

"THERMAL TRANSFER PRINTER"

This invention concerns a thermal transfer printer.

A thermal transfer printer is known from Japanese Patent Publication No. 21471/82 which utilizes a drive means for effecting travel of a carriage which carries a thermal head in order to wind a ribbon, while another thermal printer utilizes a motor exclusively for moving an ink ribbon. Moreover, a solenoid plunger is generally utilized for biasing/releasing the thermal head.

However, in the construction of Japanese Patent Publication No. 21471/82, the carriage must be moved when it is desired to change the colour of the ink ribbon, resulting in low-speed printing and high costs.

Further, the solenoid plunger which has been used for head biasing/releasing is noisy so that quiet printing, which is one of the major benefits of thermal printers, is not achieved.

Furthermore, when a ribbon take-up mechanism is actuated by its own specific driving source, a thermal head biasing/releasing driving system has to be controlled separately, so that the construction of a driving control system becomes complicated and expensive.

According, therefore to the present invention, there is provided, a thermal transfer printer comprising a platen; a thermal head; a motor; head moving means, at least a rotatable cam member of which receives drive from the motor, for moving the thermal head into and out of a printing position in which it is adapted to press an ink ribbon and a record medium against the platen; ribbon travel means for effecting travel of the ink ribbon past the thermal head; and drive transmission means for transmitting drive from the motor to the ribbon travel means.

Thus, in the thermal transfer printer of the present invention, the ribbon travel means, such as a ribbon take-up mechanism, and the head moving means may be operated by the same motor as a single driving source. In the preferred form of the printer, moreover, the printer comprises a substantially noiseless head moving means, while the ribbon travel means may be operated without having to move a carriage on which it is mounted. Furthermore, in the preferred form of the invention, an optimum biasing force can be selected for biasing the thermal head towards the platen, its force being based upon the particular printing conditions, such as the print mode and the nature of the record medium.

Preferably a part of the head moving means resiliently urges the thermal head, at least when the latter is in the printing position, towards the platen.

5 The head moving means preferably comprises a reciprocable member which is arranged to be reciprocated by the rotatable cam member, the said part comprising resilient means which engage the reciprocable member.

There are preferably means for varying the degree of force with which the said part urges the thermal head
10 towards the platen. Thus the rotatable cam member may have a plurality of cam surfaces of different radii of curvature.

Preferably, when the motor is driven in one direction of rotation, it transmits drive to the portion of the head moving means, and when the motor is driven in the
15 opposite direction of rotation, it transmits drive to the drive transmission means. Thus the head moving means may comprise a planet gear which meshes with a sun gear driven by the motor, rotation of the motor in the said one direction moving the planet gear into mesh with a drive
20 gear for rotating the rotatable cam member, and rotation of the motor in the said opposite direction moving the planet gear out of mesh with the said drive gear. Moreover, the

arrangement may be such that when the motor is rotated in the said opposite direction, it moves the planet gear into mesh with a further drive gear which is arranged to transmit drive to the ribbon travel means, rotation of the motor in the said one direction moving the planet gear out of mesh with the further drive gear.

In one form of the invention, the reciprocable member comprises a spring support member which engages the rotatable cam member, the said part comprising a spring which is mounted on the spring support member.

Alternatively, the reciprocable member may comprise a lever having an engagement part which engages the cam, one arm of the lever being engaged by a spring.

In one embodiment of the invention, the rotatable member is drivingly connected to the reciprocable member by a pin and slot connection.

The thermal head is preferably carried by a carriage on which the head moving means and the ribbon travel means are mounted.

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

Figures 1(a) and 1(b) are plan views of a portion of a first embodiment of a thermal transfer printer in accordance with the present invention, Figures 1(a) and 1(b) showing parts of the said printer in different relative positions;

Figure 2 is a perspective view of part of the structure shown in Figures 1(a) and 1(b);

Figure 3 is a broken away section on a larger scale of part of the structure shown in Figures 1(a) and 1(b);

5 Figure 4 is a schematic diagram illustrating an electrical control circuit which controls the operation of the said first embodiment;

Figure 5 is a schematic view showing a second embodiment of a thermal transfer printer constructed in accordance with
10 the present invention; and

Figure 6 is a schematic view of an embodiment of a movement direction changing mechanism which may be employed in a thermal transfer printer in accordance with the present invention.

