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(71) Applicant
Sony Corporation (Japan),
7—35 Kitashinagawa 6-chome, Shinagawa-ku, Tokyo, Japan

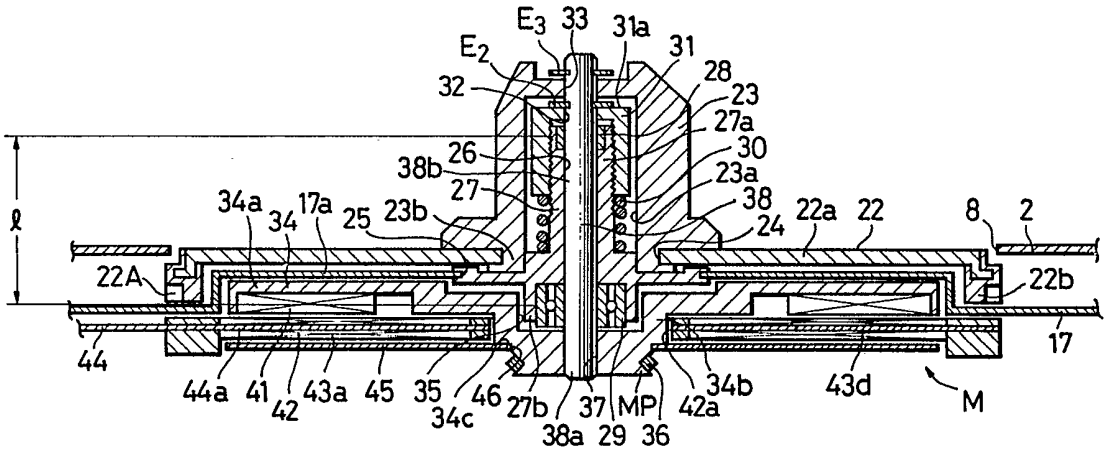
(72) Inventor
Mitsuru Ida

(74) Agent and/or Address for Service
D. Young & Co., 10 Staple Inn, London WC1V 7RD

(54) **Tape players**

(57) A compact cassette tape player has a motor drive system which enables a high-fidelity tape player to be made only slightly larger than the cassette being played. The tape player includes a motor M which has a flat stator 42 mounted to the player chassis 17, a motor shaft 38 and a flat rotor 34 which is mounted to the motor shaft 38 for rotation relative to the stator 42. The recorder includes reel spindles for engaging the tape reels in the cassette. The motor shaft 38 extends into one of the spindles 23 and is mounted in bearings 28, 29 at the ends of the shaft 38. One 28 of the bearings is located inside the spindle 23 so that the bearing mountings for the motor shaft 38 can be spaced as far apart as possible, thus reducing the amount of wow and flutter even though the player is extremely compact. The spindle 23 mounting the motor shaft 38 is driven independently of the motor M by a drive gear which engages the periphery of a gear wheel 22A secured to the spindle 23. The drive gear is driven by a drive belt 36 which extends from the rotor 34 to the motor M to a capstan of the tape player.

