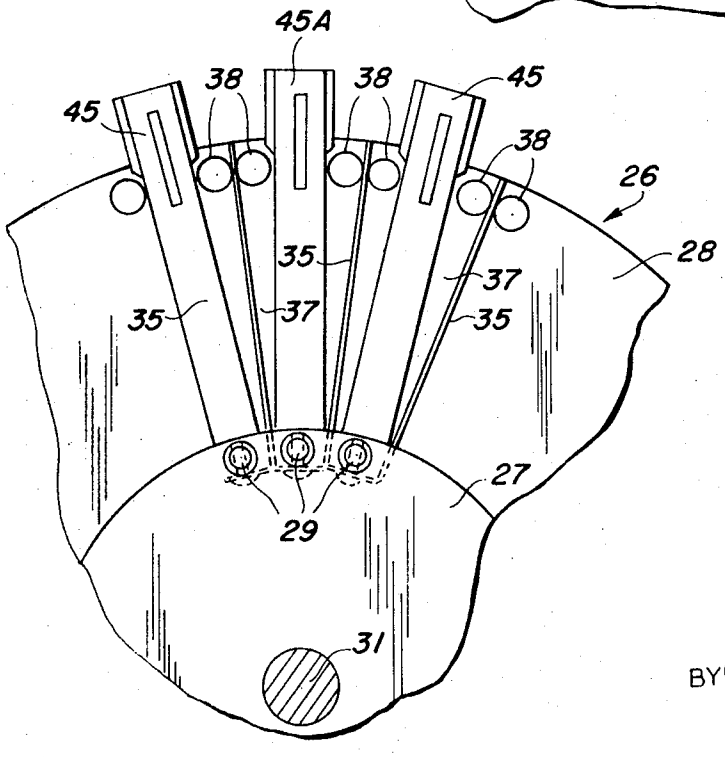

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FIG 7

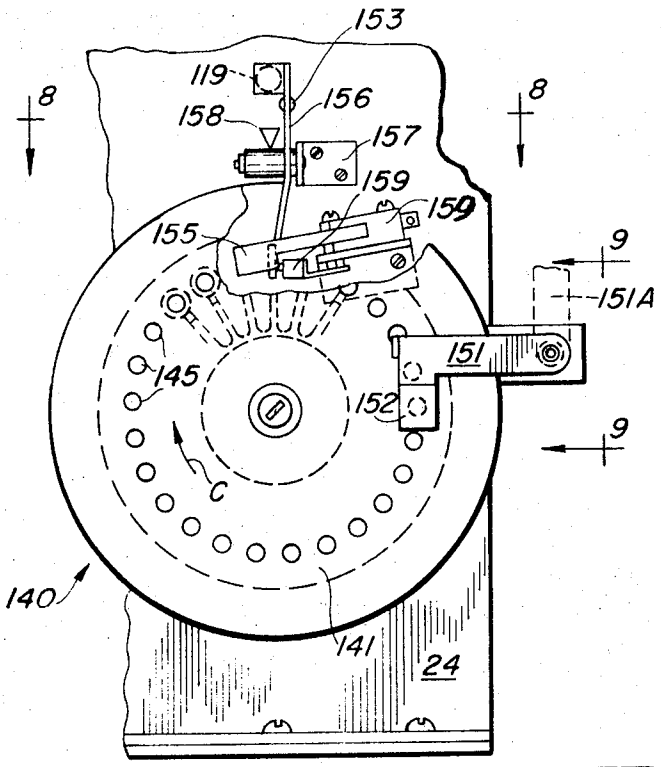


FIG 9

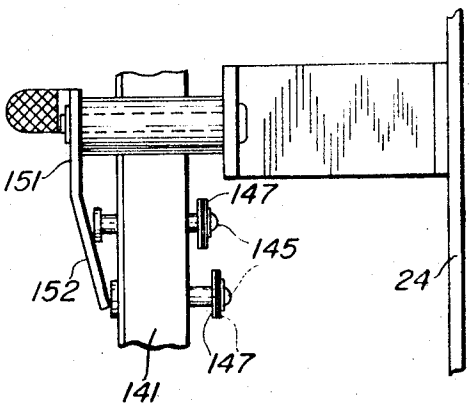
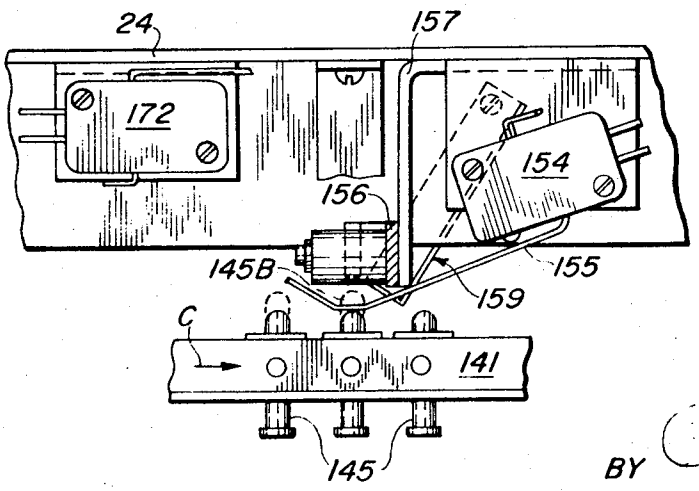


