

Description

Technical Field

[0001] The invention relates to a rotary printing apparatus for printing on a disk print medium such as a CD-R (Compact Disk-Recordable).

Background Art

[0002] CD-Rs (compact disk-recordables) are write-once optical disks onto which data can be recorded only once unlike disks such as read-only CDs and CD-ROMs (read only memories). Data recorded on CD-Rs can be reproduced by a reproducing apparatus for CD-Rs as well as CDs and CD-ROMs. Because of their inexpensiveness, easiness to handle and large recording capacity, CD-Rs are frequently used for software publication on a small scale of approximately 100 copies.

[0003] One surface of a CD or CD-ROM is used as a record surface for data-recording and data-reading, and the other surface is generally used as a print surface for printing a title or the like. Since CDs or CD-ROMs having the same design are generally published in large quantity, printing is performed by use of a large-size printer. Since CD-Rs are used for small-scale publication and private uses, a small-size and inexpensive printer is desired which is capable of easily producing and changing print contents for a small number of disks or for each disk.

[0004] Examples of such printers are described in Japanese Unexamined Patent Publications JP-A 5-238005 (1993) and JP-A 6-31906 (1994). In these information recorders, information is recorded onto a record surface of an optical disk through a pickup, while ink-jet printing is performed on the print surface. The printing of the optical disk is performed while moving an ink-jet nozzle in the radial direction of the optical disk and rotating the optical disk.

[0005] Such information recorders are large-sized and complicated because the information recorders have an ink cartridge and a mechanism for supplying ink to an ink-jet head for an ink-jet printing method and as well a pickup for information recording. Moreover, since the ink-jet head and the pickup are provided in the same apparatus, information recording may be hindered for a reason such that ink scattering from the ink-jet head adheres to the pickup. Further, maintenance such as replacement of the ink cartridge and cleaning of parts around the ink-jet head takes time.

[0006] Further, if fluctuations in rotational speed of the optical disk occur during the printing operation, density variations such as uneven images, streaks, etc. are caused in the radial direction, with the result that the image quality is greatly degraded.

Disclosure of Invention

[0007] It is an object of the invention to provide a rotary printing apparatus that can achieve high quality image printing by stably rotating a disk print medium in printing operations.

[0008] The invention provides a rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer; head pressing means for pressing the thermal head against the disk print medium;

rotation supporting means for supporting the disk print medium rotatably in a sub-scanning direction along a circumferential direction of the disk print medium; and

rotation-driving means for rotation-driving the disk print medium by contacting an outer circumferential portion thereof.

[0009] According to the invention, since in the rotational torque T applied to the disk print medium = radius $R \times$ external force F , the radius R can be increased by rotation-driving the disk print medium by contacting the outer circumferential portion thereof, a large rotational torque can be obtained with a small drive force. In particular, in a thermal recording system using a thermal head, since the thermal head and the medium must be brought into intimate and uniform contact with each other, the frictional resistance between them becomes relatively large. Since the effects of load variations due to the friction, external disturbances, etc. can be reduced by increasing the rotational torque for driving, the large rotational torque serves to reduce variations in rotational speed, and high quality image printing can thus be achieved.

[0010] In the case of a disk print medium such as an optical disk, one side is a data recording surface which an optical pickup accesses, the other side is a label printing surface, and both surfaces are sensitive to contamination and scratches. By employing a rotation-driving method in which the disk print medium is driven by contact of the outer circumferential portion thereof, effects on the data recording surface and label printing surface can be avoided.

[0011] Furthermore, by applying the drive force directly to the disk print medium, the effects of mechanical errors of a drive transmission mechanism and transmission losses can be minimized, so that stabilization of the rotational speed can be achieved.

[0012] In the invention, it is preferable that the rotation-driving means includes a pinch roller for pressing the outer circumferential portion of the disk print medium, a roller driving mechanism for driving the pinch roller, and a roller displacing mechanism for displacing the pinch roller and thereby controlling the pinch roller to

contact with or separate from the outer circumferential portion.

[0013] According to the invention, with the pinch roller pressing the outer circumferential portion of the disk print medium, torque can be transmitted smoothly to the disk print medium. Furthermore, the elasticity of the pinch roller itself works to absorb variations in rotation and thereby stabilize the rotational speed.

[0014] Furthermore, the loading and changing of the disk print medium is facilitated by displacing the pinch roller so as to separate from the outer circumferential portion. When the pinch roller is made of rubber, roller deformation over time can be prevented by keeping the roller in the separated condition at all times except during printing operations.

[0015] In the invention, it is preferable that the rotation-driving means includes a belt disposed so as to contact the outer circumferential portion of the disk print medium, a belt driving mechanism for driving the belt in a longitudinal direction, and a tension control mechanism for controlling the tension of the belt.

[0016] According to the invention, since the elasticity of the belt itself works to absorb variations in rotation, and the belt contacts the outer circumferential portion over an increased length, factors contributing to variations in rotation such as torque variations and dimensional errors of the belt and the disk print medium are equalized, serving to stabilize the rotational speed.

[0017] Furthermore, the loading and changing of the disk print medium is facilitated by controlling the tension of the belt to separate the belt from the outer circumferential portion. When the belt is made of rubber, belt deformation over time can be prevented by keeping the belt in the separated condition at all times except during printing operations.

[0018] The invention also provides a rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer;
head pressing means for pressing the thermal head against the disk print medium; and
a backup roller for supporting the disk print medium against a head pressing force rotatably in a sub-scanning direction along a circumferential direction of the disk print medium,
wherein the backup roller is constructed of a cone-shaped roller whose diameter gradually increases toward the outer circumference of the disk print medium.

[0019] According to the invention, since the backup roller is constructed of a cone-shaped roller, the surface velocity of the backup roller increases toward the outer circumference of the disk print medium. This makes it possible to accommodate differences in surface velocity between the inner and outer radii where the surface ve-

locity increases with increasing radius from the center of the disk print medium. Accordingly, since the tangential velocity of the backup roller always coincides with that of the disk print medium irrespective of the radial position from the center, slippage due to the differences in surface velocity between the inner and outer radii does not occur, and stable rotational motion of the disk print medium can be maintained. On the other hand, in the case of a cylindrically shaped backup roller, there arises the problem that slippage occurs due to the differences in surface velocity between the inner and outer radii of the disk print medium, resulting in an inability to provide a stable rotational support.

[0020] Further, in a thermal recording system using a thermal head, the thermal head and the medium must be brought into intimate and uniform contact with each other. In view of this, by disposing the backup roller so as to support the entire recording area on which the thermal head is pressed, the head pressing force is equalized and high quality image printing can be achieved.

[0021] In the case of a disk print medium such as an optical disk, one side is a data recording surface which an optical pickup accesses, the other side is a label printing surface, and both surfaces are sensitive to contamination and scratches. Accordingly, it is preferable to form the backup roller of an elastic and non-hard material such as rubber.

[0022] In the invention, it is preferable that the backup roller is a drive roller for rotation-driving the disk print medium.

[0023] According to the invention, using the cone-shaped backup roller to rotation-drive the disk print medium, the gripping force between the disk print medium and the backup roller is spread out in the radial direction, and the contact area between them can also be made large, so that the drive force from the backup roller can be reliably transmitted to the disk print medium.

[0024] Furthermore, since the backup roller is constructed to directly drive the disk print medium by contacting it, the rotational speed can be stabilized, because the effects of mechanical errors of the drive transmission mechanism and transmission losses can be minimized. When the backup roller is formed of rubber or the like, elasticity of the roller itself works to absorb variations in rotation. This also serves to stabilize the rotational speed.

[0025] Further, when the backup roller is constructed to also serve as a drive roller, the need to provide a separate drive roller can be eliminated. This contributes to reducing the number of parts and making the apparatus compact in construction.

[0026] The invention also provides a rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer;
head pressing means for pressing the thermal head

against the disk print medium; and
 a backup roller for supporting the disk print medium
 against a head pressing force rotatably in a sub-
 scanning direction along a circumferential direction
 of the disk print medium,
 wherein the backup roller is disposed along the ra-
 dial direction of the disk print medium and includes
 a plurality of individual rollers rotating independen-
 tly of each other.

[0027] According to the invention, since the plurality
 of individual rollers arranged along the radial direction
 of the disk print medium support the disk print medium
 and rotate independently of each other, the backup roller
 can handle differences in surface velocity between the
 inner and outer radii where the surface velocity increas-
 es with increasing radius from the center of the disk print
 medium. Accordingly, since the tangential velocity of the
 backup roller always coincides with that of the disk print
 medium irrespective of the radial position from the cen-
 ter, slippage due to the differences in surface velocity be-
 tween the inner and outer radii does not occur, and sta-
 ble rotational motion of the disk print medium can be
 maintained. On the other hand, if the backup roller is
 constructed of a single cylindrically shaped roller, there
 arises the problem that slippage occurs due to the dif-
 ferences in surface velocity between the inner and outer
 radii of the disk print medium, resulting in an inability to
 provide a stable rotational support.

[0028] Further, in a thermal recording system using a
 thermal head, the thermal head and the medium must
 be brought into intimate and uniform contact with each
 other. In view of this, by disposing the many individual
 rollers so as to support the entire recording area on
 which the thermal head is pressed, the head pressing
 force is equalized and high quality image printing can
 be achieved.

[0029] In the case of a disk print medium such as an
 optical disk, one side is a data recording surface which
 an optical pickup accesses, the other side is a label
 printing surface, and both surfaces are sensitive to con-
 tamination and scratches. Accordingly, it is preferable
 to form the backup roller of an elastic and non-hard ma-
 terial such as rubber.

[0030] In the invention, it is preferable that one of the
 individual rollers is constructed as a drive roller for ro-
 tation-driving the disk print medium, and the other rollers
 as driven rollers.

[0031] According to the invention, by using one of the
 individual rollers as a drive roller, the torque can be
 transmitted at the position on which the head pressing
 force is exerted, and stable rotation-driving can thus be
 achieved. In particular, since, in the rotational torque T
 applied to the disk print medium = radius R x force F ,
 the radius R can be increased by disposing the drive
 roller at the outermost end, a large rotational torque can
 be obtained with a small drive force.

[0032] Furthermore, since the backup roller is con-

structed to directly drive the disk print medium by con-
 tacting it, the rotational speed can be stabilized, be-
 cause the effects of mechanical errors of the drive trans-
 mission mechanism and transmission losses can be
 minimized. When the backup roller is formed of rubber
 or the like, elasticity of the roller itself works to absorb
 variations in rotation. This also serves to stabilize the
 rotational speed.

[0033] Further, when one of the individual rollers is
 constructed to also serve as a drive roller, the need to
 provide a separate drive roller can be eliminated. This
 contributes to reducing the number of parts and making
 the apparatus compact in construction.

[0034] In the invention, it is preferable to provide a pair
 of holding rollers for rotation-driving the disk print me-
 dium by holding therebetween the outer circumferential
 portion of the disk print medium from both sides thereof.

[0035] According to the invention, since the disk print
 medium is rotation-driven by the pair of holding rollers
 holding the outer circumferential portion from both sides,
 the gripping force increases and the possibility of slip-
 page between the holding rollers and the disk print me-
 dium is eliminated, achieving stabilization of the rota-
 tional speed. Further, the elasticity of the holding rollers
 also works to absorb variations in rotation.

[0036] The invention also provides a rotary printing
 apparatus comprising:

a thermal head for thermally printing in a main scan-
 ning direction along a radial direction of a disk print
 medium having a heat-sensitive coloring layer;
 head pressing means for pressing the thermal head
 against the disk print medium;

a turn table for supporting the disk print medium ro-
 tatably in a sub-scanning direction along a circum-
 ferential direction of the disk print medium; and
 a backup roller for supporting the turn table so as
 to oppose a head pressing force.