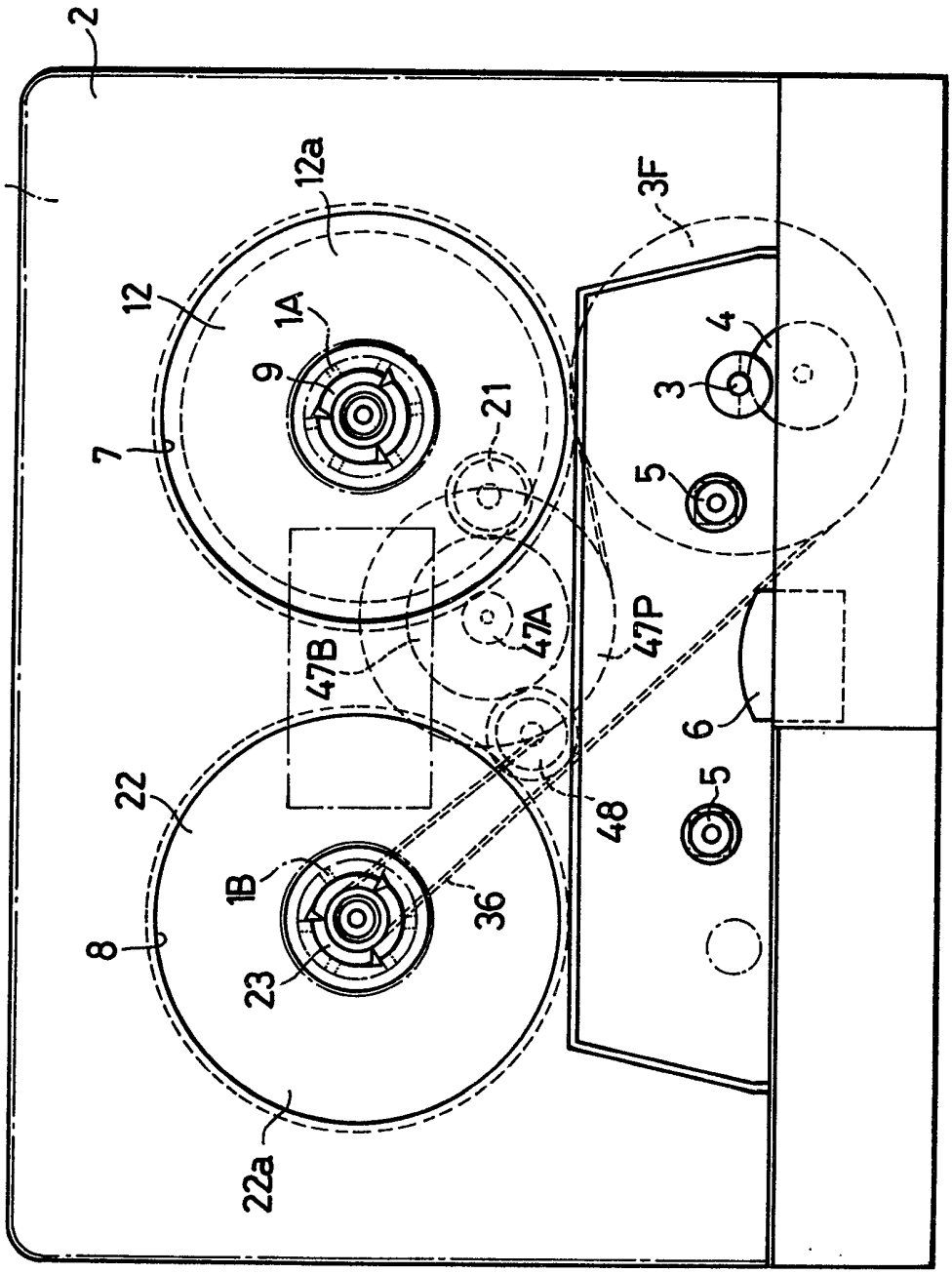
FIG.3



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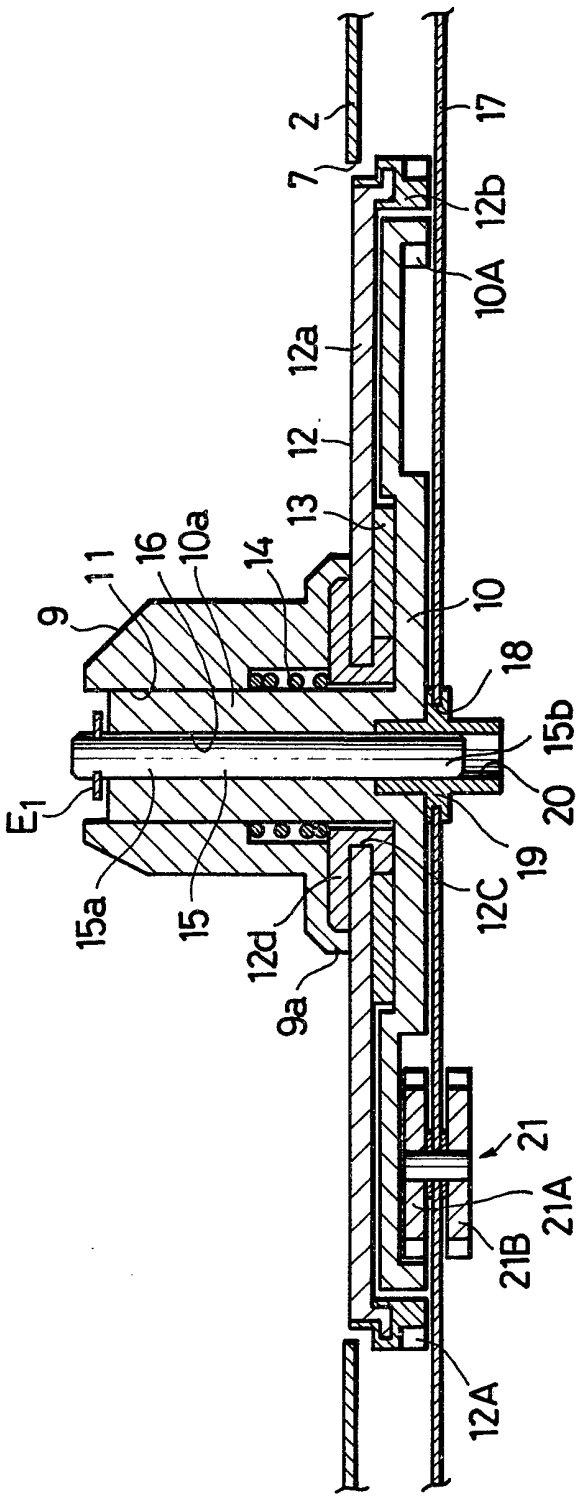
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FIG.1



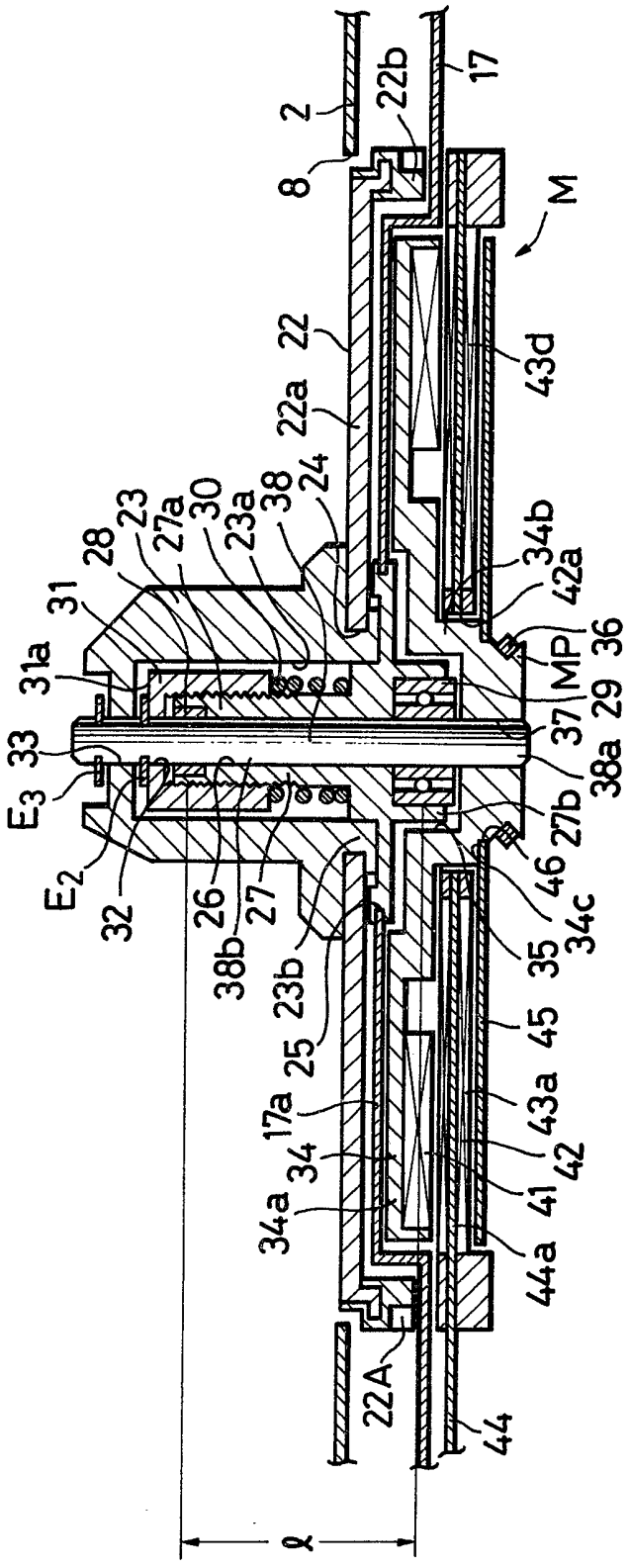
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FIG.2