FIG 8



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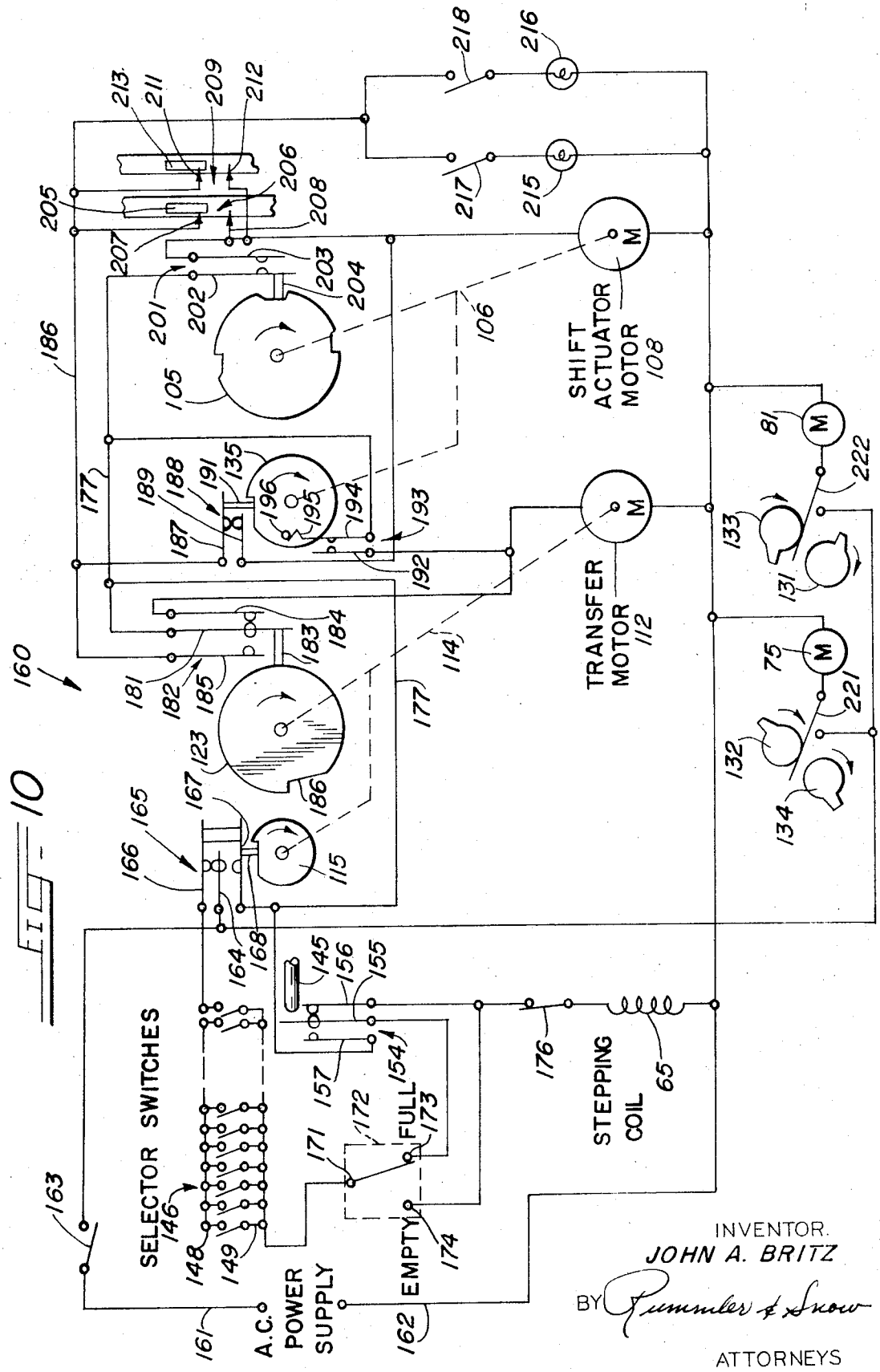

FIG. 10

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AUTOMATED CHANGER-PLAYER FOR MAGNETIC TAPE CARTRIDGE RECORDINGS

BACKGROUND OF THE INVENTION

Magnetic tape recordings of musical performances and other forms of comparable have come into increasingly popular use. In many instances, the magnetic tape record is mounted within a light plastic container or cartridge, sometimes referred to as a "cassette." Cartridge-type magnetic tape recordings are convenient for use in many environments, since the tape is protected against physical damage, dirt, and other adverse environmental factors. The tape recordings can provide high fidelity reproduction, in either monophonic or stereophonic form; in many commercial cartridge-type tape recordings, four or eight recording tracks are utilized, affording high quality in the reproduced sound. The cost of magnetic tape recordings, in cartridges, is reasonably comparably to the cost of high fidelity phonograph records and has proved commercially acceptable. Cartridge tape players are often used in automobiles, and also find applications in homes and in other locations.

The playback equipment for magnetic tape cartridge recordings, however, has not afforded the versatility and flexibility available, in many instances, with phonograph records. In particular, multiple-play equipment capable of utilizing magnetic tape cartridges has not been available. Most playback equipment is limited to a single cartridge, with manual removal and insertion necessary to effect a cartridge change. There have been magnetic tape cartridge players that play up to six cartridges in succession. Some of these players have played only the forward tracks of the tapes, requiring manual resetting to play the reverse tracks. Others have provided for play of both sides of the tapes, but without the option of selection or rejection of individual tapes. As a consequence, recordings of this kind have not gained general acceptance for use in commercial situations where a long playing time, with selectivity, is required or in home situations where the same requirement may exist.

SUMMARY OF THE INVENTION

It is a principal object of the invention, therefore, to provide a new and improved automated changer-player for magnetic tape cartridge recordings that can store and play all tracks on a substantial number of tapes with no attention from the operator and, particularly, no necessity for manual resetting.

Another object of the invention is to provide a new and improved automated changer-player for magnetic tape cartridge recordings that permits effective selection of any given number of tapes from a plurality of tapes stored in the changer mechanism, without requiring the playing of other tapes that may also be stored in the same mechanism.

A further object of the invention is to provide a new and improved automated changer-player for magnetic tape cartridge recordings that operates either to play all tapes in sequence, or to play only selected tapes, and that has a large storage capacity yet is relatively compact in size.

A particular object of the invention is to provide a new and improved automated changer-player for magnetic tape cartridge recordings that is economically and

operationally competitive with high quality phonograph record changers.

An automated changer-player for magnetic tape cartridge recordings, constructed in accordance with the invention, comprises a rotary drum storage magazine for receiving and storing a plurality of tape cartridges, together with a stepping drive for rotating the magazine to advance the cartridges, one by one, to a transfer position. The changer-player further comprises a tape play mechanism including at least one tape play deck located adjacent one side of an intermediate cartridge position, the intermediate cartridge position in the tape play mechanism being aligned with the transfer position of the drum storage magazine. In the preferred construction, there are two tape play decks, one at each side of the intermediate cartridge position. A transfer mechanism is provided for transferring a cartridge along a predetermined transfer path from the transfer position of the drum storage magazine to the intermediate position in the tape play mechanism. The tape play mechanism includes shift means for shifting a cartridge, relative to the tape play deck, to engage the tape play deck and play the tape and subsequently restore the cartridge and deck to their initial relationship with the cartridge in the aforementioned inter-mediate position. With two tape decks, the cartridge is first shifted to one tape deck for playing the forward tracks of the tape, then shifted to the other deck for playing the reverse tracks, and is then returned to the intermediate position for transfer back to the storage magazine. In addition, the changer-player includes sequential electrical control means for actuating the stepping drive, the transfer mechanism and the shift means in predetermined sequence to play the tapes in the magazine. Preferably, selector means are provided for selecting individual tape cartridges to be played, without playing other tape cartridges, in accordance with the positions of the tape cartridges in the storage magazine.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevation view, partly in cross section, of an automated changer-player for magnetic tape cartridge recordings constructed in accordance with one embodiment of the present invention;