[0037] According to the invention, the backup roller is
 disposed on the side of the turn table opposite from the
 thermal head, to support the turn table so as to oppose
 the head pressing force. This structure serves to support
 the tilting moment being exerted upon the turn table by
 the head pressing force, and to maintain the intimate
 and uniform contact between the thermal head and the
 disk print medium. In particular, the support position of
 the backup roller is preferably made as far as possible
 from the center of the turn table so that a greater tilting
 moment can be supported.

[0038] Further, in a thermal recording system using a
 thermal head, the thermal head and the medium must
 be brought into intimate and uniform contact with each
 other. In view of this, by disposing the turn table so as
 to support the entire recording area on which the thermal
 head is pressed, the head pressing force is equalized
 and high quality image printing can be achieved.

[0039] In the case of a disk print medium such as an

optical disk, one side is a data recording surface which an optical pickup accesses, the other side is a label printing surface, and both surfaces are sensitive to contamination and scratches. By disposing the turn table between the disk print medium and the backup roller, contamination and scratched can be prevented.

[0040] Further, by using the turn table for mounting the disk print medium thereon, the moment of inertia increases by the mass of the turn table compared with the case of the medium alone, and this serves to reduce variations in rotational speed.

[0041] In the invention, it is preferable that the backup roller is a drive roller for rotation-driving the turn table.

[0042] According to the invention, since the backup roller is constructed to also serve as a drive roller, the need for a separate drive roller can be eliminated. This contributes to reducing the number of parts and making the apparatus compact in construction. In particular, it is preferable to take the support position of the backup roller as far as possible from the center of the turn table. In that case, since, in the rotational torque T applied to the turn table = radius $R \times$ force F , the radius R can be increased, a large rotational torque can be obtained with a small drive force. In a thermal recording system using a thermal head, since the thermal head and the medium must be brought into intimate and uniform contact with each other, the frictional resistance between them becomes relatively large. Since the effects of load variations due to the friction, external disturbances, etc. can be reduced by increasing the rotational force for driving, the large rotational torque serves to reduce variations in rotational speed, and high quality image printing can thus be achieved.

[0043] In the invention, it is preferable that the disk-print medium has an optically readable data recording surface, and

an optical pickup for reading information recorded on the data recording surface is also provided.

[0044] According to the invention, by providing the optical pickup, a data reading function can be added to the rotary printing apparatus, that is, the rotary printing apparatus can also be used as an optical disk drive unit, thus serving to conserve space. Furthermore, it is also possible to prerecord print data on the data recording surface of the disk print medium that has yet to be printed, and to print on the rotating disk print medium by using the print data read out by the optical pickup. Further, the optical pickup may be configured as a write head for writing to the data recording surface.

Brief Description of Drawings

[0045] Fig. 1 is a perspective view explaining a thermal recording method according to the invention.

[0046] Fig. 2A is a cross-sectional view showing the structure of a heat-sensitive print sheet 21 used as a disk print medium M of Fig. 1 and Fig. 2B is a cross-sectional view showing the structure of a medium 19 in

which the heat-sensitive print sheet 21 is pasted to an optical disk 20.

[0047] Fig. 3 is a block diagram showing the electrical structure of a rotary printing apparatus 10.

[0048] Fig. 4 is a timing chart showing the operation of the rotary printing apparatus 10.

[0049] Figs. 5A to 5F are views showing printing steps of the disk print medium M.

[0050] Fig. 6 is a schematic diagram showing a first embodiment of the invention.

[0051] Fig. 7 is a diagram showing a comparative example.

[0052] Fig. 8 is a plan view showing the first embodiment of the invention.

[0053] Figs. 9A and 9B are schematic diagrams showing alternative examples of the pinch roller 31.

[0054] Figs. 10A and 10B are schematic diagrams showing a second embodiment of the invention, Fig. 10A showing the disk print medium M in a rotating condition, and Fig. 10B showing how the medium M is made ready to be removed.

[0055] Figs. 11A and 11B are schematic diagrams showing a third embodiment of the invention.

[0056] Fig. 12 is a schematic diagram showing a fourth embodiment of the invention.

[0057] Figs. 13A and 13B are schematic diagrams showing a fifth embodiment of the invention, Fig. 13A showing a plan view and Fig. 13B showing a side view.

[0058] Fig. 14 is a schematic diagram showing a sixth embodiment of the invention.

[0059] Fig. 15 is a schematic diagram showing a seventh embodiment of the invention.

Best Mode for Carrying out the Invention

[0060] Fig. 1 is a perspective view explaining a thermal recording method according to the invention. A rotary printing apparatus 10 comprises a thermal head 11, a backup roller 12 and cathode tubes 13 and 14, for printing on a disk print medium M. The disk print medium M is a disk-shaped print medium having heat-sensitive coloring layers which are colored when heat is applied. The thermal head 11 is a line thermal head extending in the radial direction of the disk print medium M. A stepping motor 15 rotates the disk print medium M about its axis. The backup roller 12, whose surface is covered with rubber, supports the disk print medium M from its rear surface against the pressure to its top surface by the thermal head 11, and rotates as the disk print medium M rotates. The cathode tubes 13 and 14 emit ultraviolet rays of wavelengths at which the coloring layers of the disk print medium M are fixed.

[0061] Printing of the rotary printing apparatus 10, in which the radial direction of the disk print medium M is the main scanning direction and the circumferential direction of the disk print medium M is the sub scanning direction, is carried out by selectively supplying heat to pixel areas arranged in the radial and circumferential di-

rections of the disk print medium M to color them.

[0062] The thermal head 11 as shown in Fig. 1 may be a serial head capable of scanning along the radial direction of the disk print medium M. Moreover, a turntable 31 may be used in place of the backup roller 12 as shown in Fig. 1.

[0063] Fig. 2A is a cross-sectional view showing the structure of a heat-sensitive print sheet 21 used as the disk print medium M as shown in Fig. 1. Fig. 2B is a cross-sectional view showing the structure of a medium 19 in which the heat-sensitive print sheet 21 is pasted on an optical disk 20.

[0064] The heat-sensitive print sheet 21 as shown in Fig. 2A has a cross-sectional structure similar to those of multicolor heat-sensitive record sheets described in Japanese Unexamined Patent Publications JP-A 3-43293 (1991) and JP-A 5-69566 (1993). The printing method of coloring a multicolor heat-sensitive record sheet by applying heat to the sheet is called a TA (thermo-auto chrome) method. The rotary printing apparatus 10 of this embodiment is also a TA printer.

[0065] In the heat-sensitive print sheet 21, a heat-sensitive coloring layer 23 is formed on the surface of a base material 22 such as paper, and the plane shape of the sheet 21 is a disk shape. The heat-sensitive coloring layer 23 is composed of a yellow coloring layer 23a, a magenta coloring layer 23b and a cyan coloring layer 23c.

[0066] The yellow coloring layer 23a contains a yellow pigment material encapsulated in microcapsules and a coupler. By applying thermal energy of 20 mJ/mm² or more, the pigment material passes through the microcapsules to react with the coupler, so that the layer 23a is colored. Moreover, by applying ultraviolet rays of a wavelength of 420 nm to the yellow coloring layer 23a, the unreacted yellow pigment material is decomposed, so that coloring does not continue any more.

[0067] The magenta coloring layer 23b contains a magenta pigment material encapsulated in microcapsules and a coupler. By applying thermal energy of not less than 40 mJ/mm², the pigment material passes through the microcapsules to react with the coupler, so that the layer 23b is colored. Moreover, by applying ultraviolet rays of a wavelength of 365 nm to the magenta coloring layer 23b, the unreacted magenta pigment material is decomposed, so that coloring does not progress any more.

[0068] The cyan coloring layer 23c contains a dye encapsulated in microcapsules, and is colored by applying thermal energy of approximately 80 mJ/mm² or more.

[0069] The thermal head 11 as shown in Fig. 1 is capable of supplying any of thermal energy of 20 mJ/mm² to 40 mJ/mm², thermal energy of 40 mJ/mm² to 80 mJ/mm² and thermal energy of 80 mJ/mm² to 120 mJ/mm². The cathode tube 13 emits ultraviolet rays of a wavelength of 420 nm to fix the yellow coloring layer 23a. The cathode tube 14 emits ultraviolet rays of a wavelength of 365 nm to fix the magenta coloring layer 23b.

[0070] In the medium 19 as shown in Fig. 2B, the heat-sensitive print sheet 21 is pasted on the print surface 20a of the optical disk 20 such as a CD-R with an adhesive layer 24 in between.

[0071] In the optical disk 20, an organic pigment layer 25, a reflective layer 26 made of metal and a protective layer 27 are laminated in this order on a polycarbonate substrate 30. For the optical disk 20, data recording is performed by phase-changing the organic pigment layer 25 by applying a laser beam from the record surface 20b. The optical disk 20 usable for the rotary printing apparatus 10 is not limited to a disk having such a structure, but may be, for example, a CD, CD-ROM or CD-RW (rewritable). Moreover, the optical disk 20 may be a DVD (digital video disk)-ROM, DVD-RAM (random access memory), DVD-R, DVD-RW or the like.

[0072] As the disk print medium M, the heat-sensitive print sheet 21 as shown in Fig. 2A may be used as it is, or the medium 19 as shown in Fig. 2B may be used. When the heat-sensitive print sheet 21 is used as it is, the heat-sensitive print sheet 21 can be pasted on the optical disk 20 after printing. Moreover, the heat-sensitive coloring layer 23 may be directly formed on the optical disk 20 by vapor deposition or the like.

[0073] Fig. 3 is a block diagram showing the electrical structure of the rotary printing apparatus 10. An interface (I/F) 94 performs data transmission with an external host such as a personal computer through communication such as parallel communication or serial communication, for example, receives image data to be printed from the external host and transmits status data representative of the operation condition of the printing apparatus 10. A CPU (central processing unit) 91 operates in accordance with a predetermined program stored in a ROM (read only memory) 92 or the like, and controls general operations such as processing of signals for the thermal head 11 and operations of the stepping motor 15 and the cathode tubes 13 and 14. The ROM 92 is a nonvolatile memory in which the program for the CPU 91 and various data are stored.

[0074] A RAM 93 is a volatile memory in which printing data and various data are stored, and functions also as a buffer memory for continuously expanding image data thereinto. The function of the buffer memory for data development may be assigned to a memory on the side of the external host to thereby save the memory capacity on the side of the printing apparatus 10.

[0075] Fig. 4 is a timing chart showing the operation of the rotary printing apparatus 10. Figs. 5A to 5F are views stepwisely showing the print condition of the disk print medium M. When printing is started, the data of a print image produced by the external host is transmitted to the thermal head 11 through the I/F 94, the CPU 91 and the like. At the same time, energization of the stepping motor 15 is started, so that the stepping motor 15 rotates the disk print medium M at a predetermined rotation speed.

[0076] In Fig. 5A, energization of the thermal head 11

is started, and thermal energy of the lowest heat-sensitive coloring level is applied to the disk print medium M. Consequently, the yellow coloring layer 23a is colored. Then, as shown in Fig. 5B, when a forefront line 73 of a colored area 75 of the yellow coloring layer 23a reaches a rearmost part 71b of a light irradiated area 71, energization of the cathode tube 13 is started. Consequently, light from the cathode tube 13 is applied to the disk print medium M. The light irradiated area 71 is an area irradiated with light from the cathode tube 13. Then, when the forefront line 73 has reached the thermal head 11 again, energization of the thermal head 11 is stopped to end coloring of the yellow coloring layer 23a.