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FIG.3



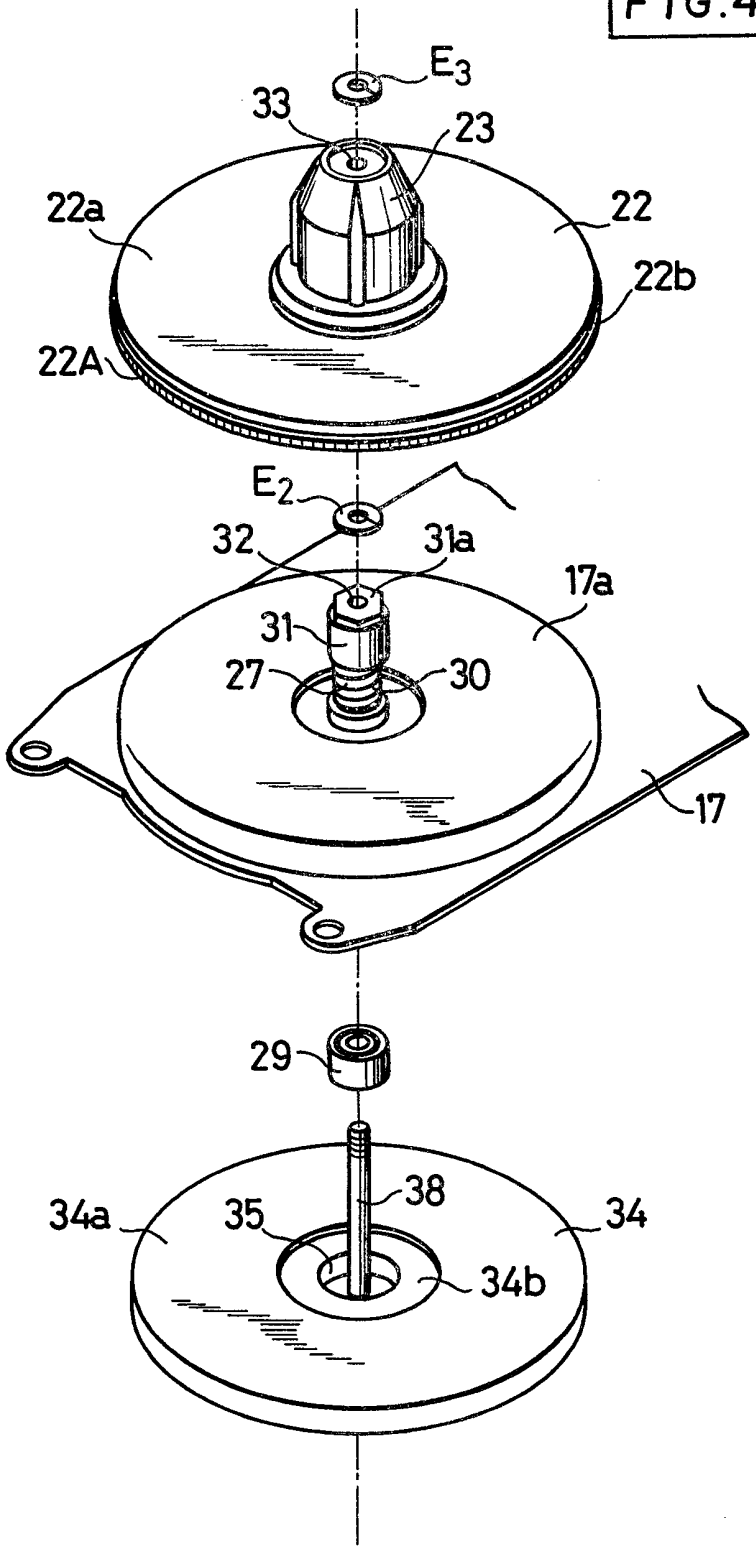
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FIG.4

FIG.4A

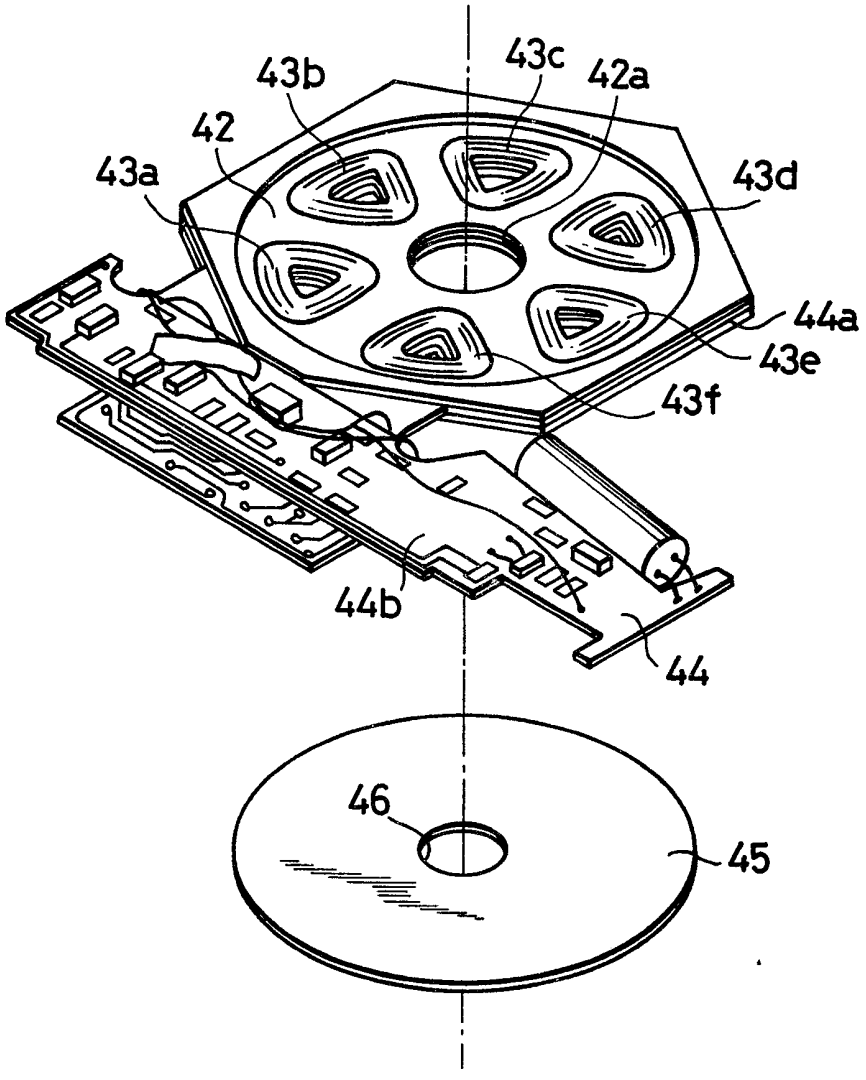
FIG.4B

FIG.4A



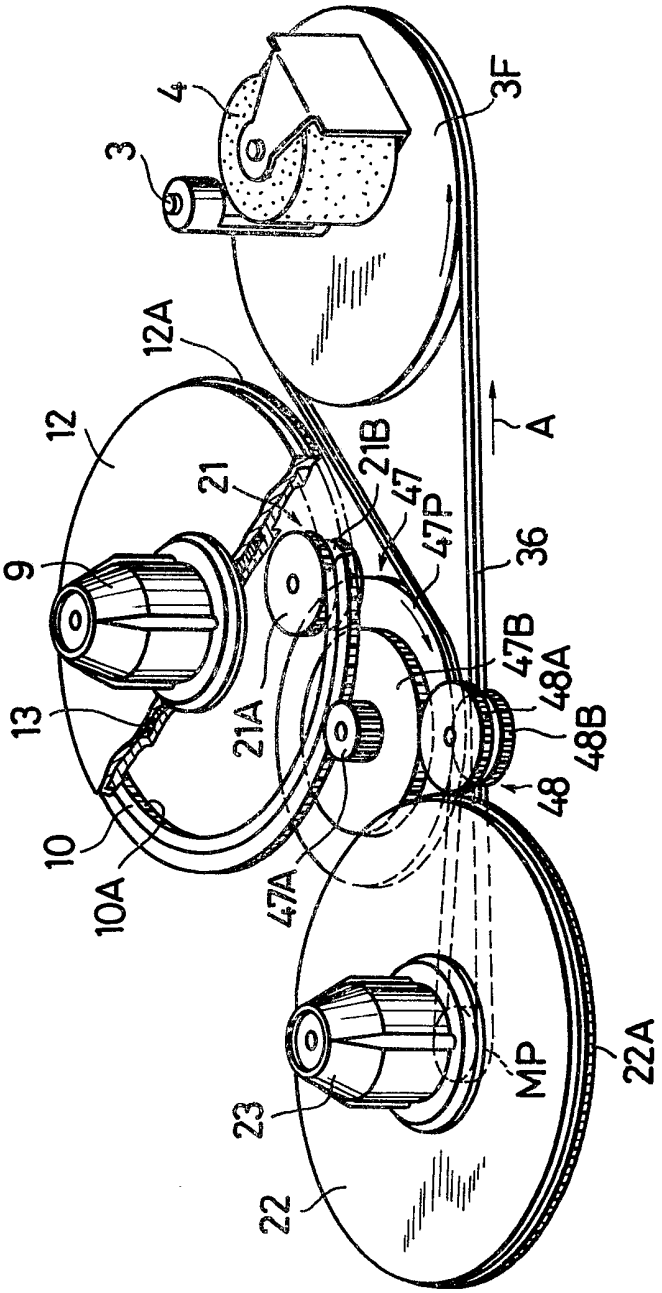
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FIG.4B