FIG. 2 is a partially cut away plan view of the changer-player apparatus of FIG. 1, taken approximately along line 2—2 in FIG. 1;

FIG. 3 is a detail view of the stepping drive for the tape cartridge storage magazine, taken approximately along line 3—3 in FIG. 1;

FIG. 4 is a sectional elevation view of the tape play mechanism of the changer-player, taken approximately along line 4—4 in Fig. 1;

FIG. 5 is a detail elevation view taken approximately as indicated by line 5—5 in FIG. 1;

FIG. 6 is a detail view of a part of the rotary drum storage magazine for the automated changer-player;

FIG. 7 is a detail elevation view of a part of the selector mechanism for the automated changer-player;

FIGS. 8 and 9 are detail views of control switches incorporated in the automated changer-player; and

FIG. 10 is a schematic diagram of the sequential electrical control system for the changer-player.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The automated changer-player 20 for magnetic tape

cartridge recordings that is generally illustrated in the elevation view of FIG. 1 comprises a frame that includes a base member 21 on which three vertical frame members 22,23 and 24 are mounted, with a tubular member 25 extending between the vertical frame members 22–24 in the upper part of the frame. In the right-hand side of the frame of the changer-player 20, a rotary drum storage magazine 26 is mounted between frame members 23 and 24.

The drum storage magazine 26 comprises two central disc-shaped plates 27 and 28 joined together by a plurality of spacer rods 29. The plate 27 is of relatively small diameter and is mounted upon a shaft 31 journalled in the center frame member 23. The plate 28 is substantially larger in diameter than the plate 27 and is supported by a bearing 32 that is mounted in the right-hand vertical frame member 24. The plate 28 is connected to a drive shaft 33 by a drive connection comprising a drive member 34 having its radial outer ends affixed to the plate 28; the center portion of the drive member 34 is secured to the drive shaft 33. The drive shaft 33 extends through the bearing 32 and is connected to a stepping drive described more fully hereinafter.

As shown in FIGS. 1 and 6, the drum storage magazine 26 further includes a plurality of compartment plates 35, one affixed to each of the spacer rods 29. The compartment plates 35 each extend radially outwardly of the drum storage magazine 26, defining a plurality of individual tape cartridge compartments 37. At the outer end of each of the compartment plates 35, there are two additional spacer rods 38 affixed to the opposite sides of the compartment plate. In the illustrated construction, there are a total of 25 individual tape storage compartments 37 in the drum storage magazine 26; it will be recognized that this particular storage capacity for the drum 26 is not critical and may be selected to meet the needs of the intended use for the changer-player 20.

The drum storage magazine 26 is provided with a stationary housing or cover comprising two lightweight cover members 41 and 42. The cover member 41 is affixed to frame member 23 and projects over the peripheral portion of drum 26. The complementary cover member 42 is affixed to an auxiliary frame member 43 that is mounted upon the vertical frame member 24 by appropriate means such as a plurality of support posts 44. The auxiliary frame member 43 also serves as an additional support for the hub 32 through which the drum drive shaft 33 extends and lends greater rigidity to the overall structure.

The rotary drum storage magazine 26 has a storage capacity of 25 individual tape cartridges or cassettes 45, one in each of the compartments 37 as illustrated in IG. 6. In FIG. 1, most of the cartridges 45 have been omitted from the drawing to enable better illustration of the structure of the storage drum. However, one cartridge is shown in the uppermost position 45A in the drum 26 in FIG. 1, this particular cassette position 45A is referred to hereinafter as the transfer position for the drum. The cartridges 45 illustrated in the drawings are of the "Philips" type, but other tape cartridges can be used with appropriate dimensions and arrangement of the various components of the player-changer 20.

The drum storage magazine 26 is provided with a stepping drive 51 (FIGS. 1 and 3) for rotating the magazine to advance the cartridges 45, one by one, to the transfer position 45A. The stepping drive 51 includes a ratchet wheel 52 mounted upon the drive shaft 33; the ratchet wheel and the shaft may be formed as a single, integral plastic molded part. The ratchet wheel 52 is engaged by a holding pawl 53 that is pivotally mounted upon a small shaft 54 affixed to the vertical frame member 24. The ratchet wheel is also engaged by a drive pawl 55 which is pivotally mounted upon a pin 56. The drive pawl 55 is connected to the retaining pawl 53 by a spring 57. The pin 56 is mounted on the upper end of an elongated drive lever 58 that is pivotally mounted on a shaft 61 supported upon the frame member 24. The lower end 62 of the lever 58 is connected by a pin 63 to the armature shaft 64 of a solenoid coil 65.

Operation of the stepping drive 51, the control of which is described in detail hereinafter in connection with FIG. 10, is effected by energization of the solenoid coil 65. Upon energization of the coil 65, the armature shaft 64 is pulled into the coil, pivoting drive lever 58 about shaft 61 in a counterclockwise direction. As the drive pawl 55 moves to the left, counterclockwise rotation of the ratchet wheel 52 is prevented by the holding pawl 53. The drive pawl 55 moves far enough counterclockwise to engage the next tooth on the ratchet wheel 52 and at the same time actuates a switch 176 to de-energize the solenoid coil 65. With the coil de-energized, the spring 57 pulls the drive pawl 55 and its support lever 58 back to the right, rotating the ratchet wheel 52 one step in a clockwise direction.

During the clockwise rotation of the ratchet wheel 52, the retaining pawl 53 rides up on the ratchet tooth with which it is engaged to the end of that tooth. The retaining pawl drops in behind the adjacent tooth and prevents the ratchet wheel 52 from rotating back in a counterclockwise direction in the next stepping operation of the ratchet drive 51. The teeth on the ratchet wheel 52 are equal in number to the number of cartridge storage positions in the drum 26; consequently, the stepping drive 51 rotates the drum storage magazine to advance each of the cartridges 45, one by one, to the transfer position 45A. In the course of this operation, each storage compartment of the drum also passes a loading opening 67 in the housing members 41 and 42 (see FIG. 3) which permits convenient insertion and removal of individual cartridges from the storage drum.

The changer-player 20 further comprises a tape playing mechanism 71 that is mounted intermediate frame members 22 and 23 (FIGS. 1 and 4). As shown in FIG. 4, the tape play mechanism 71 includes two tape decks 72 and 73 that are mounted between frame members 22 and 23 in an angular V-alignment relation to each other. The bight of the V formed by the tape decks 72 and 73 is aligned with the axis 74 of the storage drum 26.