[0077] Then, as shown in Fig. 5C, when a forefront line 74 of a fixed area 77 where fixing of the yellow coloring layer 23a is completed reaches the thermal head 11, energization of the thermal head 11 is started, and thermal energy of the second lowest heat-sensitive coloring level is applied to the disk print medium M. Consequently, coloring of the magenta coloring layer 23b is started from the forefront line 74. Then, when the forefront line 74 of the fixing-completed area of the yellow coloring layer again reaches the rearmost part 71b of the light irradiated area 71, energization of the cathode tube 13 is stopped to end fixing of the yellow coloring layer 23a.

[0078] Then, as shown in Fig. 5D, when the forefront line 74 of a colored area 79 where the magenta coloring layer 23b is colored reaches a rearmost part 72b of a light irradiated area 72, energization of the cathode tube 14 is started. Consequently, light from the cathode tube 14 is applied to the disk print medium M, so that the magenta coloring layer 23b is fixed. The light irradiated area 72 is an area irradiated with light from the cathode tube 14. Then, when the forefront line 74 of the colored area of the magenta coloring layer reaches the thermal head 11, energization of the thermal head 11 is stopped to end coloring of the magenta coloring layer 23b.

[0079] Then, as shown in Fig. 5E, when a forefront line 78 of a fixed area 81 where fixing of the magenta coloring layer 23b is completed reaches the thermal head 11, energization of the thermal head 11 is started, and thermal energy of the highest heat-sensitive coloring level is applied to the disk print medium M. Consequently, coloring of the cyan coloring layer 23c is started from the forefront line 78. Then, when the forefront line 78 of the fixing-completed area of the magenta coloring layer again reaches the rearmost part 72b of the light irradiated area 72, energization of the cathode tube 14 is stopped to end fixing of the magenta coloring layer 23b.

[0080] Then, as shown in Fig. 5F, when the forefront line 78 of the colored area of the cyan coloring layer again reaches the thermal head 11, energization of the thermal head 11 is stopped to end coloring of the cyan coloring layer 23c. At this time, the disk print medium M is all covered with a colored area 82 where the cyan coloring layer 23c is colored, and printing is completed.

[0081] By successively performing coloring and fixing

of the yellow coloring layer 23a, coloring and fixing of the magenta coloring layer 23b and coloring of the cyan coloring layer 23c as described above, full-color printing can be performed.

[0082] Fig. 6 is a schematic diagram showing a first embodiment of the invention, and Fig. 7 is a diagram showing a comparative example. Fig. 8 is a plan view showing the first embodiment of the invention. Referring first to Fig. 6, the disk print medium M is mounted on a turn table 19. At the center of the turn table 19 is provided an engagement protrusion whose outer diameter substantially matches the center hole of the disk print medium M and thus centers the disk print medium M thereon. The thermal head 11 is arranged along the radial direction of the disk print medium M, and is pressed toward the disk print medium M with a pressing force F_t by a spring 11a attached to the apparatus cover. The backup roller 12 is driven to rotate so as to oppose the pressing force F_t , and stably supports the rotating surface of the disk print medium M. The backup roller 12 shown in Fig. 6 is cylindrical in shape, but a cone-shaped roller such as the one shown in Fig. 1 may also be used.

[0083] The pinch roller 31 connected to the motor 15 is located on a line extended from the recording line of the thermal head 11, and directly rotation-drives the disk print medium M. The pinch roller 31 is formed of rubber or like material that does not easily slip on the medium M, and presses the outer circumference of the disk print medium M inwardly toward the center thereof by a pressing force F_p . The turntable 19 supports the disk print medium M against the pressing force F_p . Since this force balance works to position the disk print medium M in place, the medium clamping mechanism disposed opposite the turn table 19 may be omitted.

[0084] The rotation angle of the turn table 19 is detected by a rotary encoder RE and, by using the detection signal as a feedback signal to the motor 15, the rotation angle and the rotational speed of the disk print medium M can be controlled accurately.

[0085] With the pinch roller 31 directly driving the disk outer circumference, a large rotational torque can be obtained with a small driving force, and thus the disk print medium M can be driven to rotate stably. Furthermore, the elasticity of the pinch roller 31 itself works to absorb variations in rotation, serving to stabilize the rotational speed.

[0086] On the other hand, in the comparative example of Fig. 7, the disk print medium M is held between a turn table 18 and a clamp 30 with a pressing force F_c , and the turn table 18 is driven by a motor 15 via gears 16 and 17. In this construction, though the gears 16 and 17 provide a reducing mechanism, the motor 15 is required to generate a large rotational torque. Furthermore, backlash of the gears 16 and 17, slippage between the disk print medium M and the turn table 18, and variations in rotation due to deformed parts, etc. tend to occur.

[0087] A displacing mechanism for the pinch roller 31

is shown in detail in Fig. 8. The pinch roller 31 and a gear 32 rotating with it engage with an intermediate gear 33 which, in turn, engages with a drive gear 34. The drive gear 34 is rotation-driven by a drive shaft 35 of the motor 15. The pinch roller 31 and the gear 32 are rotatably supported at one end of a lever 37. The lever 37 is supported so as to pivot about a shaft that coincides with the axis of the intermediate gear 33. The rear end of the lever 37 is engaged with a spring 36, and the restoring force of the spring 36 generates the pressing force F_p for pressing the pinch roller 31 against the medium M. Also, an electromagnetic plunger 38 for controlling the expansion and contraction of the spring 36 is attached to the rear end of the lever 37, and controls the pinch roller 31 to contact with or separate from the outer circumference of the medium M.

[0088] Fig. 8 shows the medium M in a rotating condition. With the electromagnetic plunger 38 off, and with the pinch roller 31 being pressed against the outer circumference of the medium M by the spring 36, the motor 15 drives the pinch roller 31 via the drive gear 34, the intermediate gear 33, and the gear 32, and thus drives the medium M to rotate. When changing the medium M, the electromagnetic plunger 38 is energized, angularly displacing the lever 37 and thereby causing the pinch roller 31 to separate from the outer circumference of the medium M. It is also possible to interlock the operation of the electromagnetic plunger 38 with the open/close action of the apparatus cover.

[0089] With the pinch roller 31 thus displaced and separated from the outer circumference, the loading and changing of the disk print medium M becomes easier. If the pinch roller 31 is made of rubber, roller deformation over time can be prevented by keeping the roller in the separated condition at all times except during printing operations.

[0090] Figs. 9A and 9B are schematic diagrams showing alternative examples of the pinch roller 31. In Fig. 9A, there are provided two pinch rollers 31 contacting the upper and lower edges of the outer circumference of the medium M obliquely at an angle of 45 degrees. The two rollers together exert a pressing force F_p to press the outer circumference of the disk print medium M inwardly toward the center thereof, and the medium M can thus be rotation-driven with the rotation of the pinch rollers 31.

[0091] In Fig. 9B, a V-shaped groove is formed around the outer circumferential face of the pinch roller 31 so that the pinch roller 31 contacts the upper and lower edges of the outer circumference of the medium M obliquely at an angle of 45 degrees. With this structure, the pressing force is exerted on the outer circumference of the disk print medium M to press it inwardly toward the center thereof, and the medium M can thus be rotation-driven with the rotation of the pinch roller 31.

[0092] Figs. 10A and 10B are schematic diagrams showing a second embodiment of the invention, Fig. 10A showing the disk print medium M in a rotating con-

dition, and Fig. 10B showing how the medium M is made ready to be removed.

[0093] The disk print medium M is mounted on a turn table 19 having an engagement protrusion for centering, similar to the one shown in Fig. 6. The thermal head 11 is arranged along the radial direction of the disk print medium M, and is pressed toward the disk print medium M with a pressing force F_t by a spring attached to the apparatus cover. As in Fig. 6, there is also provided a backup roller which is driven to rotate so as to oppose the pressing force F_t .

[0094] A belt 40 is wrapped passing around the outer circumference of the disk print medium M and a drive pulley 42 connected to the motor 15, and is supported by being held between the drive pulley 42 and a belt retaining roller 43 rotating with it. The belt 40 is formed of a flexible material such as rubber that does not easily slip on the medium M or the drive pulley 42.

[0095] The drive unit comprising the drive pulley 42, belt retaining roller 43, motor 15, etc. is biased with a pressing force F_b by a spring mechanism or the like so as to apply a predetermined tension to the belt 40. The belt 40 thus presses the outer circumference of the disk print medium M inwardly toward the center thereof, and the turn table 19 supports the disk print medium M mounted on it. Since this force balance works to position the disk print medium M in place, the medium clamping mechanism disposed opposite the turn table 19 may be omitted.

[0096] The rotation angle of the turn table 19 is detected by a rotary encoder or the like and, by using the detection signal as a feedback signal to the motor 15, the rotation angle and the rotational speed of the disk print medium M can be controlled accurately.

[0097] When the motor 15 drives the drive pulley 42, the belt 40 is driven in the longitudinal direction, causing the disk print medium M contacting the belt 40 to rotate. With the belt 40 directly driving the disk outer circumference, a large rotational torque can be obtained with a small driving force, and thus the disk print medium M can be driven to rotate stably. Furthermore, since the elasticity of the belt 40 itself works to absorb variations in rotation, and the belt 40 contacts the outer circumference over an increased length, factors contributing to variations in rotation such as torque variations and dimensional errors of the belt and the disk print medium are equalized, serving to stabilize the rotational speed.

[0098] When removing the medium M from the turn table 19, as shown in Fig. 10B, the drive unit is displaced toward the medium M, loosening the tension of the belt 40 and thus slackening the belt 40 to allow it to separate from the outer circumference of the medium M. Belt guides 41a to 41c are provided to prevent the belt 40 from being widely displaced at this time, and to ensure that the belt 40 can be remounted in its original position; in particular, the belt guides 41a and 41c move together with the drive unit. Here, it is also possible to interlock the displacing operation of the drive unit with the open/

close action of the apparatus cover.

[0099] With the tension of the belt 40 thus controlled to separate the belt 40 from the outer circumference, the loading and changing of the disk print medium M becomes easier. If the belt 40 is made of rubber, belt deformation over time can be prevented by keeping the belt in the separated condition at all times except during printing operations.

[0100] Figs. 11A and 11B are schematic diagrams showing a third embodiment of the invention, Fig. 11A showing a rotary printing mode and Fig. 11B showing a data reading mode. The disk print medium M is mounted on the turn table 19 and held pressed thereon from above by means of a clamp 30 attached to the apparatus cover. At the center of the turn table 19 is provided an engagement protrusion whose outer diameter substantially matches the center hole of the disk print medium M and thus centers the disk print medium M thereon. The thermal head 11 is arranged along the radial direction of the disk print medium M, and is pressed toward the disk print medium M with a pressing force F_t by a spring 11a attached to the apparatus cover.

[0101] The backup roller 12 is constructed of a cone-shaped roller whose diameter gradually increases toward the outer circumferential side of the disk print medium M. The rotational center line of the cone-shaped roller passes through the center of the lower surface of the disk print medium M, and the angle that the rotational center line makes with the lower surface of the medium defines the cone generating angle. Using such a cone-shaped roller, it becomes possible to accommodate differences in surface velocity between the inner and outer radii where the surface velocity increases with increasing radius from the center of the disk print medium M. The backup roller 12 rotates so as to oppose the pressing force F_t , and stably supports the rotating surface of the disk print medium M.

[0102] The shaft of the backup roller 12 is connected to the motor 15 via gears 16 and 17. The drive torque of the motor 15 is transmitted to the backup roller 12, and the backup roller 12 directly contacting the lower surface of the disk print medium M rotation-drives the medium M.