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FIG.5



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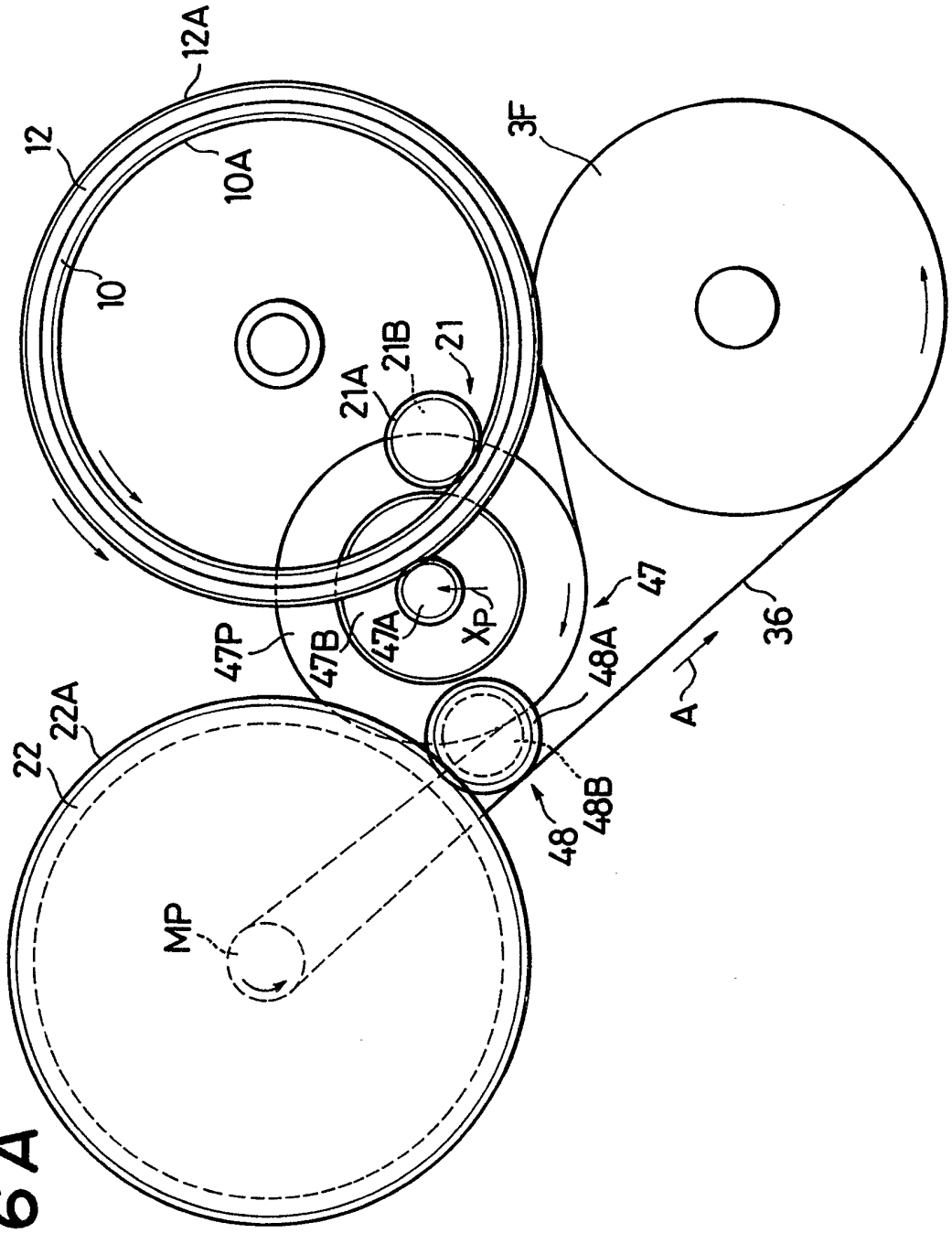


FIG. 6A

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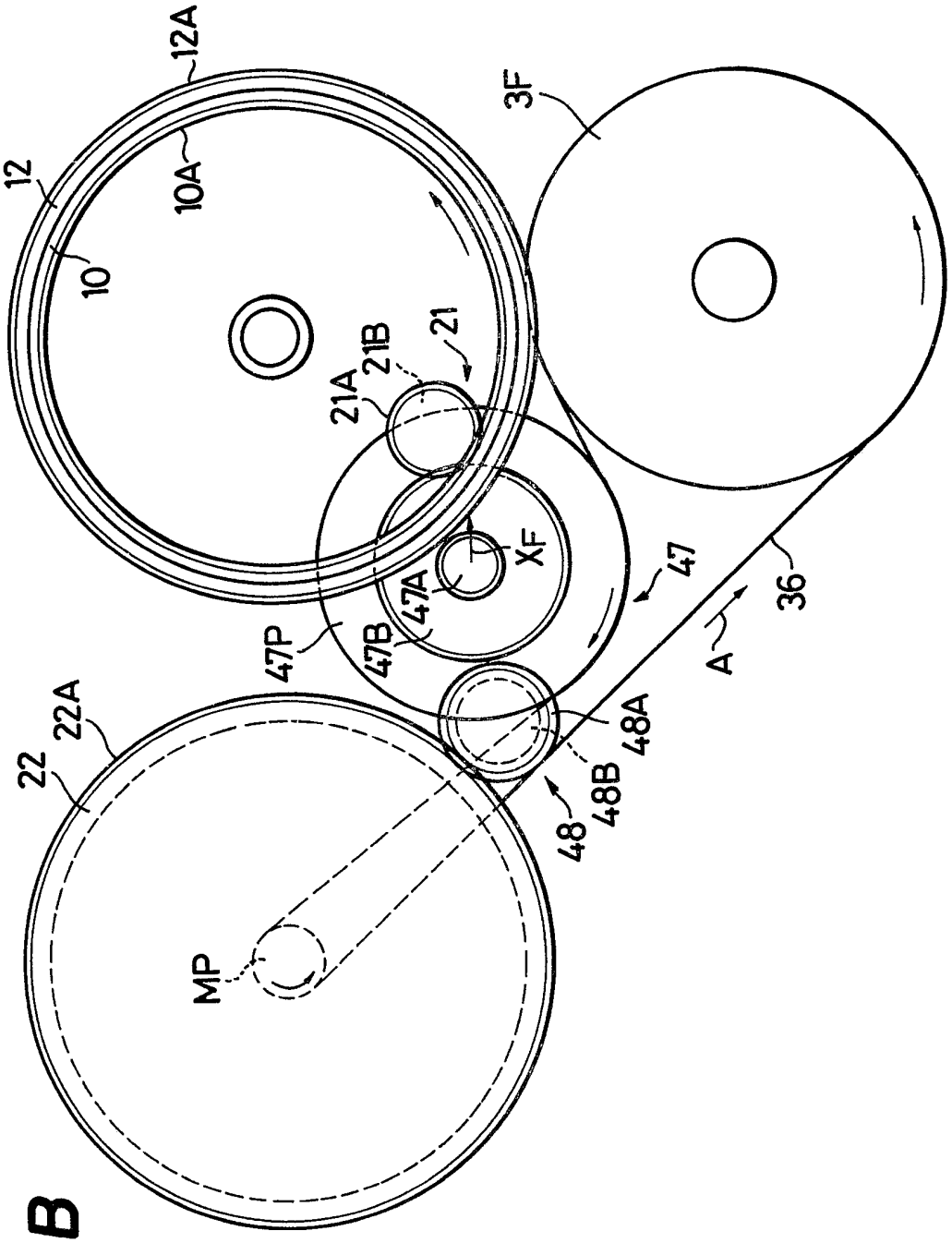