15 Referring to a first embodiment of the present invention shown in Figures 1(a) and 1(b), a radiating plate 19 supports a thermal head 1 rotatably around a shaft 21, the shaft 21 being fixed to a carriage frame 20. The carriage frame 20 is supported by guide shafts 16 which are capable
20 of reciprocating movements in the directions of arrows E1 and E2. A step motor is mounted in the lower portion of the carriage frame 20, and a motor gear 8 is secured to a motor shaft 4a which passes through the carriage frame 20. A sun gear 9 engages with the motor gear 8. The sun gear 9 is
25 provided with a planet gear 11, and an enlarged cross

sectional view of this portion of the printer is depicted in Figure 3. A support arm 10, which supports the planet gear 11, and the sun gear 9 are rotatably mounted on a pin or shaft 31 which is secured to the carriage frame 20. The planet gear 11 is rotatably mounted on a shaft 32 which is itself mounted in and extends through the support arm 10, A belleville spring 33 transmits rotations of the sun gear 9 to the support arm 10 and urges the planet gear 11 against the support arm 10.

A drive gear 12 and a gear 13 transmit rotations of the planet gear 11 to a gear 14 which is fixed to a toothed take-up member 24 (Figure 2) for taking-up an ink ribbon 25.

Figure 1(a) illustrates an operative condition of a mechanism for moving an ink ribbon which is constituted by an ink ribbon take-up mechanism.

When the motor 4 rotates in the direction of an arrow A1, the sun gear 9 rotates in the direction of an arrow B1 to cause corresponding movement of the support arm 10 so as to bring the planet gear 11 into mesh with the drive gear 12. Due to the consequential rotation of the gear 13 in the direction of an arrow C1, the gear 14, and consequently the take-up member 24, rotates in the direction of an arrow D1. As a result, the ribbon 25 is taken-up by a spool (not shown) in an ink ribbon.

cassette (not shown), and the ink ribbon 25 is caused to travel past the thermal head 1. The gears 12, 13 and 14 and the take-up member 24 thus constitute a ribbon take-up mechanism.

5 A rotatable member 3, which is constituted by a cam, is rotatable through an angle of 360° and greater around a shaft 3d which is mounted in the carriage frame 20. The cam 3 includes three portions having different radii of curvature, such as a cam portion 3a having a minimum radius
10 r₁, a cam portion 3c having a maximum radius r₃, and a cam portion 3b having an intermediate radius r₂. A reflective portion 6 is provided on the upper surface of the cam 3 so as to provide a reference position which can be detected by a reflective type photosensor 5. The reflective portion 6
15 and the photosensor 5 thus constitute a cam position detector means. In the present embodiment, the arrangement is such that the cam portion 3a having the radius r₁ is selected when the photosensor 5 detects the reflective portion 6.

20 A cam engagement member, constituted by a spring support member 18, is adapted to contact the peripheral surface of the cam 3. The spring support member 18 is unitarily formed with a support portion 18a (Figure 2) and is rotatably mounted on a guide shaft 16. A resilient member, constituted by a compression spring 2 is provided to
25 transmit force from the spring support member 18 to the

radiating plate 19 so that the thermal head 1 can be urged from the back towards a platen 17 in the direction of an arrow F1 by selecting an appropriate portion of the cam 3 for engagement with the spring support member 18. When
5 the cam 3 is in contact with the spring support member 18 at the cam portion 3a, the thermal head 1 moves in the direction of an arrow F2 so as to be separated from the platen 17, such movement being effected by a head release means constituted by a tension spring 15. Thus, the ink
10 ribbon 25 and record paper or other record medium (not shown) can be inserted between the thermal head 1 and the platen 17. If the cam portion 3c is selected to be in engagement with the spring support member 18 during printing, the force with which the thermal head 1 is urged towards the platen 17
15 is at a maximum, and if the cam portion 3b is selected, the said force becomes small.