[0103] Further, since the backup roller 12 is disposed so as to support the entire recording area on which the thermal head 11 is pressed, the head pressing force is equalized, and high quality image printing with little variation in density can be achieved. Furthermore, to protect the lower surface of the disk print medium M and to absorb vibrations and variations in rotation, it is preferable to form the backup roller 12 of an elastic and non-hard material such as rubber.

[0104] The rotation angle of the turn table 19 is detected by the rotary encoder RE and, by using the detection signal as a feedback signal to the motor 15, the rotation angle and the rotational speed of the disk print medium M can be controlled accurately.

[0105] The above description has dealt with an exam-

ple in which the backup roller 12 is used as a drive roller, but in an alternative construction, the backup roller may be used as a driven roller and a drive mechanism for the disk print medium M may be provided separately.

[0106] Next, the data reading mode will be described. When the disk print medium M is an optical disk such as a CD or CD-R, that has an optically readable data recording surface, a data reading function can be added to the rotary printing apparatus by providing an optical pickup 85. The optical pickup 85 is moved along the radial direction of the disk print medium M by a motor 87 and a lead screw 86. The disk print medium M is driven to rotate, for example, at a CD standard velocity (about 500 rpm) or higher velocity by means of a motor 88 connected to the turn table 19. When reading or writing data at a constant linear velocity, the number of revolutions of the motor 88 is varied according to the position of the optical pickup 85.

[0107] When reading data, the thermal head 11 and the backup roller 12 are moved away from the disk print medium M, as shown in Fig. 11B. After that, the motor 88 is energized to rotate the disk print medium M at high speed, and the optical pickup 85 reads the information recorded on the data recording surface and transfers it to a data processor 89 and, if necessary, to an external host device (not shown). The rotary printing apparatus can thus be used as an optical disk drive unit.

[0108] Further, by temporarily storing the information, read out by the optical pickup 85, into a memory or the like in the data processor 89, and then moving to a rotary printing mode and driving the thermal head 11 based on the readout information, the information recorded on the data recording surface of the disk print medium M can be printed on the label print surface thereof. For example, by just reading out CD title or identification code, character information such as copyright number, or label image information prerecorded on the data recording surface, a large number of rotary printing data can be generated. This eliminates the need to prepare rotary printing data separately and, besides, label printing different for each individual disk print medium M can be easily achieved.

[0109] In the above example, the motor 15 for rotary printing and the motor 88 for data reading are provided separately, but it is also possible to handle the different rotational speeds in the two modes by using either one of the motors if it is combined with a variable speed mechanism.

[0110] Fig. 12 is a schematic diagram showing a fourth embodiment of the invention. The disk print medium M is mounted on the turn table 19 and held pressed thereon from above by means of a clamp 30 attached to the apparatus cover. At the center of the turn table 19 is provided an engagement protrusion whose outer diameter substantially matches the center hole of the disk print medium M and thus centers the disk print medium M thereon. The thermal head 11 is arranged along the radial direction of the disk print medium M, and is

pressed toward the disk print medium M with a pressing force F_t by a spring 11a attached to the apparatus cover.

[0111] The backup roller 12 is arranged along the radial direction of the disk print medium M so as to oppose the pressing force F_t and includes a plurality of individual rollers 12a rotating independently of each other. Since each individual roller 12a rotates independently of the others in accordance with the surface velocity that differs according to the radial position at which the roller contacts the disk print medium M, slippage due to differences in surface velocity between the inner and outer radii does not occur, and thus the rotating surface of the disk print medium M is stably supported.

[0112] The individual rollers 12a are rotatably supported on a shaft 12b. Only the individual roller 12a located in the outermost position rotates with a gear 17 and is connected to the motor 15 via the gears 16 and 17. Therefore, the drive torque of the motor 15 is transmitted to the outermost individual roller 12a, and this individual roller 12a directly contacts the lower surface of the disk print medium M and rotation-drives the medium M. The remaining rollers 12a rotate with the rotation of the disk print medium M. It is preferable to choose the outermost individual roller 12a as the drive roller, and a large rotational torque can then be generated with a small drive force.

[0113] Since the many individual rollers 12a are disposed so as to support the entire recording area on which the thermal head 11 is pressed, as described above, the head pressing force exerted on the disk print medium M is equalized, and high quality image printing with little variation in density can be achieved. Further, to protect the lower surface of the disk print medium M and to absorb vibrations and variations in rotation, it is preferable to form each individual roller 12a of an elastic and non-hard material such as rubber.

[0114] The rotation angle of the turn table 19 is detected by the rotary encoder RE, as in Fig. 11, and by using the detection signal as a feedback signal to the motor 15, the rotation angle and the rotational speed of the disk print medium M can be controlled accurately.

[0115] The above description has dealt with an example in which one of the individual rollers 12a is used as a drive roller, but in an alternative construction, all the individual rollers 12a may be used as driven rollers and a drive mechanism for the disk print medium M may be provided separately.

[0116] Figs. 13A and 13B are schematic diagrams showing a fifth embodiment of the invention, Fig. 13A showing a plan view and Fig. 13B showing a side view. The disk print medium M is mounted on the turn table 19 and held pressed thereon from above by means of a clamp 30 attached to the apparatus cover. At the center of the turn table 19 is provided an engagement protrusion whose outer diameter substantially matches the center hole of the disk print medium M and thus centers the disk print medium M thereon. The thermal head 11 is arranged along the radial direction of the disk print

medium M, and is pressed toward the disk print medium M with a pressing force F_t by a spring attached to the apparatus cover.

[0117] A plurality of pairs of holding rollers (three pairs in Fig. 13A) for holding therebetween the outer circumferential portion of the disk print medium A are arranged at the same radius of the medium M. In each pair of holding rollers, one roller is a drive roller 50a to 50c, and the other roller is a driven roller 51a to 51c. The drive roller 50a is driven by the motor 15 via gears 16 and 17, and the other drive rollers 50b and 50c are driven by the same motor 15 via a transmission mechanism (not shown) such as a belt. All the drive rollers 50a to 50c rotate at the same rotational speed to rotation-drive the medium M.

[0118] Since the pairs of holding rollers rotation-drive the medium M by holding the outer circumferential portion of the medium M from both sides, the gripping force increases and the possibility of slippage between the holding rollers and the disk print medium is eliminated, achieving stabilization of the rotational speed. Further, the holding rollers are formed of rubber or like material, and the elasticity of the rollers also works to absorb variations in rotation.

[0119] Further, as in the example of Fig. 12, the backup roller 12 comprising a plurality of individual rollers 12a that rotate so as to oppose the pressing force F_t is arranged along the radial direction of the disk print medium M. Since each individual roller 12a rotates independently of the others in accordance with the surface velocity that differs according to the radial position at which the roller contacts the disk print medium M, slippage due to differences in surface velocity between the inner and outer radii does not occur, and thus the rotating surface of the disk print medium M is stably supported.

[0120] Fig. 14 is a schematic diagram showing a sixth embodiment of the invention. The disk print medium M is mounted on a turn table 55 having a diameter equal to or greater than the outer diameter of the medium M. At the center of the turn table 55 is provided an engagement protrusion whose outer diameter substantially matches the center hole of the disk print medium M and thus centers the disk print medium M thereon. A rubber sheet 56 is mounted on the turn table 55 to increase the grip on the medium M, to suppress vibrations, and to equalize the pressing force F_t . The disk print medium M is held with a pressing force F_c between the turn table 55 and the clamp 30, while the turn table 55 is rotatably supported on a shaft 57 so as to oppose the pressing force F_c , and is driven by the motor 15 via gears 58 and 59.

[0121] The thermal head 11 is arranged along the radial direction of the disk print medium M, and is pressed toward the disk print medium M with the pressing force F_t by a spring attached to the apparatus cover.

[0122] To oppose this pressing force F_t , a cylindrical portion 55a is formed extending parallel to the axis of

rotation from the outer circumference of the turn table 55, and a backup roller 60 is provided which is driven by contact with an end face of the cylindrical portion 55a to be rotated.

[0123] With the backup roller 60 thus supporting the outer circumference so as to oppose the pressing force F_t , the turn table 55 is prevented from tilting from its proper position, and the uniform and intimate contact between the thermal head 11 and the disk print medium M can be maintained. Furthermore, using the turn table 55 having a large diameter offers the effect of increasing the moment of inertia and thereby reducing variations in rotational speed.

[0124] Fig. 15 is a schematic diagram showing a seventh embodiment of the invention. The disk print medium M is mounted on a turn table 55 having a diameter equal to or greater than the outer diameter of the medium M. At the center of the turn table 55 is provided an engagement protrusion whose outer diameter substantially matches the center hole of the disk print medium M and thus centers the disk print medium M thereon. A rubber sheet 56 is mounted on the turn table 55 to increase the grip on the medium M, to suppress vibrations, and to equalize the pressing force F_t . The disk print medium M is held with a pressing force F_c between the turn table 55 and the clamp 30, while the turn table 55 is rotatably supported on a shaft 57 so as to oppose the pressing force F_c .

[0125] The thermal head 11 is arranged along the radial direction of the disk print medium M, and is pressed toward the disk print medium M with the pressing force F_t by a spring attached to the apparatus cover.

[0126] To oppose this pressing force F_t , a cylindrical portion 55a is formed extending parallel to the axis of rotation from the outer circumference of the turn table 55, and a backup roller 61 is provided which is driven and rotated by contact with an end face of the cylindrical portion 55a. The backup roller 61 is driven by the motor 15.

[0127] With the backup roller 61 thus supporting the outer circumference so as to oppose the pressing force F_t , the turn table 55 is prevented from tilting from its proper position, and the uniform and intimate contact between the thermal head 11 and the disk print medium M can be maintained. Furthermore, using the turn table 55 having a large diameter offers the effect of increasing the moment of inertia and thereby reducing variations in rotational speed.

[0128] Further, since the backup roller 61 rotation-drives the outer circumference of the turn table 55, a large rotational torque can be obtained with a small drive force. This serves to reduce variations in rotational speed, and achieves high quality image printing.

Effect of the Invention

[0129] As described above, according to the invention, since the outer circumference of the disk print me-

dium is rotation-driven in contacting relationship, a large rotational torque can be obtained with a small drive force. This serves to reduce variations in rotational speed, and achieves high quality image printing.

[0130] By employing the rotation-driving method in which the disk print medium is driven by contact of the outer circumference thereof, effects on the data recording surface and label printing surface can be avoided.

[0131] Furthermore, since the drive force is applied directly to the disk print medium, the effects of mechanical errors of the drive transmission mechanism and transmission losses can be minimized, serving to stabilize the rotational speed.

[0132] When the backup roller for opposing the head pressing force is constructed of a cone-shaped roller or a plurality of individual rollers, it becomes possible to accommodate differences in surface velocity between the inner and outer radii of the disk print medium, so that slippage due to the differences in surface velocity between the inner and outer radii does not occur, and stable rotating motion of the disk print medium can be maintained.

[0133] Further, when the backup roller is constructed to also serve as a drive roller, the need to provide a separate drive roller can be eliminated, and this contributes to reducing the number of parts and making the apparatus compact in construction.

Claims

1. A rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer;
head pressing means for pressing the thermal head against the disk print medium;
rotation supporting means for supporting the disk print medium rotatably in a sub-scanning direction along a circumferential direction of the disk print medium; and
rotation-driving means for rotation-driving the disk print medium by contacting an outer circumferential portion thereof.

2. The rotary printing apparatus of claim 1, wherein the rotation-driving means includes a pinch roller for pressing the outer circumferential portion of the disk print medium, a roller driving mechanism for driving the pinch roller, and a roller displacing mechanism for displacing the pinch roller and thereby controlling the pinch roller to contact with or separate from the outer circumferential portion.