FIG.6B

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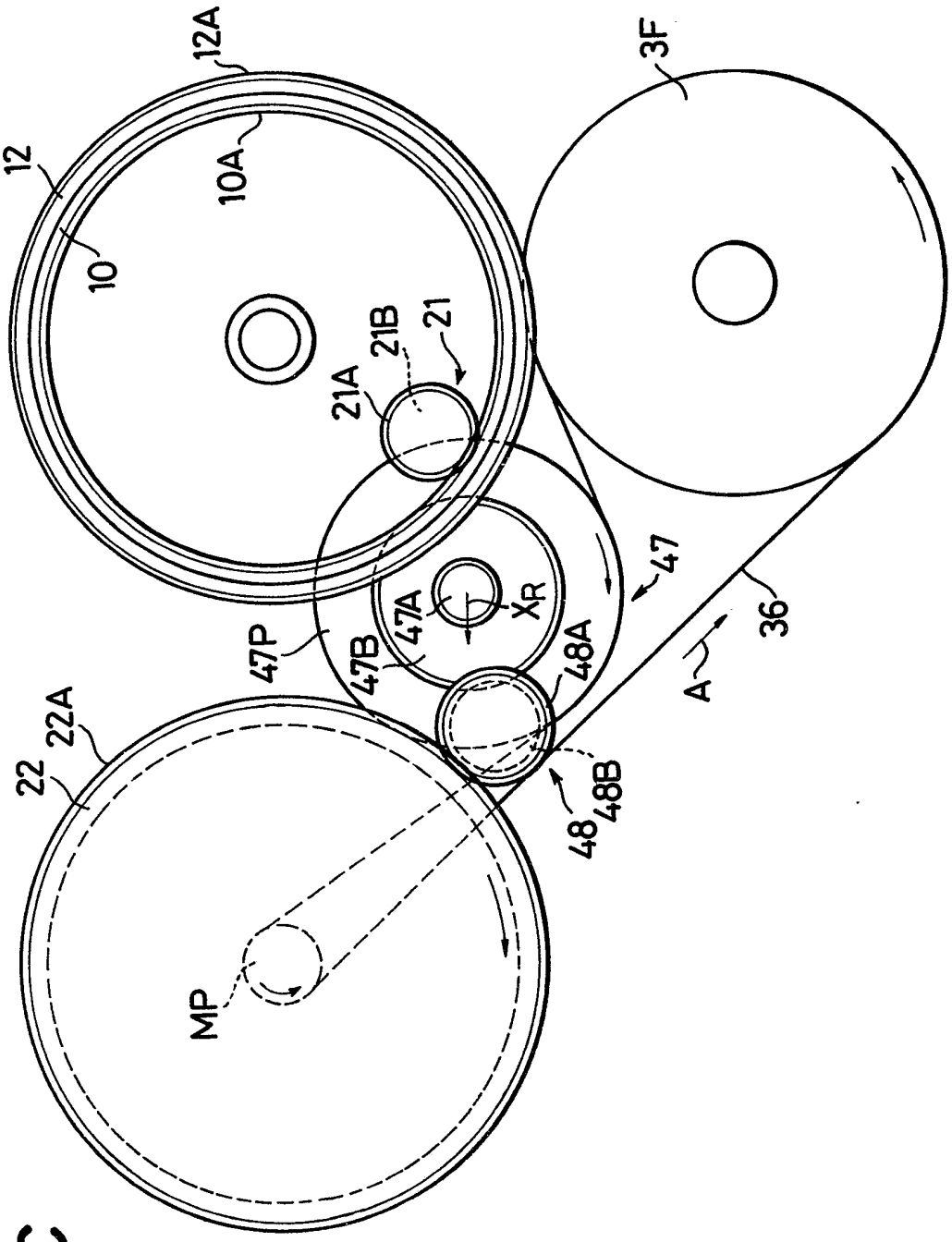
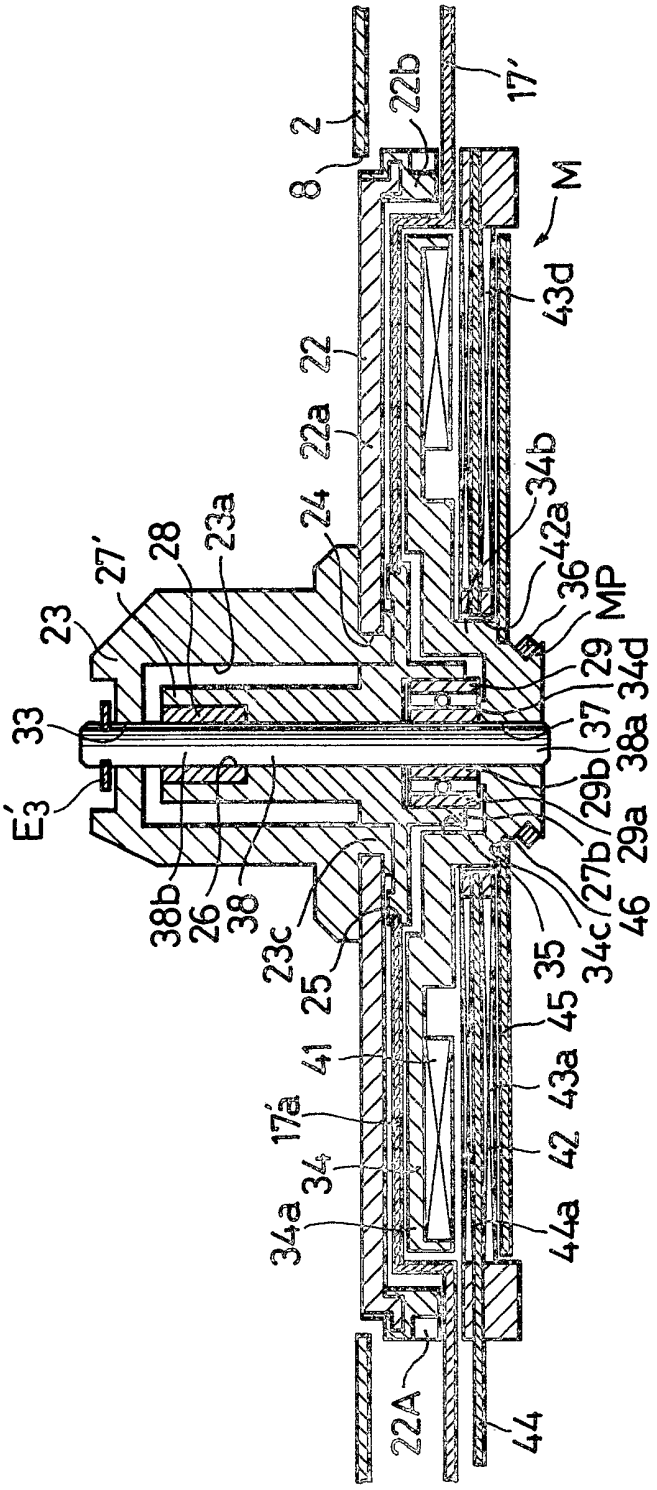