Figure 1(b) illustrates the manner in which a head biasing/releasing mechanism is driven by the step motor 4.

When the step motor 4 rotates in the direction of
20 an arrow A2, the sun gear 9 rotates in the direction of an arrow B2. The planet gear 11 thus moves into engagement with a drive gear 7 which is unitarily formed with the cam 3. As a result, the cam 3 rotates in the direction of an arrow G. The outer circumference of the cam 3 has at least two radii
25 (e.g. the three radii described above) in order to reciprocate

the spring support member 18 which contacts the said outer circumference. The cam 3 and the spring support member 18 thus constitute or form part of a movement direction changing mechanism for changing the direction of movement of the spring support member 18. The spring support member 18 is arranged to support the coil spring 2 and it is preferably arranged that the coil spring 2 directly contacts the spring support member 18. The coil spring 2 is thus associated with the said changing mechanism so as to provide the biasing force by means of which the thermal head 1 is pressed against the platen 17. However, as explained above, at least two levels of biasing force can be obtained by selection of the cam position.

It is known that the biasing force with which a thermal head is pressed against a record paper in a thermal transfer printer makes a difference to the print density and the print quality. When rough bond paper or normal paper are used, a large biasing force is required for high print quality. On the other hand, when smooth thermal transfer paper is used, a small biasing force is required. Further, when the biasing force is large, the energy to move the carriage which carries the thermal head increases. Therefore, it is useful to change the biasing force in accordance with the print mode, and the head biasing/releasing mechanism, i.e. the movement changing

mechanism 3, 18, of the present embodiment also functions as a biasing force changing mechanism.

When the photosensor 5 detects the reflective portion 6, the number of steps of the step motor 4 is controlled based on the fact that the reflective portion 6 acts as a reference position, whereby the angular position of the cam 3 is fixed so as to select a predetermined cam portion. The cam 3 as a rotating member is capable of rotation through an angle of 360° or greater in the direction of an arrow G, so that all of the cam portions 3a, 3b, 3c can be selected for engagement with the spring support member 18 by one-way rotation of the motor 4. Therefore, the motor 4 constitutes a driving source of the head biasing/releasing mechanism 3,18 and also acts as a driving source for the other mechanisms of the present embodiment. Further, the head biasing/releasing can be achieved without using a noise generating member, such as a plunger or the like.

Figure 4 is a schematic view showing a construction of a thermal transfer printer of the present invention, parts corresponding to those shown in Figures 1 and 2 being given the same reference numerals.

As shown in Figure 4, a heat resistance element 1a, which constitutes a heater element, is disposed on the surface of the thermal head 1. A flexible cable

or strip 1b acts as an electrode of the thermal head
 1. 31 is a head driving circuit; 32 is an emission-reception
 circuit which drives the reflective type photosensor
 5; 33 is a first motor driving circuit for driving the
 5 step motor 4; 37 is a carriage motor for moving the
 carriage frame 20 in the direction of a column of print;
 38 is a second motor driving circuit which is a driving
 circuit of the carriage motor 37; 30 is a CPU which
 controls the thermal transfer printer as a whole; 34 is
 10 a ROM which stores the numbers of rotating steps from the
 reference position of the cam 3 to respective cam
 positions in addition to the control program of the
 CPU 30; 35 is a RAM having a counter 36 which counts the
 number of steps of the step motor 4; and 39 is an interface
 15 which inputs print data.

When print data is inputted to the CPU 30 from the
 interface 39, the print mode is judged, and the first
 motor driving circuit 33 is at first actuated to rotate
 the step motor 4 in the direction of an arrow A2. As
 20 a result, the head biasing/releasing mechanism 3, 18
 causes the thermal head 1 to be urged towards the platen
 17 with a predetermined force. At this moment, the cam 3
 is rotated through a predetermined angle by the CPU 30
via the first motor driving circuit 33. The arrangement
 25 is such that the number of steps of the step motor 4 stored

in the ROM 34 is made to be the same as that indicated by the counter 36 which counts the number of driving steps from the reference position obtained by emission-reception circuit 32. Then the step motor 4 rotates in the reverse direction indicated by an arrow A1, so that the cam 3 maintains the selected position. Next, the step motor 4 once again rotates in the reverse direction, so that drive is imparted to the ribbon take-up mechanism and the ribbon take-up operation is started. At this same moment, the motor 37 is driven by second motor driving circuit 38, and a printing operation is carried out by moving the carriage frame 20 in the direction of a column of print. When the print operation is completed, the step motor 4 is rotated in the direction of the arrow A2, and the cam portion 3a having the minimum radius is selected so as to move the thermal head 1 away from the platen 17. Then, the carriage frame 20 is returned to the print-starting position by the driving carriage motor 37.