3. The rotary printing apparatus of claim 1, wherein the rotation-driving means includes a belt disposed in

contacting relationship to the outer circumferential portion of the disk print medium, a belt driving mechanism for driving the belt in a longitudinal direction, and a tension control mechanism for controlling the tension of the belt.

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4. A rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer;

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head pressing means for pressing the thermal head against the disk print medium; and

a backup roller for supporting the disk print medium against a head pressing force rotatably in a sub-scanning direction along a circumferential direction of the disk print medium, wherein the backup roller is constructed of a cone-shaped roller whose diameter gradually increases toward the outer circumference of the disk print medium.

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5. The rotary printing apparatus of claim 1, wherein the backup roller is a drive roller for rotation-driving the disk print medium.

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6. A rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer;

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head pressing means for pressing the thermal head against the disk print medium; and

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a backup roller for supporting the disk print medium against a head pressing force rotatably in a sub-scanning direction along a circumferential direction of the disk print medium, wherein the backup roller is disposed along the radial direction of the disk print medium and includes a plurality of individual rollers rotating independently of each other.

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7. The rotary printing apparatus of claim 6, wherein one of the individual rollers is constructed as a drive roller for rotation-driving the disk print medium, and the other rollers as driven rollers.

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8. The rotary printing apparatus of claim 6, comprising:

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a pair of holding rollers for rotation-driving the disk print medium by holding therebetween the outer circumferential portion of the disk print medium from both sides thereof.

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9. A rotary printing apparatus comprising:

a thermal head for thermally printing in a main scanning direction along a radial direction of a disk print medium having a heat-sensitive coloring layer;

head pressing means for pressing the thermal head against the disk print medium;

a turn table for supporting the disk print medium rotatably in a sub-scanning direction along a circumferential direction of the disk print medium; and

a backup roller for supporting the turn table so as to oppose a head pressing force.

10. The rotary printing apparatus of claim 9, wherein the backup roller is a drive roller for rotation-driving the turn table.

11. The rotary printing apparatus of any one of claims 1, 4, 6 and 9,

wherein the disk print medium has an optically readable data recording surface,

the apparatus comprising:

an optical pickup for reading information recorded on the data recording surface.