FIG.6C

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FIG.7



SPECIFICATION

Tape players

The invention relates to tape players and, more particularly, to tape players of the compact cassette-kind.

Generally, there are two kinds of drive systems for tape players. One of them uses a drive motor shaft as a capstan of the tape player. In theory, such a "direct drive" stystem is simple. However, the capstain must be rotated at a low speed, with a minimum of vibration, at a very uniform rate and without induction noise from the motor. In practice these requirements make known direct drive systems expensive and thus unsuitable for mass-marketed tape players.

The other kind of drive system uses a belt to transmit the rotation of a motor to a flywheel, the shaft of which comprises a capstan. The advantage of a "belt drive" system lies in its use of a flywheel for masking vibration and irrregular rotation of the motor. In addition, the motor does not have to be as near to the capstan as it does in a direct drive system. As a result, belt drive systems are preferred in mass-marketed tape players, both cassette and open-reel as well as in many professional-class open-reel tape players.

Manufacturers are constantly attempting to reduce the size of portable cassette-type tape players. A particularly difficult problem to overcome has proved to be reducing the thickness of such a tape player. One proposal for reducing the thickness of a cassette-type tape player involves the use of a reduced-diameter cylindrical drive motor and orienting it so that the shaft lies parallel to the cassette. Thus, the motor shaft is perpendicular to the capstan and the drive belt must be twisted from one plane into another. In addition, the reduction of the diameter of the motor reduces the power capacity of the motor which places a limit on how small the motor can be made.

Another proposal for making a thin cassette-type tape player involves the use of a flat motor. The rotor and stator of a flat motor are substantially planar and parallel to each other, with the motor shaft normal to the motor plane. Using a flat, thin motor would, of course, enable the tape player to be made thinner. However, practically speaking, the motor shaft must be mounted in bearings. To reduce vibration and increase performance, there should be two bearings located as far apart from each other as possible. Therefore, the tape player must be thick enough to enable the bearings to be spaced apart a sufficient distance to provide the necessary rotational stability for the motor shaft. The only alternative to widely spacing the bearings is the use of additional restrictions on the rotating shaft along its length. However, such restrictions introduce frictional losses and thus required a more powerful motor, which is a disadvantage in a portable tape player.

According to the invention there is provided a tape player comprising:

a drive motor having a stator, a shaft and a rotor mounted on the shaft for rotation relative to the stator to drive a capstan;

a spindle member for engaging a tape reel when the tape reel is mounted on the player, the shaft of the drive motor being supported by a bearing member disposed at least partially internally of the spindle member; and a drive member rotated by the drive motor for driving the spindle member; wherein the spindle member is supported coaxially with the shaft of the drive motor and is selectively driven by the drive member when the drive member is moved to its operative position.

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which:-

Figure 1 is a plan view of a cassette-type tape player according to the invention;

Figure 2 is a sectional view of the take-up reel of the cassette-type tape player of Figure 1;

Figure 3 is a sectional view of the supply reel of the cassette-type tape player of Figure 1;

Figures 4A and 4B are exploded perspective views of the motor and supply reel of Figures 1 and 3;

Figure 5 is a perspective view of the tape reels and drive means of the cassette-type tape player of Figure;

Figures 6A—6C show the position of the drive means of Figure 5 in the PLAY, FAST-FORWARD and REWIND modes, respectively;

Figure 7 is a sectional view of a supply reel and motor in accordance with an alternate embodiment of the cassette-type tape player shown in Figure 1.

Figure 1 shows a tape cassette 1 having a pair of reel hubs 1A and 1B mounted in a cassette-type tape player with a chassis 2. The tape player includes a capstan 3, a pinch roller 4 opposite the capstan 3, guide pins 5 for the tape being played and a play head 6, arranged on the chassis 2. A pair of circular openings 7 and 8 are formed in the chassis 2.

A take-up reel spindle means includes a take-up reel spindle 9 that engages the reel hub 1A of the tape cassette 1 for driving the take-up reel of the cassette when the spindle 9 rotates. As shown in Figure 2, a fast-forward gear 10 includes a tubular projection 10*a* that is press-fitted into a vertical through-hold 11 in the take-up reel spindle 9. (It will be understood that directional terms such as "vertical", "lower", "downwardly", etc., are used here to facilitate the description of the invention and do not limit the invention to apparatus so oriented. Rotation of the fast-forward reel gear 10 thus rotates the spindle 9. Gear teeth 10A are formed on the inside of a flange at the periphery of the fast-forward reel gear 10.

Take-up reel pawl means also includes a play reel gear 12 formed as a circular metal plate 12*a* and a gear-tooth ring member 12*b*. The metal plate 12*a* has a central hole 12*c* therein in which is disposed a central body 12*d*. The gear-tooth

ring member 12*b* is formed integrally on the periphery of the plate 12*a* by injection moulding a synthetic resin in place on the plate 12*a*. External gear teeth 12A are formed in the ring member 12*b*. The central body 12*d* is formed integrally on the central hole 12*c* of the plate 12*a* by injection moulding a synthetic resin in place in the hole 12*c*. The relative sizes of the tubular projection 10*a* and the central opening in the central body 12*d* are such that the fast-forward reel gear 10 and the play reel gear 12 are rotatable freely relative to each other. The take-up reel spindle 9 includes a depending flange 9*a*. which co-operates with the outer edge of the central body 12*d* to form a bearing between the fast-forward reel gear 10 and the play reel gear 12. A friction plate 13 made of felt is adhered to the lower surface of the play reel gear 12 to provide a frictional drive between the fast-forward reel gear 10 and the play reel gear 12. Thus, rotation of the play reel gear 12 will rotate the take-up reel spindle 9. The play reel gear 12 is biased towards the fast-forward reel gear 10 by a coil spring 14 which extends between the outside of the tubular projection 10*a* and an inside face of the take-up reel spindle 9.