The tape deck 72 may be of generally conventional construction. It includes a tape drive motor 75 connected by a timing belt or other appropriate drive means (not shown), to a capstan 76. The capstan 76 projects through an opening in a cartridge positioned on the tape deck, this cartridge position being indicated by the dash outline 45C. The tape deck 72 further includes support members 77 and 78 for positioning a cartridge in the position 45C, with other elements such as the spindle 79 to assure effective playing of the tape. A magnetic pick-up head (not shown) is also mounted on and constitutes a part of tape deck 72.

The second tape deck 73 in the tape play mechanism 71 is of similar construction and includes a tape drive motor 81, a capstan 82, suitable support and guide members 83 and 84, and a spindle 85 for supporting a tape cartridge on tape deck 73 in the position indicated by the dash outline 45D. The tape deck 72 also includes an appropriate magnetic pick-up head (not shown).

The tape play mechanism 71 further includes a cartridge holder 87 that is aligned with the drum axis 74 but is located above the drum axis, intermediate the two tape decks 72 and 73. The cartridge holder 87 is of generally U-shaped cross-sectional configuration, open at the end toward the drum 26 and closed at the opposite end. The cartridge holder 87 is mounted upon a shaft 88 that extends between the frame members 22 and 23 (FIGS. 1 and 4). With the cartridge holder 87 in the position illustrated, it is seen that a cartridge can be moved from the transfer position 45A (FIG. 1) through aligned openings 89 and 91 in the magazine cover member 41 and the frame member 23 into the vertical position 45B in which the cartridge is shown in FIG. 4.

FIGS. 1, 4 and 5 illustrate a shift means 90, including the cartridge holder 87, for shifting a tape cartridge between positions 45B, 45C and 45D. The end of the cartridge holder 87 nearest the frame member 22 includes an upwardly extending element 93 to which an elongated pin 94 is affixed. The pin 94 projects through an arcuate slot 95 in the frame member 22 and through a small opening 96 in a cartridge shift pivot arm 97. The arm 97 is pivotally mounted upon a shaft 98 affixed to the frame member 22 (FIGS. 1 and 5) and is normally maintained in the illustrated vertical alignment of FIG. 5 by biasing means comprising two springs 101 and 102.

The upper end of the pivot arm 97 has an elongated slot 103 through which a pin 104 projects. The pin 104 is affixed to a cam 105 that is mounted upon a tape play actuation shaft 106. The shaft 106 is connected to the output shaft 107 of a tape play actuation motor 108. The left-hand end of the shaft 106 is journalled in a bearing 109 mounted in the vertical frame member 22. The motor 108 is mounted upon the upper part of the vertical frame member 23. The shaft 106 carries a series of cams 131-135 employed for control purposes as explained hereinafter.

The basic mechanical operation of the cartridge shift means 90 may be understood from the mechanism illustrated in FIGS. 1, 4 and 5; control of the shift means 90 is described hereinafter in connection with FIG. 10. A tape cartridge that is to be played is first positioned in the intermediate position 45B in the tape play mechanism 71. To shift the cartridge from position 45B to position 45C, the motor 108 is energized to rotate the shaft 106 in a clockwise direction as indicated by the arrow A in FIG. 5. The clockwise rotation of the shaft 106 and the disc 105 pivots the arm 97 in a clockwise direction. As the arm 97 moves to the right (FIG. 5) it causes a corresponding pivotal movement of the cartridge holder 87, due to the connection between the cartridge holder 87 and the arm 97 that is afforded by the element 93 and the pin 94.

After the cam disc 105 rotates through an arc of about 120°, the motor 108 is stopped, at which point the arm 97 has been pivoted to bring the pin 94 to the right-hand end of the slot 95. The resulting pivotal shift of the cartridge holder 87 moves a cartridge mounted in the cartridge holder to the position 45C, where the cartridge is engaged by the operative components of the tape deck 72. With the cartridge in the position 45C, the forward tracks of the tape are played.

When the play of the forward tracks has been completed, the shift motor 108 is again energized to rotate the shaft 106 and the disc 105 in a clockwise direction. In this instance, rotation is maintained for approximately 180°, pivoting the arm 97 in a counterclockwise direction and bringing the pin 94 to the left-hand end of the slot 95. The arcuate movement of the pin 94 causes a corresponding movement of the cartridge holder 87, shifting the cartridge in the holder from position 45C on the tape deck 72 to position 45D on the second tape deck 73. At this point, the motor 108 is deenergized and the reverse tracks of the tape in the cartridge are played. When play of the reverse tracks has been completed, the motor 108 is again energized and rotates the shaft 106 and the disc 105 through an additional arc of approximately 60° back to the position illustrated in FIG. 5.

This returns the pivot arm 97 to its original vertical alignment and thus swings the cassette holder 87 back to vertical position to locate the cartridge in the intermediate position 45B, from which it can be transferred back to the storage drum 26.

The changer-player 20 further comprises a transfer mechanism 111 that is best illustrated in FIGS. 1, 2 and 4. The transfer mechanism 111 comprises a motor 112 mounted upon a shelf 113; the shelf 113 extends from the upper part of the vertical frame member 23 to an upper extension 24A of the vertical frame member 24. The shaft 114 of the transfer motor 112 carries a cam 115 and a large cam disc 123. The large cam disc 123 has a pin 116 mounted near the periphery of the disc. The pin 116 is pivotally connected to one end of a transfer drive link 117. The other end of the link 117 carries a pin 118 that extends downwardly into an aperture in a transfer slide rod 119. The slide rod 119 is slidably mounted in the tubular member 25, the tube 25 having an elongated slot 125 to provide for the pin 118. A pin 121 is mounted on the slide rod 119, near the left-hand end of the slide rod as seen in FIG. 1, and extends downwardly through a slot 124 in the tube 25. A similar pin 122 projects downwardly through slot 124 from a point near the opposite end of the slide rod.

The operation of the transfer mechanism 111 is initiated by energizing the transfer motor 112, rotating the shaft 114. As the shaft 114 rotates, the disc 123 rotates, carrying the pin 116 with it. Starting from the position illustrated in FIG. 2, with the motor shaft and the disc 123 rotating in a clockwise direction, the arcuate movement of the pin 116, starting from the center line 126, begins to drive the link 117 to the left. This imparts a corresponding movement to the slide rod 119.

With a tape cartridge in the position 45A in the drum storage magazine, the movement of the slide rod 119 to the left brings the slide rod pin 122 into engagement with the right-hand edge of the cartridge and starts the cartridge sliding from the position 45A toward the intermediate position 45B in the tape play mechanism 71. After approximately 180° rotation of the disc 123, the slide rod 119 has been driven to the left, as seen in FIGS. 1 and 2, through a distance sufficient to move the tape cartridge completely into the cartridge holder 87 in the transfer mechanism as indicated by the dash

outline 45B in FIG. 1. From this intermediate position, the cassette can be played on both sides as described above.