FIG. 1

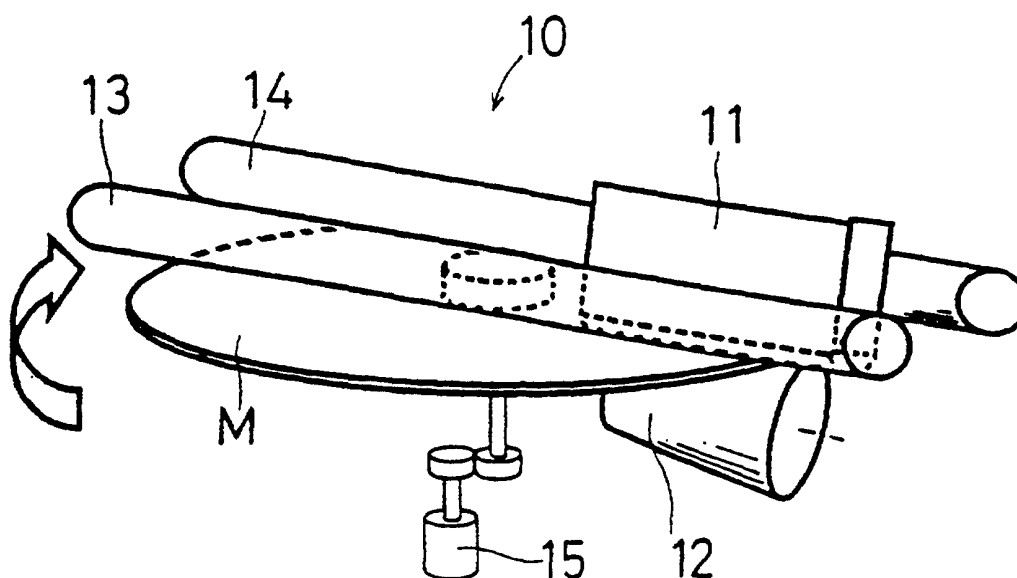


FIG. 2A

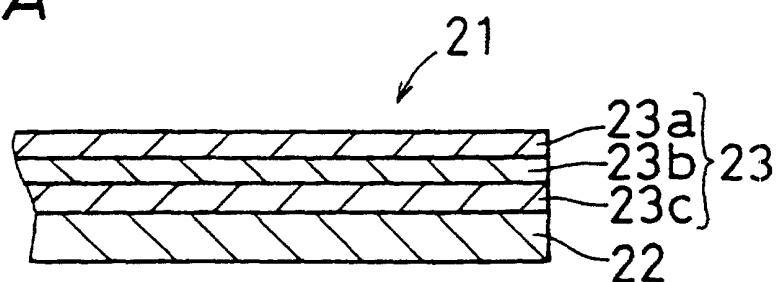


FIG. 2B

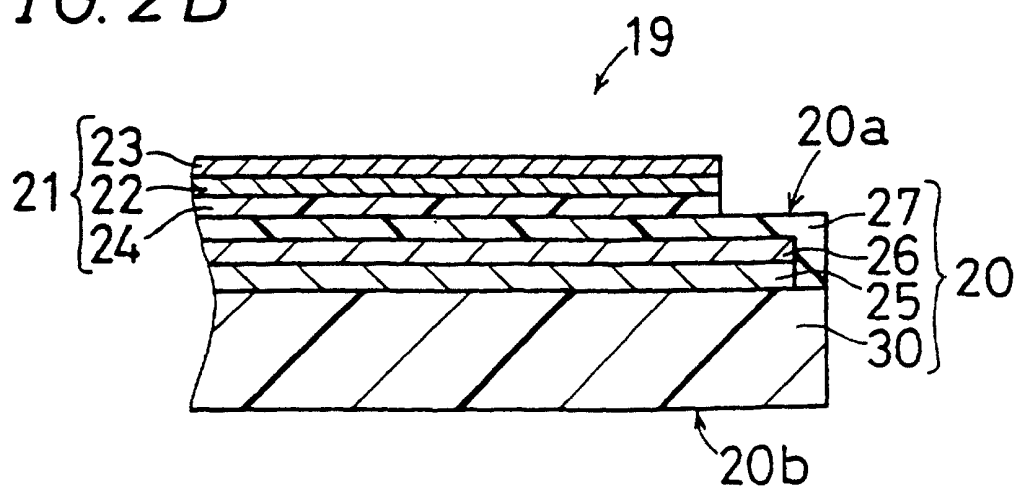


FIG. 3

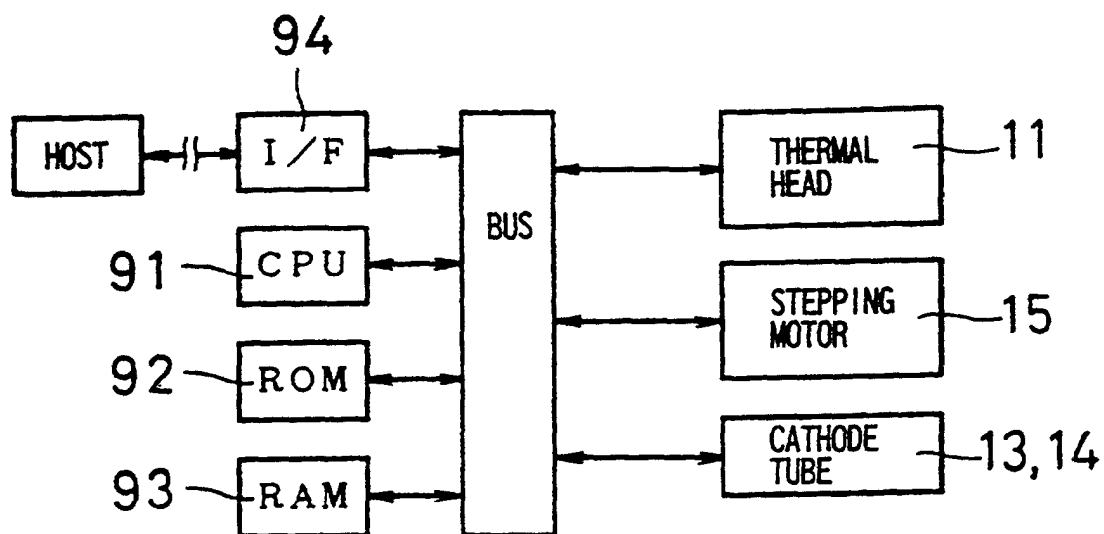


FIG. 4

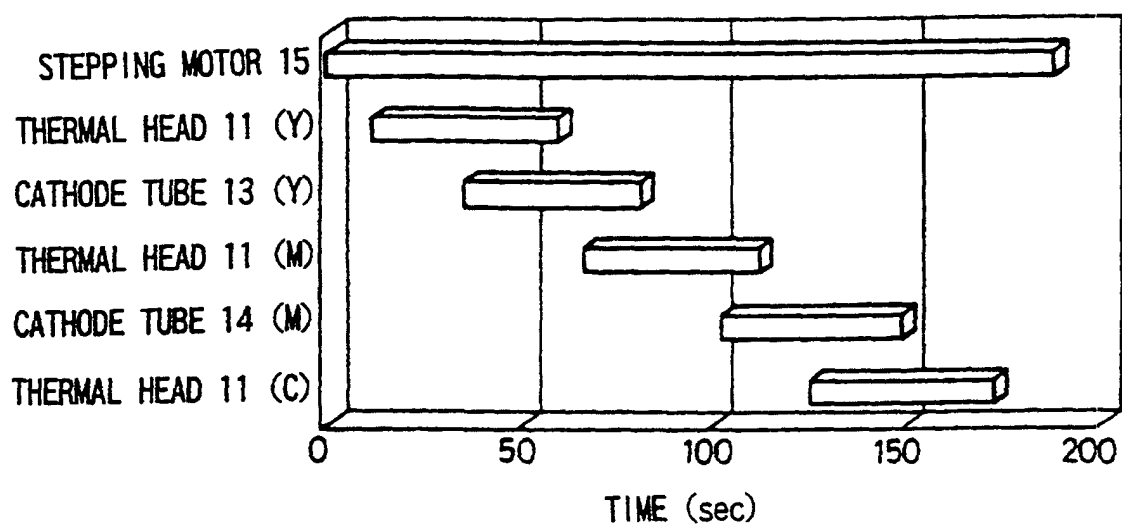


FIG. 5A

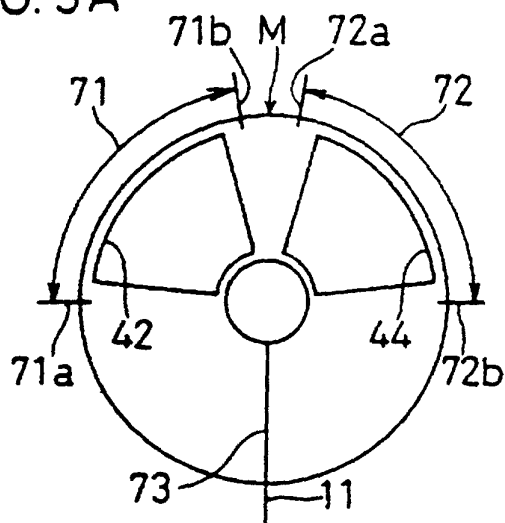


FIG. 5B

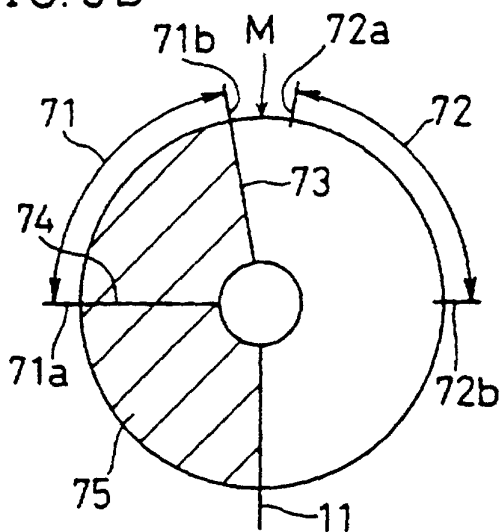


FIG. 5C

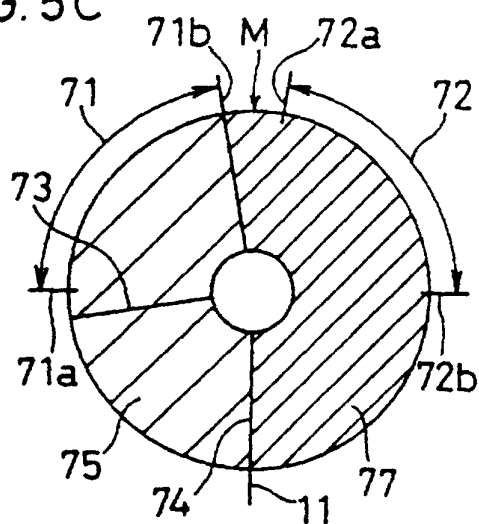


FIG. 5D

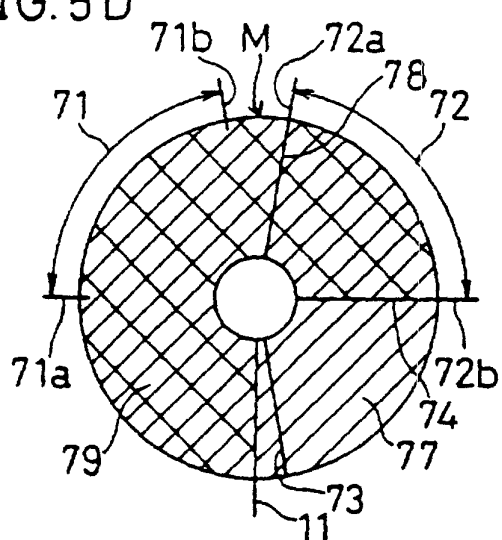


FIG. 5E

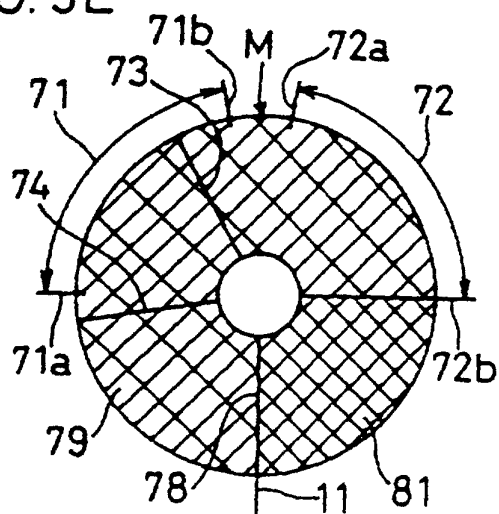


FIG. 5F

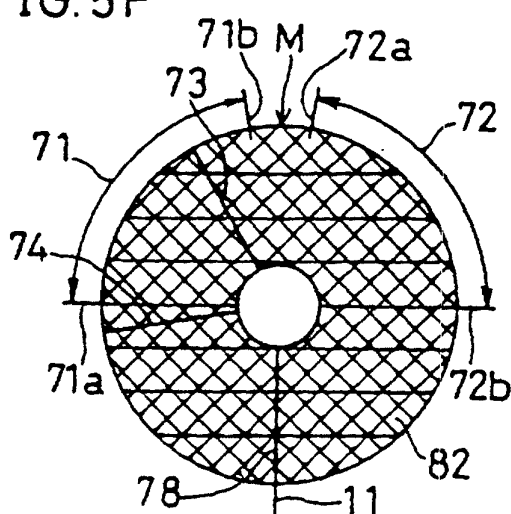


FIG. 6

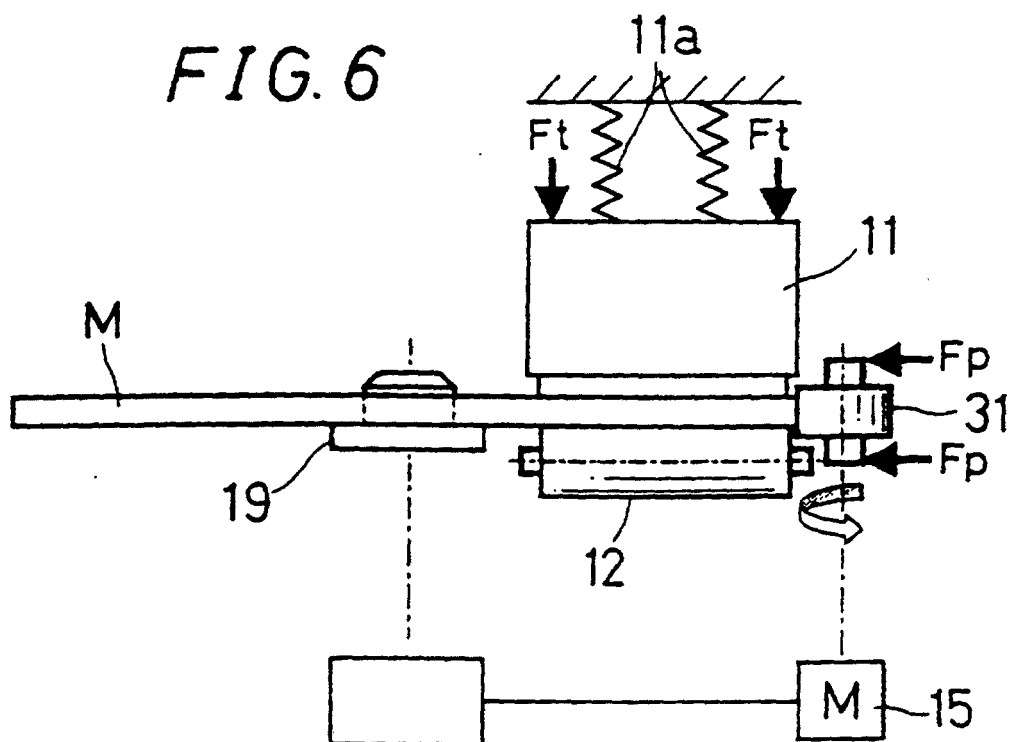


FIG. 7

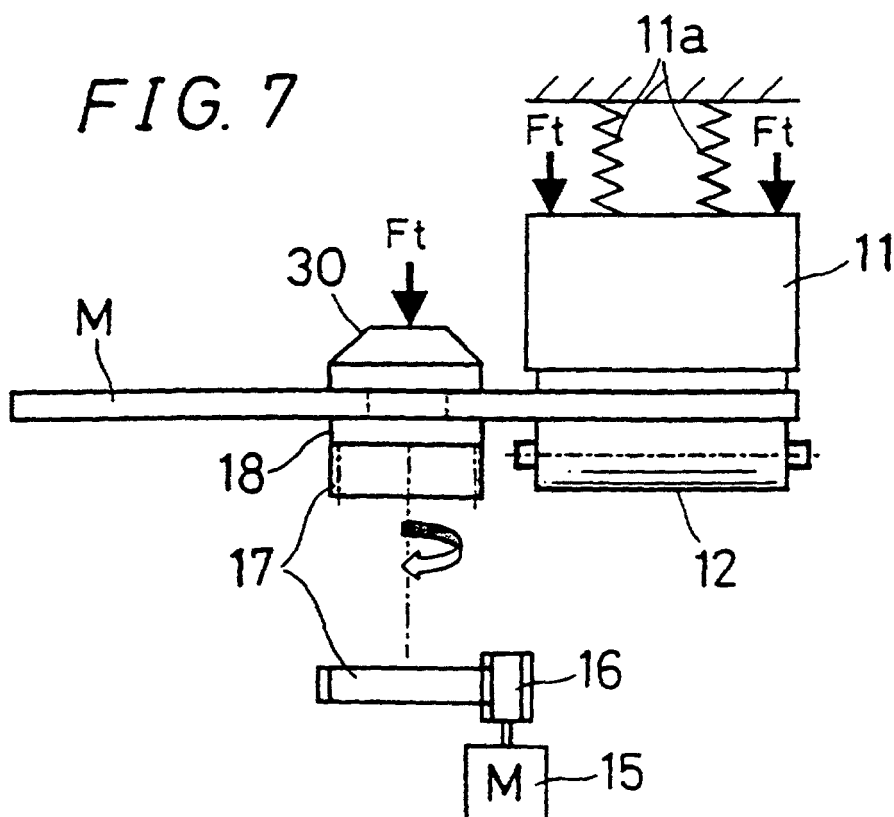


FIG. 8

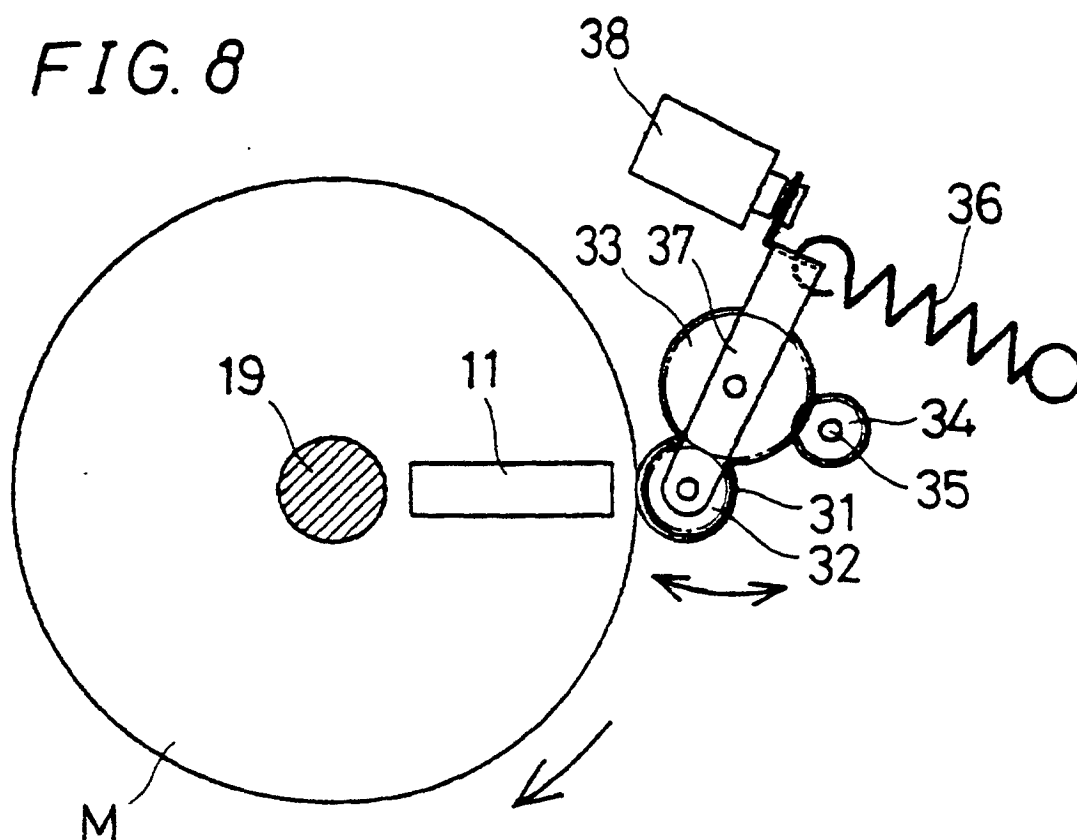


FIG. 9A

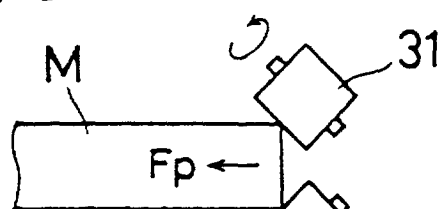


FIG. 9B