The fast-forward reel gear 10, the take-up reel spindle 9 and the play reel gear 12 are rotatably supported by a take-up reel shaft 15. The shaft 15 has an uppper portion 15*a*, which passes through a central hole 16 in the tubular projection 10*a*, and a lower portion 15*b*. The lower portion 15*b* supports the take-up reel spindle means on a chassis plate 17 having a mounting hole 18. The mounting hole 18 has a sleeve 19 secured to it and the lower poriton 15*b* of the shaft 15 is press-fitted into a central passage 20 in the sleeve 19. The chassis plate 17 is secured to the chassis 2. Twin fast-forward drive gears 21, to be described later, are rotatably mounted on the chassis plate 17 and mesh with the fast-forward reel gear teeth 10A. An "E" ring E1 fits in a circumferential groove in the shaft 15 to prevent removal of the take-up reel spindle means from the tape player.

Figure 3 shows a supply reel spindle means that includes a rewind reel gear 22 arranged at the centre of the other opening 8 in the chassis 2. The rewind reel gear 22 comprises a metal plate 22*a* and a gear-tooth ring member 22*b*. The gear-tooth ring member 22*b* is formed at the periphery of the metal plate 22*a* by injection moulding a synthetic resin and has at its outer periphery gear teeth 22A. Supply reel pawl means includes a supply reel spindle 23 having a hollow interior 23*a* and a bearing portion 23*b*. The supply reel spindle 23 is formed integrally in a central opening 24 of the metal plate 22*a* by injection moulding a synthetic resin in place on the metal plate 22*a*. The supply reel spindle 23 engages the supply reel hub 1B of the tape cassette 1 for driving the tape cassette supply reel when the supply reel spindle 23 rotates.

A drive motor M is attached to the chassis plate 17 under the rewind reel gear 22, as shown in Figure 3. The motor M is a flat, substantially planar brushless motor, the main body of which comprises a rotor portion and a stator portion, both of which are very thin.

The drive motor M and its mounting are shown in detail in Figures 3, 4A and 4B. A circular platform portion 17*a* of the chassis plate 17 nests inside the rewind reel gear 22. The chassis plate 17 has a central opening 25. A through hole 26 is formed axially of a cylindrical bearing sleeve 27 secured to the chassis plate 17 in the opening 25. An upper end portion or extension 27*a* of the bearing sleeve 27 is disposed within the hollow interior 23*a* of the supply reel spindle 23. A cylindrical, oil-impregnated sintered bearing 28 fits within the upper end of the bearing sleeve 27, a cylindrical ball bearing 29 is press-fitted into the through hole 26 at a lower end portion or extension 27*b* of the bearing sleeve 27 which extends beyond the supply reel spindle 23.

An external thread is formed on the upper end portion 27*a* of the bearing sleeve 27. A coil spring 30 is disposed between a cylindrical thrust member 31 and the bearing sleeve 27. An internal thread is formed in the cylindrical thrust member 31 and the thrust member 31 is screwed onto the upper end portion 27*a* of the sleeve against the biasing force of the coil spring 30. The spring 30 prevents the thrust member 31 from inadvertently moving during use of the tape player. A central hole 32 is formed in the top of the thrust member 31 and a hole 33, aligned with the hole 32, is formed in the supply reel spindle 23.

The rotor 34 of the motor M is made of a magnetic material such as BMC (bulkmold compound). The rotor 34 includes a flat portion 34*a* which nests inside the platform portion 17*a* of the chassis plate 17, and a downwardly projecting central portion 34*b*. The central portion 34*b* includes a shoulder 34*c*. The lower end portion 27*b* of the bearing sleeve 27 extends into a recess 35 formed by the central portion 34*b*. A motor pulley MP carrying a drive belt 36 is formed integrally with the lower end of the portion 34*b* of the rotor 34.

A hole 37 is formed centrally in the central portion 34*b* of the rotor 34. A motor shaft 38 has its lower portion 38*a* press-fitted into the hole 37. The shaft 38 extends vertically from the rotor 34 and an upper portion 38*b* of the shaft extends through the ball bearing 29, the through hole 26 of the bearing sleeve 27, the sintered bearing 28, and the holes 32 and 33. "E" rings E2 and E3 fit into respective circumferential grooves in the upper portion 38*b* of the motor shaft 38. The lower "E" ring E3 prevents removal of the supply reel pawl means.

The supply reel spindle 23 and the rewind reel gear 22 rotate freely on the motor shaft 38. The inner surface of the supply reel spindle 23 at the bearing portion 23*b* thereof slides on an outer circumferential surface of the bearing sleeve 27. Thus, the supply reel pawl means rotates independently of the motor 34 of the motor M.

A ring-like flat rotor magnet 41, alternately magnetized to North and South poles around its

circumference, is fixed to the lower surface of the flat portion 34*a* of the rotor 34. A stator coil assembly 42 having an annular flat configuration is fixed to the chassis plate 17 by screws (not shown) or other suitable fastening means to face the rotor magnet 41. A central opening 42*a* in the stator coil assembly 42 loosely receives the central portion 34*b* of the rotor 34. As shown in Figure 4B, the stator coil assembly 42 includes six coil units 43*a* to 43*f*, each of which comprises a pair of coils, mounted on a lead mounting portion 44*a* of a printed circuit board 44. The circuit board 44 includes a drive circuit 44*b* adjacent to the lead mounting portion 44*a*. The six coil pairs 43*a* to 43*f* are located in an annular pattern around the ring-shaped lead mounting portion 44*a* so that each pair of coils sandwiches the lead mounting portion 44*a* therebetween. The lead mounting portion 44*a* and the coil units 43*a* to 43*f* are made into an integral unit using synthetic resin.

A circular hysteresis plate 45 is attached to the rotor 34 opposite the lower surface of the stator coil assembly 42. The hysteresis plate 45 is centred by the central portion 34*b* of the rotor 34 in a central hole 46 of the plate 45. The hysteresis plate 45 is attracted upward by the magnetic attraction of the magnet 41. The hysteresis plate 45 is supported by the shoulder 34*c* on the central portion 34*b*.

The bearing sleeve 27 has the oilless bearing 28 and the ball bearing 29 disposed therein at a significant distance "1" from each other, as shown in Figure 3. Thus, power consumption and distortion from wow and flutter are minimized even though a flat brushless motor is used because the distance between the two bearings 28, 29 can be made great enough to overcome those problems. The motor M is arranged coaxially with a spindle means of the recorder which is rotatable independently of the motor. A separate drive means, described in detail below, is used to drive the supply and take-up spindles. The thickness of the motor M in the axial direction of the shaft 38 is therefore greatly reduced, and the size of the tape player can be made very compact.