In the take-up member 24, a slipping mechanism is provided to wind the ink ribbon 25 without slack. The step motor 4 rotates at a high speed so that the ink ribbon 25 is wound at a speed faster than that at which the ink ribbon 25 is fed from the thermal head 1 in the direction of an arrow H.

In this embodiment, step motors are utilized as driving sources of the head biasing/releasing mechanism 3, 18 and of the ink ribbon take-up mechanism 12, 13, 14, 24. However, a DC motor can be utilized if it is provided with a rotation detector for detecting the angular portion of the cam 3 or of the reflective portion 6 corresponding to each cam portion of the cam 3. Moreover, in addition to the photosensor 5 shown in the said first embodiment, a mechanical switch can be utilized as a detector.

Furthermore, instead of the cam 3 utilized in the said first embodiment, a link mechanism may be used as a movement direction changing mechanism which changes rotational motion into reciprocating motion.

Further, although in the said first embodiment the power transmission which is effected in dependence upon the direction of rotation of the step motor 4, is achieved by means of a sun gear 9 having a planet gear 11, one of the directions of rotation of the step motor 4 which is used as a driving source can be picked up by a one-way spring clutch (not shown) provided both in the ribbon take-up mechanism and in a rotating member or the like.

In Figure 5 there is shown a cross sectional view of a portion of a second embodiment of a thermal transfer printer constructed in accordance with the present invention. Reference numerals used in Figure 5 which

are the same as those used in relation to the first embodiment indicate similar parts.

Transmission gears 43 and 45 engage with a motor gear 44 mounted on the drive shaft of the motor 4. A transmission gear 41, which is engaged with the gear 42, is adapted to effect a drive to a worm gear 40 through a spring clutch 42 to transmit one-way rotational drive to the cam 3 so that the latter is rotatable only in the direction of an arrow I. The cam 3 is engaged by an engagement portion 19a of the radiating plate 19 so that rotation of the cam 3 is changed into reciprocating movement of the engagement portion 19a in the direction of an arrow J. The radiating plate 19 is constituted by a lever mounted on a pivot 19b, so that the reciprocating movement of the engagement portion 19a causes reciprocating movement of the thermal head 1 in the direction of an arrow K. A resilient member constituted by a compression coil spring 2 urges the thermal head 1 towards a platen 50. In contrast to the embodiment shown in Figure 1, the thermal head 1 is urged towards the platen 50 when a small radius portion r of the cam 3 contacts the engagement portion 19a, and the head 1 is moved away from the platen 50 when a large radius portion R of the cam 3 contacts the engagement portion 19a. A mechanical switch 49, which detects the position of the cam 3, is turned to the ON

position when it is engaged by the large radius portion R of the cam 3. One end of the compression coil spring 2 engages a support member 48 which is secured to the carriage frame 20.

5 A transmission gear 46 which is engaged with the gear 45, transmits one-way rotation thereof to an ink ribbon take-up member 24 through a spring clutch 47. In this manner, a ribbon take-up mechanism comprising the ribbon take-up member 24, and a heat biasing releasing mechanism
10 which includes the radiating plate 19 are selectively driven in dependence upon the direction of rotation of the motor 4.

 Reference is next made to Figure 6 wherein an embodiment of a movement direction changing mechanism, constituted by a link mechanism, is illustrated. A rotating member 51
15 rotates in the direction of an arrow L, and a pin 53 which is fixed to the rotating member 51 engages with a cut-out or slot 52b in a lever 52, pivoted at 52a, so that the lever 52 performs a reciprocating movement in the direction of an arrow M about the pivot 52a. This reciprocating movement
20 can be utilized to effect a biasing/releasing movement of the thermal head.