When the play of the tape cartridge has been completed and the cartridge is to be returned to the storage drum 26, the transfer motor 112 is again energized and drives the shaft 114 through approximately 180°. During this rotation of the shaft 114, the disc 123 also rotates ends up free of the pins 121 and 122 when the cartridge is finally positioned of approximately 180° and pulls the transfer link 117 back to the position shown in FIGS. 1 and 2. As a consequence, the slide rod 119 moves back to the right to its original position. In the course of this movement, the slide rod pin 121 engages the cassette that has been located in position 45B in the tape play mechanism 71 and moves it back to its original position 45A in the storage drum 26. In each instance, there is a slight overriding movement for the slide rod 119 so that the cartridge is finally positioned in either the transfer position 45A or the intermediate tape play position 45B.

FIGS. 1 and 7 illustrate a selector means 140 utilized to select individual tape cartridges for play without playing other cartridges stored in the drum 26. The selector means 140 comprises a selector disc 141 mounted upon an extension 143 of the ratchet shaft 33 for rotational movement in synchronism with the rotation of the drum.

A series of selector pins 145 are mounted around the periphery of the selector disc 141. The total number of selector pins 145 corresponds to the number of cartridge compartments in the storage drum 26 and suitable indicia are applied to the selector disc 141 to identify each of the selector pins 145 as corresponding to a particular storage compartment in the drum. The pins 145 are each actuatable, on an individual basis, from a normal non-selective position as shown at the top of the disc 141 in FIG. 1 and an actuated or selection position illustrated by the pin 145A at the bottom of the disc 141. Each pin 145 is provided with a simple resilient detent.

For each of the selector pins 145, there is a corresponding selector switch 146 on the selector disc 141. The switch construction is best illustrated in FIG. 1. As shown therein, each of the selector pins 145 has a pair of insulator washers 147 mounted on the pin. The end of a spring contact 148 is held between the two insulator washers. The contact 148 is held in open position, spaced from the other contact 149 of the switch 146, when the pin is in its non-selective, retracted position as shown by pin 145 in FIG. 1. Whenever the selector pin 145 is pressed inwardly of the selector disc 141 to effect a selection operation, the movement of the pin to the position shown by pin 145A moves the contact 148 to the left into engagement with the second contact 149 of the switch.

In some instances, it may be desirable to depress all of the selector pins 145 to play any and all tape cartridges that are present in the storage drum. This could be done manually, by pushing each of the pins 145 on an individual basis. To eliminate the necessity for manual actuation of the selector pins when it is desired to play all tape cartridges present in the storage drum, a camming lever 151 can be shifted from a normal retracted position 151A out of engagement with the selector mechanism into the automatic-play position illustrated in FIGS. 7 and 9.

The rotational movement of the selector disc 141 is in a clockwise direction as indicated by the arrow C in FIG. 7. As the drum is stepped by the ratchet drive 51 to bring successive cartridges to playing position, as described above, the corresponding rotation of the selector disc 141 brings each of the pins 145 into engagement with an angularly inclined cam portion 152 of the cam lever 151. Each selector pin 145 is thus driven inwardly of the selector disc 141 to its selection position; consequently, each selector pin is actuated to permit the playing of the corresponding tape cartridges.

The selector pins 145 are also employed to actuate an index position switch 154 that is best illustrated in FIG. 8. The switch 154 is a single-pole double-throw switch, operated by an extension arm 155. When an undepressed selector pin 145 reaches the top index position for the selector disc 141, as indicated by the index marker 158, the pin does not actuate the switch 154. This signals the control system of the changer-player 20 that a particular compartment of the storage drum 26 that has reached the cartridge transfer position 45A is not to be played. On the other hand, if the selector pin 145 has previously been depressed to the position 145B (FIG. 8), upon reaching the top index position 158 the pin engages the extension arm 155 of the switch 154. This signals to the control system that the tape cartridge at the transfer position for the storage drum is to be played.

To avoid repetitive playing of the same selections, a reset mechanism is provided for the selector pins 145. This mechansim includes a lever 156 that is pivotally mounted on a bracket 157 affixed to the frame member 24. The upper end of the lever 156 engages the right-hand end of the slide rod 119, being biased toward the slide rod by a spring 153. The lower end of the lever 156 carries a roller 150 aligned with the selector pin 145 at the index position 158 of the selector disc 141.

In each operation of the trasfer mechanism 111, as the slide 119 starts its transfer motion, the lever 156 is pivoted in a counterclockwise direction by the spring 153. This drives the roller 150 outwardly toward the disc 141, and resets the selector pin at the transfer position from its depressed position (dash outline 145B) to its origninal unactuated position. A camming bracket 159 may be provided to assure deflection of each of the pins 145 back to the initial retracted position as the continuing movement of the selector disc 141 shifts the pins beyond the index or transfer position 158.

FIG. 10 affords a schematic illustration of a sequential and selective control means 160 for the player-changer 20. As illustrated in FIG. 10, the control system 160 may be connected to a conventional A.C. power supply by two main power leads 161 and 162. A main control switch 163 is connected in series in the power lead 161, which extends to the center terminal 164 of a single-pole double-throw cam-actuated switch 165. The switch 165 has two contacts 166 and 167 that are engageable in alternation with the center contact 164. The switch contact 167 carries a cam follower pin 168 that engages the cam 115 on the output shaft 114 of the transfer motor 112 (see FIG. 1). When the cam 115 is at its home position with the slide rod 119 completely retracted as shown in FIG. 1, the switch 165 is in the operating condition illustrated in FIG. 10 with the switch contacts 164 and 166 closed and the contacts 164 and 167 open.

The contact 166 of the cam switch 165 is connected to the contacts 148 in all of the twenty-five selector switches 146 (see FIG. 1). The contact 149 for each selector switch 146 is connected to the center terminal 171 of a magazine sensing switch 172. The switch 172 is a single-pole double-throw device having two output terminals 173 and 174. As shown in FIGS. 1 and 2, the magazine switch 172 is mounted adjacent the frame member 24 near the top of the rotary drum 26 and includes an actuator arm 175 that projects through an opening in the vertical frame member 24 and through an aligned opening in the cover member 42 into a position adjacent the transfer position for the storage drum 26. When a tape cartridge is present in the transfer position 45A of the storage drum, it engages the arm 175 and maintains the switch 172 in the "full" operating condition illustrated in FIG. 10, with contact 171 engaging contact 173. If there is no cartridge in the transfer position of the storage drum, however, the magazine sensing switch 172 is actuated to its opposite condition, opening contact 171 from the "full" contact 173 and closing contact 171 on the "empty" contact 174.

