

"POWER TRANSMISSION APPARATUS"

The present invention relates to a power transmission apparatus, e.g. for use in a printer.

According to the present invention, there is provided a power transmission apparatus comprising a rotatable clutch member having differently shaped first and second abutment means which are respectively engageable by a clutch control member to prevent rotation of the rotatable clutch member; an electromagnetic member for controlling the position of the clutch control member so as to permit or prevent movement of the rotatable clutch member, the clutch control member being respectively movable into and out of engagement with the first and second abutment means of the rotatable clutch member so as to permit the latter to be moved either through a relatively small angle  $\theta_1$  or a relatively large angle  $\theta_2$ , where  $\theta_1 + \theta_2 = 360/n$ ,  $n$  being a positive integer; and means for selectively setting the electromagnetic member in one of its two states either for a period shorter than that required for the rotatable clutch member to move through the angle  $\theta_1$  or for a period longer than that required for the rotatable clutch member to move through the angle  $\theta_1$  but shorter than that required for it to move through the angle  $\theta_2$ .

Preferably, the said one state of the electromagnetic member is energisation thereof.

In this connection it should be pointed out that in a power transmission apparatus using a rotatable clutch member which was rotatable through less than one rotation, it has been heretofore usual for the manufacturer to check the position at which the clutch member stopped. This required use of a detector which was not very reliable, was expensive, and increased the over-all size of the apparatus.

In the case of the feature described above, however, the clutch can be always stopped at a given standby position by appropriately selecting the said angles and by varying the energization time of the electromagnetic member. This enables the manufacturer to dispense with a detector and enables the manufacturer to stop the clutch member in one of two alternative positions.

Although many apparatus have been devised to transmit or interrupt motive power using a clutch, in most apparatus using a plurality of clutches the latter are usually controlled by respective electro-magnetic members such as electromagnets. Each such electromagnetic member has a large number of parts, is expensive and occupies considerable space, and since the number of such electromagnets corresponds to that of the clutches, the apparatus tends to be expensive and large. This is, however, particularly unsatisfactory when such an apparatus is applied to, for example, an inexpensive printer.

It is an object of the present invention in its preferred form to provide an inexpensive power transmission apparatus in

which two clutches are controlled in accordance with the rotational direction of a motor, thus making it possible to use a single electromagnetic member, whereby to reduce both cost and weight.

5            Preferably, therefore, the apparatus comprises a motor arranged to rotate both in a first angular sense and in an opposite angular sense; first and second clutches which are drivingly connected to the motor, the said rotatable clutch member forming part of the said second clutch, the said clutch control member  
10           being movable between a first position in which it engages both the first and second clutches to prevent drive transmission therethrough and a second position in which it is spaced from both the first and second clutches so as to permit drive transmission therethrough, the said electromagnetic member being arranged to move the clutch  
15           control member between said positions; a locking member movable between a first position, in which it locks the first clutch to prevent drive transmission therethrough but not the second clutch, and a second position in which it locks the second clutch to prevent drive transmission therethrough but not the first clutch;  
20           and a position control member connected to said motor for controlling the position of the locking member, the arrangement being such that when the motor rotates in the said first angular sense, the position control member causes the first clutch to be locked by the locking member to prevent drive transmission therethrough,  
25           and when the motor is rotated in the opposite angular sense, the position control member causes the second clutch to be locked by the locking member to prevent drive transmission therethrough.

The clutch control member is preferably a trigger lever having arms which are respectively engageable with parts of the first

and second clutches.

5       The electromagnetic member may have an armature which engages a said arm of the trigger lever, energisation of the electromagnetic member moving the trigger lever from one of its positions to the other.

      The position control member may have a cam which engages a part of the locking member.

10       Preferably, the trigger lever and the position control member are mounted on the same shaft, the position control member being a gear fixed to said shaft and driven by the motor.

      The locking member is preferably a locking lever having arms which are respectively engageable with parts of the first and second clutches.