 The present invention is applicable not only to a thermal printer using heating elements as shown in the embodiments but also to an electrothermal transfer printer
25 wherein electrodes are utilized as heating elements which apply

an electric current to a resistive layer arranged on the back surface of a thermal transfer ribbon, as a result of which ink is transferred to a record paper by heating the said layer.

5 The embodiments of the invention described above employ an ink ribbon take-up mechanism for use with a disposable ink ribbon. However, the ink ribbon take-up mechanism can be modified for use with a recycled, i.e. reusable ribbon as a ribbon travelling mechanism.

10 As described heretofore, the biasing/releasing of the head 1 can be carried out by forward rotations of the motor 4, and the ink ribbon 25 can be taken-up by reverse rotations of the motor 4. Thus the printer can be of simpler construction and lower cost than in the prior art wherein separate motors are provided for these
15 respective operations.

 Further, the ink ribbon 25 can be taken-up without movement of the carriage frame 20 so that a respective head for the particular colour of the ink ribbon employed can be properly positioned in a stand-by condition before printing.
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 Furthermore, the ink ribbon 25 can be taken-up at any desired position in the movement of the carriage in the direction of a column of print. Thus the present invention may be used for high-speed printing of a colour
25 thermal transfer printer.



C L A I M S

1. A thermal transfer printer comprising a platen; a thermal head; a motor; head moving means, at least a rotatable cam member of which receives drive from the motor, for moving the thermal head into and out of a printing position in which it is adapted to press an ink ribbon and a record medium against the platen;
5 ribbon travel means for effecting travel of the ink ribbon past the thermal head; and drive transmission means for transmitting drive from the motor to the ribbon travel means.
2. A thermal transfer printer as claimed in claim 1 in which
10 a part of the head moving means resiliently urges the thermal head, at least when the latter is in the printing position, towards the platen.
3. A thermal transfer printer as claimed in claim 2 in which the head moving means comprises a reciprocable member
15 which is arranged to be reciprocated by the rotatable cam member, the said part comprising resilient means which engage the reciprocable member.
4. A thermal transfer printer as claimed in claim 2 or 3 in which there are means for varying the degree of force
20 with which the said part urges the thermal head towards the platen.
5. A thermal transfer printer as claimed in any preceding claim in which the rotatable cam member has a plurality of cam surfaces of different radii of curvature.



6. A thermal transfer printer as claimed in any preceding claim in which, when the motor is driven in one direction of rotation, it transmits drive to the said portion of the head moving means, and when the motor is driven in the opposite direction of rotation, it transmits drive to the drive transmission means.

7. A thermal transfer printer as claimed in claim 6 when dependent upon claim 3 in which the head moving means comprises a planet gear which meshes with a sun gear driven by the motor, rotation of the motor in the said one direction moving the planet gear into mesh with a drive gear for rotating the rotatable cam member and rotation of the motor in the said opposite direction moving the planet gear out of mesh with the said drive gear.

8. A thermal transfer printer as claimed in claim 7 in which when the motor is rotated in the said opposite direction, it moves the planet gear into mesh with a further drive gear which is arranged to transmit drive to the ribbon travel means, rotation of the motor in the said one direction moving the planet gear out of mesh with the further drive gear.

9. A thermal transfer printer, as claimed in claim 3 or in any claim dependent thereon in which the reciprocable member comprises a spring support member which engages the rotatable cam member, the said part comprising a spring which is mounted on the spring support member.



10. A thermal transfer printer as claimed in any of claims 4-8 when dependent upon claim 3 in which the reciprocable member comprises a lever having an engagement part which engages the cam, one arm of the lever being engaged by a spring.
11. A thermal transfer printer as claimed in claim 3 in which the rotatable member is drivingly connected to the reciprocable member by a pin and slot connection.
12. A thermal transfer printer as claimed in any preceding claim in which the thermal head is carried by a carriage on which the head moving means and the ribbon travel means are mounted.
13. A thermal transfer printer substantially as hereinbefore described with reference to and as shown in the accompanying drawings.
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