The "full" contact 173 of the switch 172 is electrically connected to the center contact 155 of the index position switch 154 described above in connection with FIG. 7. The contact 157 of switch 154 is connected to the contact 167 of the cam switch 165 and to a conductor 177. The contact 156 of the index position switch 154 is connected to the "empty" contact 174 of the switch 172 and is also connected to a normally closed stepping switch 176. The stepping switch 176 is connected to one terminal of the stepping coil 65, the other terminal of the stepping coil being returned to the power line 162. The stepping switch 176 is shown in FIG. 3; this switch is normally closed but is opened whenever the pawl 55 has been actuated to drive the ratchet wheel 52 through a stepping movement of the storage drum 26. The opening of the switch 176 occurs in the early part of the stepping drive operation; the switch closes again upon completion of the stepping action.

As shown in FIG. 10, the conductor 177 extends from the contacts 157 and 167 of the switches 154 and 165 to the center contact 181 of a control switch 182 actuated by the disc 123 in the transfer mechanism 111. As shown in FIG. 2, the control switch 182 includes a cam follower 183 that engages the periphery of the disc and that normally maintains the switch 182 in the operating condition illustrated in FIG. 10 with the center contact 181 engaged with an external contact 184 and out of engagement with a second external contact 185. However, rotation of disc 123 in the course of a transfer movement is effective to bring the follower 183 into a notch 186 in the disc 123 to actuate the control switch 182, opening the contacts 181,184 and closing the contacts 181,185.

The normally closed contact 184 of the control switch 182 is electrically connected to one input terminal of the transfer motor 112, the other input terminal of the transfer motor being connected to the power line 162. The normally open contact 185 of the control switch 182 is electrically connected to a conductor 186 that is connected to one contact 187 of a normally closed cam-actuated switch 188 having a second contact 189. The contact 187 of the switch 188 carries a cam follower 191 that engages the periphery of the cam 135 on the tape deck actuation shaft 106 that is driven by the actuator motor 108 (see FIG. 1). The contact 189 of the switch 188 is electrically connected to one of the input leads for the shift actuator motor 108, the other input to the motor 108 being connected to the power line 162.

The conductor 177 is electrically connected to one contact 194 of a normally open control switch 193. The second contact 192 of the switch 193 is electrically connected to the transfer motor 112. The switch contact 194 includes a cam follower extension 195 that extends into alignment with a pin 196 mounted upon the disc 135 that is a part of the tape deck actuator mechanism, being mounted on the actuator shaft 106 driven by the shift actuator motor 108.

In the control system 160 of FIG. 10, the conductor 177 is also connectd to one contact 202 of a control switch 201. The contact 202 is engageable with another contact 203 of the switch. The contact 202 is a movable contact that carries a cam follower 204 that rides on the periphery of the disc 105 in the cartridge shift mechanism 90, the physical arrangement for the switch 201 being illustrated in FIG. 5. The second contact 203 of the switch 201 is electrically connected to the shift actuator motor 108.

The control system 160 is provided with a means for detecting the completion of playing of individual tape records, both in a forward and in a reverse direction. For forward direction sensing, this means comprises a sensing switch 206 including two spaced contact members 207 and 208 positioned to engage the tape in a cartridge mounted upon the first tape deck 72. The general location of the switch 206 is shown in FIG. 4. The two contacts 207 and 208 of the switch 206 do not physically engage each other; they are positioned to be bridged by a small conductive strip 205 affixed to the end of the magnetic tape in each cartridge. A second similar switch 209 is utilized in connection with the second tape deck 73, and comprises a pair of sensing contacts 211 and 212 that can be bridged by a small conductive strip 213 at the opposite end of the magnetic tape in each cartridge. In the two sensing switches 206 and 209, the contacts 207 and 211 are electrically connected to the conductor 186. The contacts 208 and 212 are electrically connected to the contact 203 of the switch 201.

It is desirable to afford a positive indication of the positioning of a tape cartridge for playing on either of the two decks 72 and 73. In the electrical control system 160 of FIG. 10, this positive indication is afforded by two indicator lamps 215 and 216 for indicating the presence of a cartridge on the tape decks 72 and 73 respectively. A switch 217 is mounted upon the tape deck 72 in position to have its contacts closed whenever a tape cartridge is mounted in playing position on the tape deck 72. A similar switch 218 is mounted upon the second tape deck 73 and performs the same function (see FIG. 4). The switch 217 and the lamp 215 are connected in series between the conductor 186 and the power line 162. Similarly, the switch 218 and the indicator lamp 216 are connected in series with each other between the conductor 186 and the power line 162.

The control circuits for the tape decks 72 and 73, and particularly the tape deck motors 75 and 81, are illustrated at the bottom of FIG. 10. As shown therein, the motor 75 for the first tape deck 72 is connected in series with a normally open cam-actuated start-stop

switch 221 between the main switch 163 and the power line 162. The switch 221 is actuated by the cams 132 and 134 on the output shaft 106 of the actuator motor 108, (see FIG. 1). The control circuit for the second tape deck motor 81 is similar and includes a normally open start-stop switch 222 actuated by the cams 131 and 133. The mounting arrangements for these two swtiches are similar. As shown in FIG. 4, each of the switches may be provided with a manual actuation lever, such as the lever 225 on swtich 222, to permit control of the tape decks independently of the cartridge shift drive.

In considering operation of the player-changer 20, under the control of the control system 160, it may first be assumed that a number of tape cartridges have been inserted into the storage drum 26 and are ready for play. To start the changer-player in operation, the main switch 163 is closed, completing an electrical circuit from the input lead 161 through the normally closed contacts 164 and 166 of the switch 165 to the contacts 145 of the selector switches 146. As long as at least one of the selector pins 145 has been depressed for playing of a given tape cartridge, at least one of the selector switches 146 is closed. Consequently, the electrical circuit is completed through the selector switches and through the switches 172, 154 and 176 to the stepping coil 165, energizing the stepping coil. The circuit is somewhat different if the compartment of the storage drum 26 located at the transfer position is empty when the switch 163 is closed; under those conditions, the switch 172 is in its alternate operating condition and the energizing circuit for the stepping coil bypasses the switch 154.

Under either circumstance, the energization of the stepping coil 65 actuates the stepping drive 51, as described above, rotating the drum 26 through a short arcuate distance, the arc subtended by one ratchet tooth. The stepping switch 176 opens early in the stepping cycle, but the inertia of the stepping drive enables it to complete its stepping operation, so that the switch 176 again closes. In this manner, the coil 65 is energized to step the drum storage magazine 26 from position to position until one of the selector pins 145 actuates the index switch 154 to indicate that a tape cartridge selected for playing is in the transfer position of the storage drum 26. When this occurs, and there is a cartridge present at the transfer position, the operating circuit for the stepping coil 65 is opened at the switch 154 with a selected cartridge in position for playing.