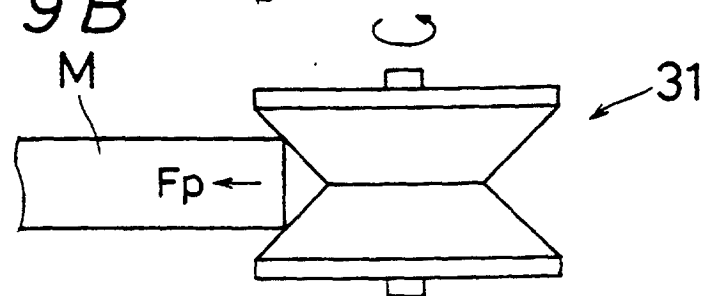


FIG. 10A

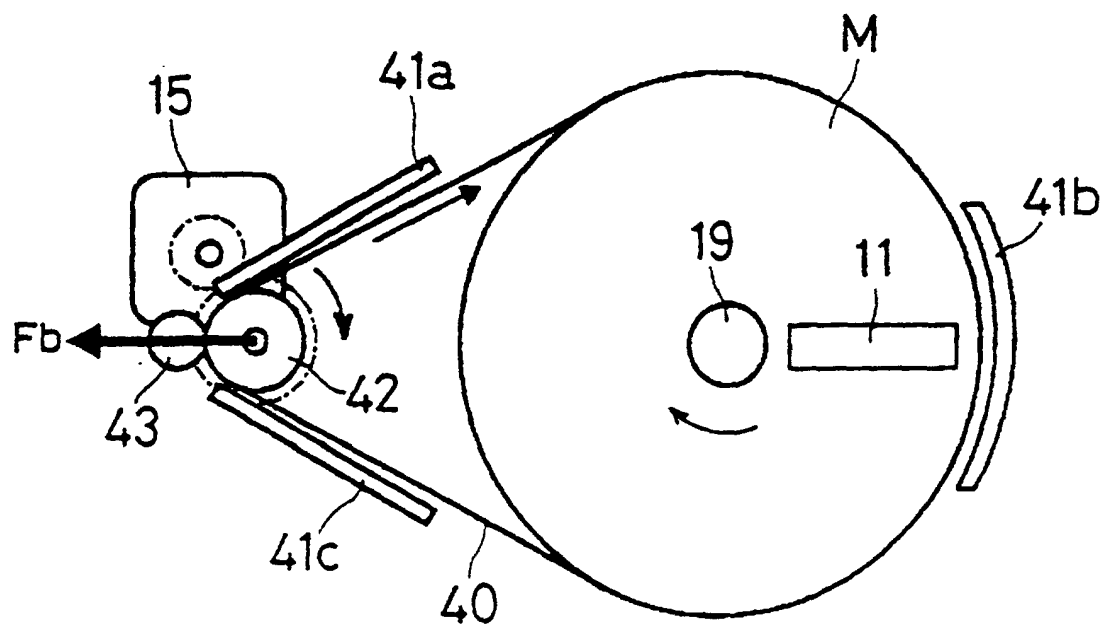


FIG. 10B

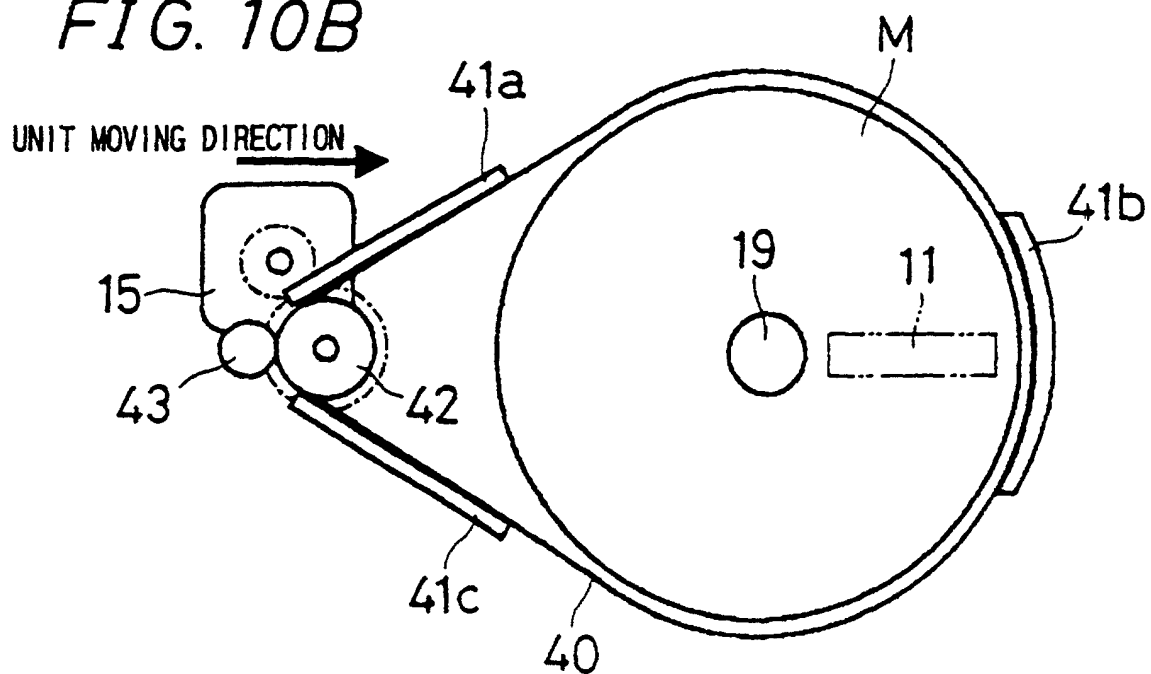


FIG. 11A

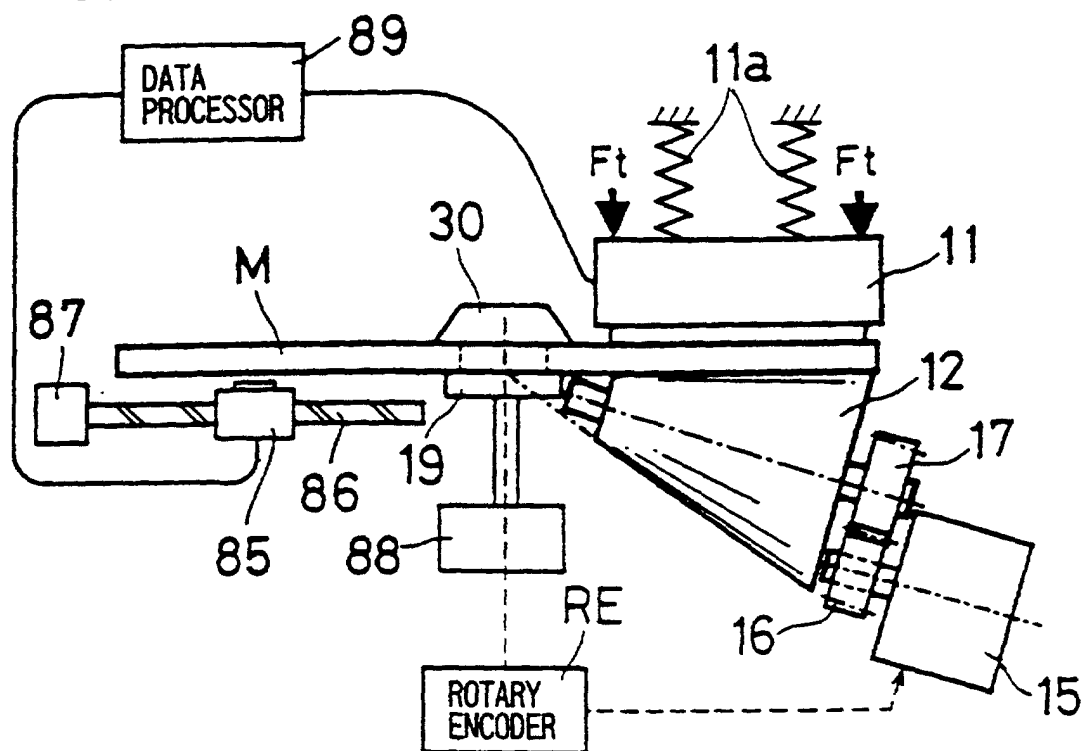


FIG. 11B

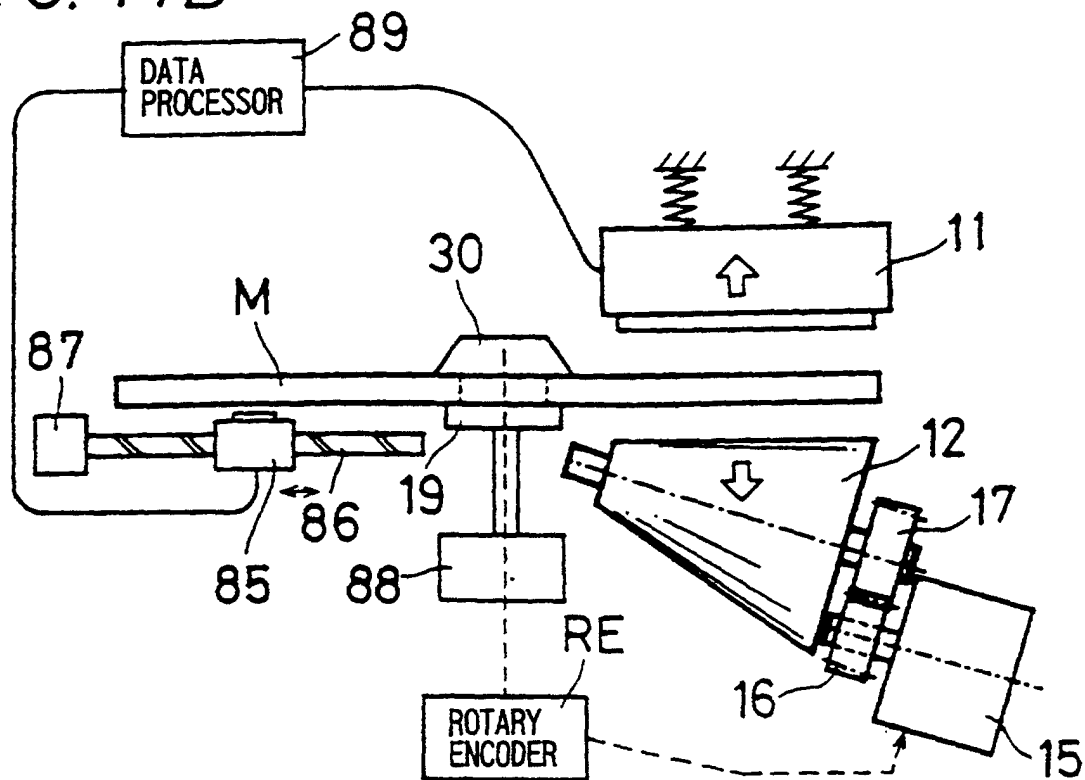


FIG. 12

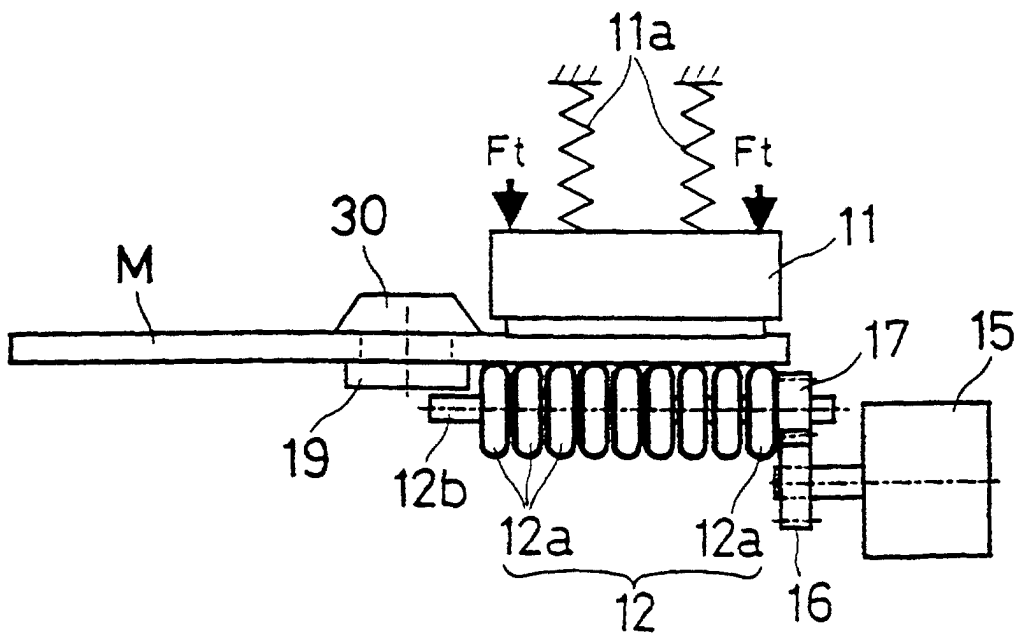


FIG. 13A

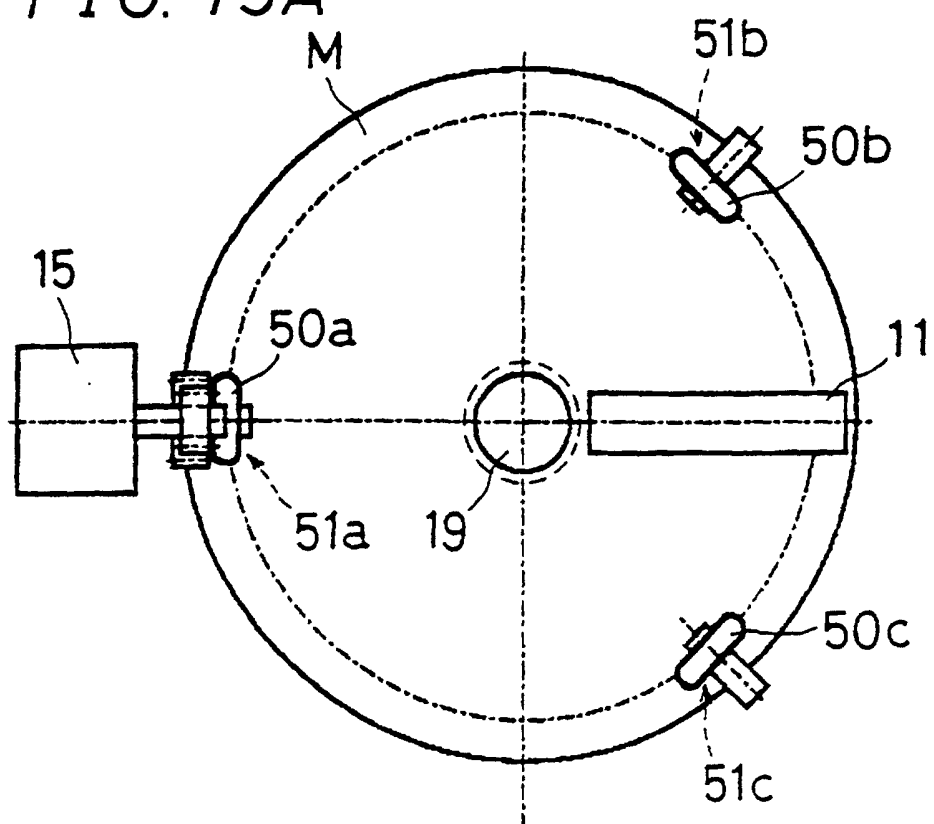


FIG. 13B

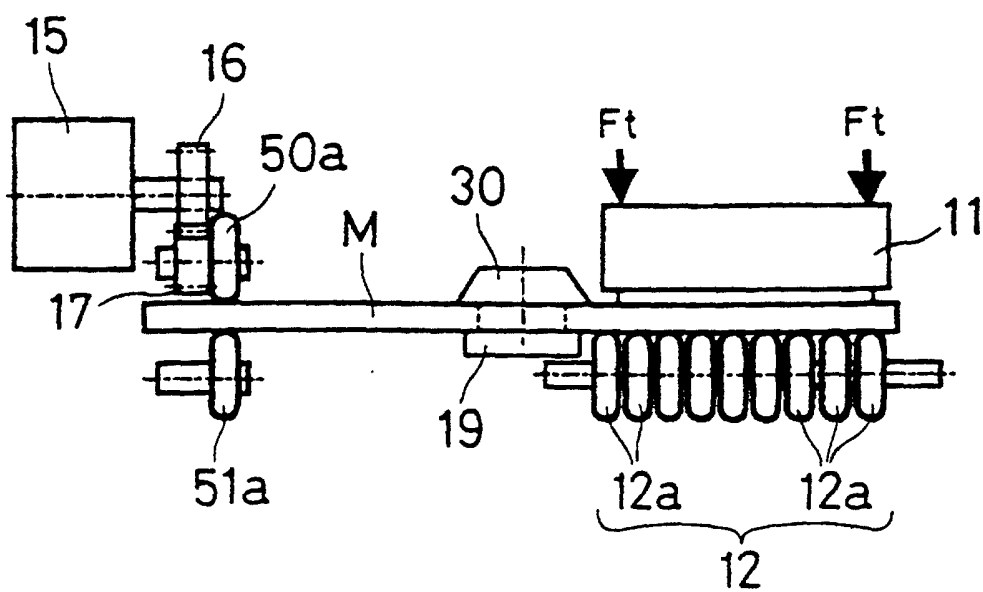


FIG. 14

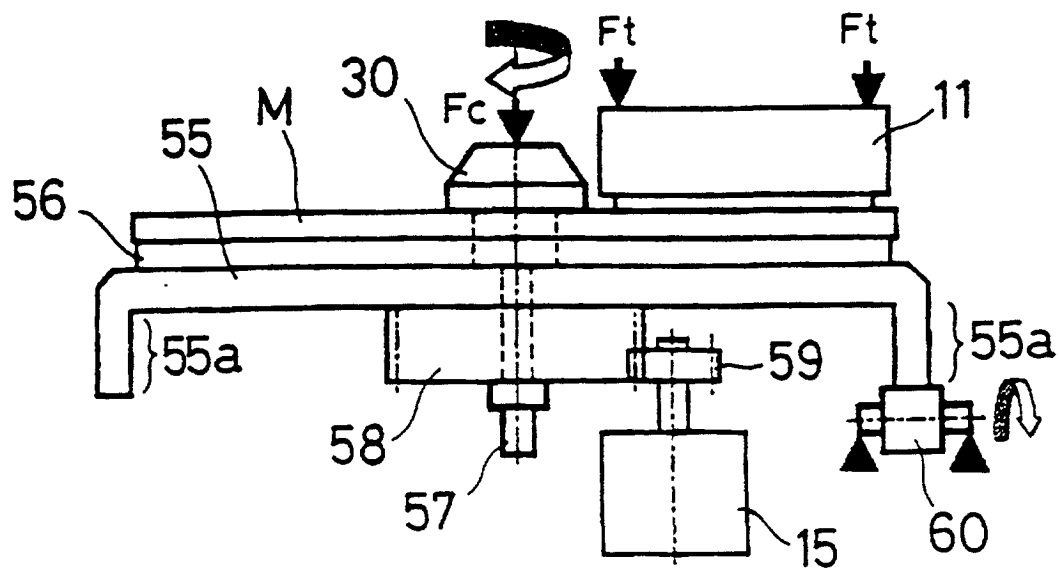
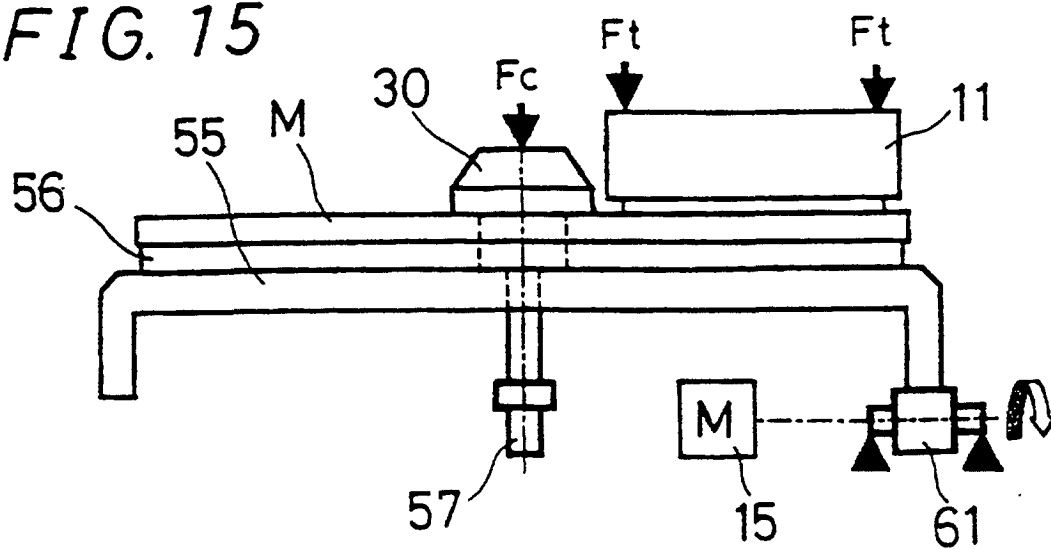


FIG. 15



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP99/04569

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁶ B41J2/32, 3/407		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) Int.Cl. ⁶ B41J2/01, 2/32, 3/407, B41M5/26, 17/14, 17/20, G11B7/24		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-1999 Kokai Jitsuyo Shinan Koho 1971-1999 Jitsuyo Shinan Toroku Koho 1996-1999		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 6-338079, A (ALPS ELECTRIC CO., LTD.), 06 December, 1994 (06.12.94), Full text; Figs. 1 to 7 (Family: none)	1-11
A	JP, 7-220281, A (Hitachi, Ltd.), 18 August, 1995 (18.08.95), Full text; Figs. 1 to 5 (Family: none)	1-11
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No.118671/1988 (Laid-open No.42221/1990) (Ricoh Company, Ltd.), 23 March, 1990 (23.03.90), Full text; Figs. 1 to 5	1-11
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 05 November, 1999 (05.11.99)		Date of mailing of the international search report 24 November, 1999 (24.11.99)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

Form PCT/ISA/210 (second sheet) (July 1992)