15       The said shaft may be a carriage shifting shaft which is rotatably mounted in fixed structure and which is arranged to shift a carriage linearly, the said carriage being carried by and movable with respect to the fixed structure.

20       There may be an axially movable member which is connected to said carriage and which is splined on said carriage shifting shaft so as to be axially movable thereon but non-rotatable with respect thereto, the axially movable member having an external helical groove, there being a row of equally spaced apart fixed shifting pins which are fixed  
25       to the fixed structure, are arranged axially of the carriage shifting shaft and are engageable with the said helical groove that rotation of the carriage shifting shaft in a first

angular sense causes the carriage to move in a given axial direction and rotation of the carriage shifting shaft in the opposite angular sense causes the carriage to move in the opposite axial direction.

5        There may be a substantially axially movable shifting pin which is engageable with the said helical groove, and means for urging said substantially axially movable shifting pin in a given axial direction.

10        The arrangement is preferably such that, when the carriage shifting shaft is rotated in a first angular sense and the said helical groove is engaged with the fixed shifting pins, the axially movable member will first move in the said given axial direction until it reaches a first position in which its helical groove ceases to be in drive engagement with the fixed

15        shifting pins and in which the axially movable shifting pin is forced by the helical groove to its limiting position in the said opposite axial direction, further rotation of the said shaft in the said first angular sense causing the axially movable member to move further in the said given

20        axial direction until the axially movable member reaches a second position in which its helical groove ceases to be in drive engagement with the substantially axially movable shifting pin, whereby the axially movable member will then be in idle rotation; rotation of the said shaft in the angular sense

25        opposite to the first angular sense when the axially movable member is in the said second position first causing the substantially axially movable shifting pin to be moved by the

urging means to its limiting position in the said given axial direction, the axially movable member then being caused to travel in the axial direction opposite to the said given axial direction so that the said helical groove is successively in drive engagement with the substantially axially movable shifting pin and the fixed shifting pins.

In prior apparatus in which shifting pins have been used, the carriage has tended to become locked at each end of its traverse so that considerable force may be required to unlock it.

The substantially axially movable shifting pin may be carried by a shifting lever which is acted on by a spring to urge the substantially axially movable shifting pin in the said given axial direction.

The substantially axially movable shifting pin may be always substantially aligned with the fixed shifting pins.

Preferably, when the substantially axially movable shifting pin is in its limiting position in the said given axial direction, it is spaced from the nearest fixed shifting pin by a distance equal to a multiple of the pitch of the fixed shifting pins.

The apparatus may form part of a thermal printer, the linearly movable carriage carrying a head mounting member on which is mounted a thermal head, the head

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mounting member being movable between a printing position  
in which in operation the thermal head engages a platen  
with a record sheet and a thermal ribbon interposed  
therebetween and a non-printing position in which the  
5 thermal head is spaced from the platen, means being provided  
for moving the thermal head between the printing and  
non-printing positions.

There may be a ribbon take-up driving member having a  
take-up gear which is engageable with a fixed rack  
10 substantially throughout a linear distance throughout  
which the carriage can be moved, rotation of the take-up  
gear effecting take-up of the thermal ribbon; the  
ribbon take-up driving member being movable by said head  
mounting member so that the take-up gear engages the fixed  
15 rack only when the head mounting member is in its printing  
position.

The head mounting member may be engaged by a push  
member which urges the thermal head towards the printing  
position the head mounting member also being engageable  
20 by a head cam which is rotatable between positions in which  
the push member is respectively permitted to push and  
prevented from pushing the thermal head into the printing

position, the push member engaging a part of the ribbon take-up driving member.