In the event that there is no cartridge in the selected position in the drum, however, there is no interruption to the circuit to the stepping coil 65 because the magazine sensing switch 172 is in its "empty" position, bypassing the switch 154. If this occurs, the stepping coil 65 continues its operation as described above until a depressed selector pin corresponding to a full chamber in the drum storage magazine 26 reaches the transfer position 45A of the drum, at which time the circuit to the stepping coil 65 is opened.

When the switch 154 is actuated with a cartridge in the transfer position, as described above, an electrical circuit is completed through the contacts 155 and 157 of the switch 154 and through the normally closed contacts 181 and 184 of the switch 182 to the transfer motor 112. This energizes the transfer motor and starts its operating cycle, rotating the cam 115 and the disc 123. Shortly after the transfer motor 112 is energized, the cam 115 operates to actuate the switch 165, opening the contacts 164 and 166 and closing the contacts 164 and 167. This breaks the circuit to the selector portion of the control system 160, at the left-hand side of the drawing, but maintains an energizing circuit for the transfer motor 112 through the switch contacts 164 and 167. This enables the transfer motor 112 to continue in operation until the follower 183 of the switch 182 drops into the notch 186 in the disc 123. When this occurs, the energizing circuit to the transfer motor 112 is interrupted. This action occurs after approximately 180° of rotation of the disc 123 and corresponds with the completion of a transfer cycle moving a cartridge from the transfer position 45A to the intermediate position 45B in the tape play mechanism 71 (FIG. 1) as described above.

When the switch 182 is actuated at the completion of the transfer cycle, the switch contacts 181 and 185 are closed. This completes an electrical circuit from the power line 161 through the main switch 163 and the switches 165 and 181 to the conductor 186. As a consequence, the shift actuator motor 108 is energized through a circuit extending from the conductor 186 through the switch 188 to the motor 108 and then to the power line 162. Consequently, the motor 108 is energized and begins to rotate the actuator shaft 106. Shortly after motor 108 is energized, the control switch 201 is closed as its cam follower 204 rides up on to the periphery of the disc 105. Shortly thereafter, the switch 188 is opened by the continuing rotation of the cam 135, so that the motor 108 is now energized from the conductor 177 in a circuit that bypasses the switches 182 and 188.

As the shift actuator motor 108 continues its rotation, it drives the shift mechanism 90 through the initial portion of its operating cycle, shifting the tape cartridge located in the cartridge holder 87 from the intermediate position 45B in the tape mechanism to the first playing position 45C on the tape deck 72 (see FIG. 4). For the illustrated mechanism, the motor 108 rotates through an angle of approximately 104° in pivoting the tape cartridge from the intermediate position 45B to the first playing position 45C on the deck 72. The motor 108 continues to rotate through approximately 20° additional arc, at which time the cam 132 closes the switch 221 in the energizing circuit for the tape deck motor 75. At this point in the operating cycle, the cam follower 204 for the switch 201 drops into a notch in the disc 105, opening the energizing circuit to the shift actuator motor 108 and de-energizing the motor. The tape deck motor 75 has been energized and the forward tracks of the tape cartridge are now played in conventional manner.

Upon completion of playing of the forward tracks of the tape cartridge, the two contacts 207 and 208 of the sensing switch 206 on the first tape deck 72 are bridged by a strip of silver foil or other conductive material 205 on the tape. This completes an energizing circuit for the shift acutator motor 108, extending from the conductor 186 through the switch 206 to the motor. The motor 108 rotates the shaft 106 through an angle of approximately 20°, at which point the cam 134 opens the switch 221 for the motor 75 of the tape deck 72. This interrupts the tape deck drive and permits removal of the tape cartridge from deck 72.

The shift actuator motor, as it rotates, also closes switch 202, since the cam follower 204 has now moved

out of the notch that caused the switch to open for playing of the first side of the tape. The continued rotation of the shift actuator motor through an additional angle of about 112° actuates the shift mechanism **90** to shift the tape cartridge from the first tape deck **72** to the second tape deck **73.** Continued rotation of the shift actuator motor **108** through an additional angle of about 20° causes the cam **133** to close the switch **222** for the motor **81** of the second tape deck. This initiates the reproduction of the reverse tracks of the tape record; as play is initiated, the cam follower **204** drops into a second notch on the disc **105,** again interrupting the energizing circuit for the shift actuator motor **108.**

The changer-player now proceeds with playing the reverse tracks of the tape cartridge. When this playback is completed, a conductrive strip **213** on the tape bridges the contacts **211** and **212** of the reverse track sensing switch **209,** again energizing the shift actuator motor **108** from conductor **186.** During the first 20° of rotation of the shift actuator motor **108,** the cam **131** is brought into position to open the switch **222,** de-energizing the second tape deck motor **81** so that the tape cartridge can be removed from the second tape deck. During this same interval, the cam follower for the switch **201** rides up on to the periphery of the disc **105,** so that the shift actuator motor **108** remains energized through the switch **201.**

The motor **108** continues to rotate through a remaining arc of about 64° necessary to complete a single revolution. During this additional rotation of the shift acutator motor **108,** the shift means **90** shifts the cartridge from the position **45D** on the tape deck **73** back to the intermediate position **45B** in the transfer mechanism. At the end of the complete revolution of shaft **106,** the cam follower **204** again drops into the notch where it started on the disc **105,** de-energizing the shift actuator motor **108.** This completes the cyclic operation of the shift means, and also completes the playing of both sides of the tape recording in the cartridge.

Shortly before the completion of the playback cycle described above, the pin **196** on the disc **135** engages the cam follower extension **195** of the switch **193.** This energizes the transfer motor **112** through a circuit that extends from the conductor **177** through the switch **193** to the transfer motor. Energization through this circuit is maintained long enough to rotate the shaft **114** and the disc **123** through an arc sufficient to clear the cam follower **183** from the notch **186.** As a consequence, when the switch **193** opens at the completion of the shift cycle, the transfer motor **112** is again energized through the conductor **177** and the switch **182.** The transfer motor continues to operate through the second half of the transfer cycle, transferring the cartridge from the intermediate position **45B** in the tape play mechanism back to the transfer position **45A** in the drum storage magazine **26.**

As the transfer motor **112** completes its 360° of rotation, the cam **115** again brings its notch into alignment with the cam follower **168** for the switch **165.** When this happens, the energizing circuit for the transfer motor that has been maintained through the switch contacts **164** and **167** is broken. However, in order to avoid continuing energization of the transfer motor, and a repeat play for the same tape cartridge, it is necessary to preclude energization through the alternate circuit that initiated the transfer operation. It is for this reason that the movement of the transfer slide **119** is utilized to reset the selector pin **145** that started the transfer operation in the first place. As described above, the resetting of the pin **145** is preferably accomplished at the beginning of the transfer cycle, just after the cam **115** has actuated the switch **165,** though this is not critical.