Figure 5 shows the drive system for the tape player. The belt 36 travels around the motor pulley MP on the rotor 34 of the motor M and around the periphery of a capstan flywheel 3F. The motor M drives the belt 36 in the direction indicated by the arrow A. The belt 36 also drives a master gear-pulley 47 that is movable between three positions, as described below, for providing PLAY, FAST-FORWARD and REWIND modes of operation, respectively. The master gear-pulley 47 includes an idler pulley 47P which remains in contact with the belt 36 and a first master drive gear 47A and a second master drive gear 47B. The motor M drives the capstan 3 and the master gear-pulley 47 in the directions indicated by the arrows in Figure 5. The first master drive gear 47A meshes with the gear teeth 12A on the reel gear 12 when the player is operated in the PLAY mode.

The twin fast-forward drive gears 21 are rotatably mounted on the chassis plate 17 near the idler pulley 47P and the fast-forward reel gear 10 (see Figure 2). The twin fast-forward drive gears 21 comprise a first FF drive gear 21A above the chassis plate 17 and a second FF drive gear 21B below the chassis plate 17. The first FF drive gear 21A meshes with the gear teeth 10A of the fast-forward reel gear 10, and the second FF drive gear 21B meshes with the second master drive gear 47B of the master gear-pulley 47 when the player operated is in the FAST-FORWARD mode.

Twin rewind drive gears 48 are rotatably mounted on the chassis plate 17 near the master gear-pulley 47 and at the side of the rewind reel gear 22. A first rewind drive gear 48A above the chassis plate 17 meshes with the gear teeth 22A on the rewind reel gear 22. A second rewind drive gear 48B below the chassis plates 17 meshes with the second master drive gear 47B of the master gear-pulley 47 when the player operated is in the REWIND mode.

The operation of the drive system is shown in Figures 4A—6C.

Figure 6A depicts the PLAY mode of the player. When a PLAY button (not shown) is depressed, the master gear-pulley 47 moves in the direction indicated by the arrow X_P, so the first master drive gear 47A meshes with the gear teeth 12A on the play reel gear 12. The play reel gear 12 rotates counter-clockwise, and, through the friction plate 13, causes the take-up reel spindle 9 to rotate. (See Figure 2). The PLAY button also actuates a mechanism (not shown) that moves the pinch roller 4 toward the rotating capstan 3 to advance the tape past the head 6.

Figure 6B depicts the FAST-FORWARD mode of operation of the player. When a FAST-FORWARD button (not shown) is depressed, the master gear-pulley 47 swings in the direction indicated by the arrow X_F, so the second master drive gear 47B meshes with the second FF drive gear 21B of the twin fast-forward drive gears 21. The twin fast-forward drive gears 21 thus rotate counterclockwise to propel the fast-forward reel gear 10 counterclockwise and advance the tape at a rapid rate. The pinch roller 4 is not pressed against the capstan 3 in the FAST-FORWARD mode.

Figure 6C depicts the REWIND mode of operation of the player. When a REWIND button (not shown) is depressed, the master gear-pulley 47 swings in the direction indicated by the arrow X_R, so that the second master drive gear 47B meshes with the second rewind drive gear 48B of the twin rewind drive gears 48. The twin rewind drive gears 48 rotate counterclockwise and rotate the rewind reel gear 22 clockwise to rewind the tape from the take-up reel to the supply reel.

Thus, a cassette tape player can be made with dimensions that only slightly exceed the dimensions of the cassette being played, as shown in Figures 1—3, while providing high fidelity reproduction and power consumption low enough to make battery operation possible. And, as Figures 2—4 show, the various parts of the player can be "nested" to reduce even further the

thickness of the player. The high fidelity and low power consumption of the tape reproducing apparatus in spite of its small size is the result of using the vertical space available in one of the spindles to increase the length between the motor shaft bearings, while permitting the spindle to rotate relative to the motor rotor. The spindle is then driven independently of the rotation of the motor shaft.

Figure 7 shows a modified embodiment which is similar to the supply reel pawl means shown in Figure 3 except that the coil spring 30, the thrust member 31, and the "E" ring E2 are omitted. A chassis plate 17′ is made of magnetic material. Thus, the rotor 34 and the shaft 38 are urged upwardly by the magnetic attraction between the chassis plate 17′ and the rotor magnet 41. The rotor 34 presses against the ball bearing 29, the outer race 29*a* of which is press-fitted in a bearing sleeve 27′, so that a pre-load is applied to the ball bearing 29. In this embodiment the inner race 29*b* of the ball bearing 29 loosely fits on the rotating shaft 38. For this reason, when the shaft 38 is attracted upwardly by the magnetic force as described above, an annular rib 34*d* on the rotor 34 urges the inner race 29*b* upwardly. However, upward movement of the inner race 29*b* is restricted by the balls between the races 29*a* and 29*b*, and thus the ball bearing 29 determines positions of the bearing sleeve 27′ and the shaft 38. In this embodiment an "E" ring E'_3 prevents removal of the shaft 38 from the bearing sleeve 27′. Omission of the thrust member 31 shown in the embodiment of Figure 3 permits the thickness of the motor measured in the axial direction of the shaft 38 to be reduced even further.

CLAIMS

1. A tape player comprising: a drive motor having a stator, a shaft and a motor mounted on the shaft for rotation relative to the stator to drive a capstan; a spindle member for engaging a tape reel when the tape reel is mounted on the player, the shaft of the drive motor being supported by a bearing member disposed at least partially internally of the spindle member; and a drive member rotated by the drive motor for driving the spindle member; wherein the spindle member is supported coaxially with the shaft of the drive motor and is selectively driven by the drive member when the drive member is moved to it operative position.

2. A tape player according to claim 1, wherein the drive member is driven by a belt looped between a motor pulley and the capstan; the shaft of the drive motor has the motor pulley mounted at one end of the shaft and the spindle member is supported at the other end thereof.

3. A tape player according to claim 1, further having a motor chassis to which the bearing member is fixed, and wherein the rotor of the drive motor and a reel base integral with the spindle member are disposed on opposite sides of the motor chassis.

4. A tape player according to claim 3, wherein the shaft of the drive motor has a circumferential groove in which a clip member is fitted so as to prevent the removal of the spindle member.

5. A tape player according to claim 3, wherein the shaft of the drive motor is further supported by a further bearing member, said bearing member and said further bearing member are disposed at a distance apart measured along the axial direction of the shaft, and said further bearing member is positioned near the rotor of the drive motor and is formed by a ball bearing.

6. A tape player according to claim 5, wherein the motor chassis is made of a magnetic material and the ball bearing receives a pre-load by a magnetic force generated between the motor chassis and a ring-shaped flat magnet which is fixed to the rotor of the drive motor and is magnetized along a circumferential direction thereof.

7. A tape player having a pair of reel bases which are formed integrally with a pair of reel spindles engaging with a pair of reel hubs of a tape cassette, a slip mechanism mounted only at a take-up reel base of the pair of reel bases for driving a capstan and a drive member rotated by the drive motor for driving a supply reel spindle, wherein the supply reel spindle is supported coaxially with the shaft of the drive motor and is selectively driven by the drive member when the drive member is moved to an operative position in response to selection of a rewind mode for the player.

8. A tape player substantially as hereinbefore described and illustrated with reference to the accompanying drawings.

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