In those instances in which there is no cartridge present in the sotrage drum at a position corresponding to a depressed selector pin **145,** the transfer mechanism does not go through an operating cycle, as described above. However, the camming bracket **159** cams the pin back to its undepressed position as the magazine and the disc **142** rotate, which prevents the changer-player mechanism from cycling indefinitely. After all selections are played, the unit automatically turns itself off because there are no longer any closed selector switches **146.**

In the foregoing operational description of the control system **160** and its actuation of the changer-player **20,** it has been assumed that the camming lever **151** has been displaced to its non-operational position **151A** (FIG. 7) that manual control has been employed in selecting the tape cartridges to be played. The operation is essentially the same with the lever **151** in operational position, except that all of the selector pins **145** are depressed by the cam extension **152** of the lever **151** and the system maintains operation continuously, playing every tape cartridge in the storage magazine. There is no automatic shut off operation in this case; when all of the tape cartridges have been played the sequence starts over again.

During the play of a given selection, an interruption may be desired as, for example, when the user must leave the room for a telephone conversation or the like. Play can be interrupted at any point by manual actuation of either of the switches **221** and **222,** since each is provided with a manual actuator such as the actuator **225** for the switch **222** (FIG. 4). Additional manual controls may be provided, if desired, for the tape decks **72** and **73** to permit complete manual operation independently of the automatic control and changer action afforded by the complete system. For example, a fast forward drive may be provided for each of the two tape decks, in accordance with conventional practice. If this is done, the operator can effectively reject either the forward or reverse tracks for any given tape simply by use of the fast forward drive for the tape deck that would play that side of the tape. Selective action of this kind is facilitated by the indicator lamps **215** and **216,** which afford a direct indication at all times of the position of the tape cartridge and the part of the tape that is being played.

The changer-player system of the present invention is capable of playing both sides of a large number of cartridges in either a selective or a sequential manner. It requires no manual resetting for any of the tape cartridges, once selection is made. The basic control, transfer, and shift mechanisms can be utilized for storage magazines of varying capacity without change. In the illustrated embodiment, the tape storage drum rotates about a horizontal axis, but it could be repositioned to provide for rotation about a vertical axis with no substantial change required in the fundamental mechanism. The same rotary magazine system can be used for continuous-loop tape cartridges, in which instance only one tape deck is required for playback.

I claim:

1. An automated changer-player for magnetic tape dual-reel cartridge recordings:

a rotary drum affording a storage magazine having a plurality of tape storage compartments each capable of receiving and storing a tape cartridge;

a stepping drive for rotating said magazine to advance said cartridges, one by one, to a transfer position;

a transfer mechanism for transferring a cartridge along a predetermined linear transfer path, parallel to the axis of the storage drum, between said transfer position and an intermediate position aligned with and immediately adjacent to one end of said drum;

a tape play mechanism, comprising first and second stationary tape play decks located immediately adjacent to the opposite sides of said intermediate position, said tape decks being disposed in an angular V-alignment relative to each other with the bight of the V parallel to the axis of the storage drum;

a shift mechanism, included in said tape play mechanism, comprising a cartridge holder support shaft extending through the bight of the V formed by said tape play decks, parallel to the storage drum axis, a cartridge holder pivotally mounted on said support shaft for receiving a cartridge at said intermediate position, and shift actuating means for pivoting the cartridge holder, about said support shaft, to shift the cartridge between said intermediate position, a first playing position in which the cartridge engages the first tape deck to play the forward tracks on the cartridge tape, and a second playing position in which the cartridge engages the second tape deck to play the reverse tracks on the cartridge tape, the total pivotal shifting movement of the cartridge holder, between the first and second playing positions, traversing an angle of less than 90°;

sequential electrical control means for actuating said stepping drive, said transfer mechanism, and said tape play mechanism, in predetermined sequence, to play the tapes in the cartridges in said magazine;

and selector means, operatively connected to said control means and to said storage magazine, for selecting individual tape cartridges for play, without playing others, in accordance with the positions of the tape cartridges in said magazine.

2. An automated changer-player for magnetic tape cartridge recordings, according to claim 1, in which said selector means comprises:

a selector disc driven in synchronism with the rotational step movements of said drum storage magazine;

a plurality of selector elements, one for each tape storage compartment in said magazine, mounted on said disc in an array corresponding to the arrangement of compartments in said magazine, each manually actuatable from a retracted position to a selection position;

selector switch means, actuated by said selector elements and electrically connected to said control means to enable initiation of operation of said changer-player only when at least one of said selector switches has been actuated to its selection position;

and a selection sensing switch, included in said control means and aligned with said selector disc at an index position corresponding to the transfer position for the storage drum, for inhibiting action of said transfer mechanism and said shift means whenever a new storage compartment is stepped to said transfer position unless the selector element corresponding to that storage compartment has previously been actuated to its selection position.

3. An automated changer-player for magnetic tape cartridge recordings, according to claim 2, in which said selector means further comprises a cam member movable from a retracted position to an operative position, adjacent said selector disc, and in which said cam member, when in its operative position, advances each selector element to its selection position, in sequence, as said drum storage mechanism is rotated, to play all of the tapes.

4. An automated changer-player for magnetic tape cartridge recordings, according to claim 1, in which said control means includes a magazine sensing switch for sensing the presence of a cartridge at said transfer position, said magazine sensing switch being connected in an enabling circuit for said transfer mechanism to prevent initial actuation of said transfer mechanism when the transfer position is empty.

5. An automated changer-player for magnetic tape cartridge recordings, according to claim 1, in which the cartridge holder comprises a U-shaped receptacle, open at its inner end to receive a cartridge from said transfer position in said storage magazine and having a stop member at its outer end to limit the movement of a cartridge transferred from said transfer position to said intermediate position, and in which said transfer mechanism comprises a slide linearly movable, along a track parallel to said cartridge holder support shaft between a first end position and a second end position, said slide having a first pin for engaging one end of a cartridge as the slide moves from its first end position to its second end position to impel the cartridge from said transfer position to said intermediate position, said slide further having a second pin for engaging the opposite end of a cartridge as the slide moves from its second end position to its first end position to impel the cartridge from said intermediate position to said transfer position, the spacing between said slide pins being somewhat greater than the length of a cartridge so that the cartridge is free of the slide pins whenever the slide is in either end position.

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