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

5           Figure 1 is a top plan view of a thermal transfer printer,

Figure 2 is an exploded perspective view of a power transmission mechanism section of the printer of Figure 1,

10           Figure 3 is a view showing a gear train of the said power transmission mechanism section in an engaged state,

Figures 4, 5, 6, 10 and 10A illustrate the operation of a clutch forming part of the said power transmission mechanism section,

15           Figures 7 and 8 are sectional views taken along the line E-E in Figure 1, and showing the parts thereof in different relative positions,

Figure 9 is a top plan view of a carriage which forms

part of the printer of Figure 1,

Figures 11(a) and (b) are sectional views of an end face cam of a shifting gear taken along the lines Q-Q and R-R in Figure 4, respectively,

5        Figures 12(a) to 12(e) are views of the area T in Figure 1 as seen from the rear and showing the parts thereof in different relative positions, and

Figure 13 is a sectional view taken along the line V-V of Figure 12(d).

10        Terms such as "left" and "right", as used in the description below are to be understood to refer to directions as seen in the respective drawings.

The present invention will now be described with reference to a preferred embodiment.

15        Figure 1 is a top plan view of a thermal transfer printer, the upper case of the printer being removed. The printer has a case 1 which serves also as a main frame, the case 1 incorporating side frames 2, 3. A thermal head 5 and a ribbon cassette 6 are mounted on a carriage 4 which is movably guided in the axial direction by means of a carriage shifting shaft 7 and a head cam shaft 8 both of which are rotatably mounted in the side frames 2, 3. A power transmission mechanism section 9 is provided for selectively transmitting power from a motor 11 (Figure 3) to the carriage shifting shaft 7, to the head cam shaft

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8 and to a paper feeding shaft 10.

Figure 2 is an exploded perspective view of the power transmission mechanism section 9, Figure 3 is a side view showing a wheel train of the power transmission mechanism section 9 in an engaged state, and

Figures 4, 5 and 6 are views illustrating the operation of a clutch of the power transmission mechanism section 9.

Rotation of the motor 11 (Figure 3) which is fixed to the side frame 3, is transmitted to a shifting gear, or position control member, 15 through a motor gear 12 and reduction gears 13a, 13b, the latter being journalled on a shaft 3a formed integrally with the side frame 3. The shifting gear 15 is fixed to the shifting shaft 7 and has three grooves on the outer periphery thereof, these three grooves including a grooved end face cam 15a provided at an end face of the shifting gear 15. The shifting gear 15 also has a gear 15b engaging with a paper feeding clutch gear 16; a gear 15c engaging with the reduction gear 13b, and a gear 15d engaging with a transmission gear 17, the latter being journalled on a shaft 3b formed integrally with the side frame 3. Sections of the end face cam 15a taken along the lines Q - Q and R - R (Figure 4) are shown in Figures 11(a) and 11(b) respectively.

The paper feeding clutch gear 16 is integrally provided

with a ratchet wheel 16a, the latter being engageable by a paper feeding clutch pawl 19 which is rigidly secured to a shaft 21a of a paper feeding driving plate 21.

5 A paper feeding clutch plate 20 is formed on the outer periphery thereof with two types of cutouts 20a and 20b, which are arranged to divide the respective outer periphery into twelve equal parts. The shaft 21a of the paper feeding driving plate 21 extends into an aperture 20c formed in the paper feeding clutch plate 20. A paper feeding clutch  
10 spring 22 has one end thereof fixed to the paper feeding driving plate 21 and the other end thereof attached to a shaft 19a of the paper feeding clutch pawl 19, the shaft 19a extending into an aperture 20d formed in the paper feeding clutch plate 20, thus urging the paper  
15 feeding clutch pawl 19 in the direction of an arrow A. The paper feeding clutch gear 16, the paper feeding clutch plate 20 and the paper feeding driving plate 21 are rigidly secured to the paper feeding shaft 10, the latter having three grooves on the outer periphery thereof. A  
20 first clutch (paper feeding clutch) 23 is composed of the paper feeding clutch gear 16, the paper feeding clutch pawl 19, the paper feeding clutch plate 20, the paper feeding clutch spring 22 and the paper feeding driving plate 21.

25 The paper feeding driving plate 21 is integrally

formed with a stub shaft 21c to which is rigidly fitted a paper feeding transmission gear 70 having an internal gear 70a. The paper feeding driving plate 21 is also provided with an eccentric shaft 21b to which is rigidly secured a paper feeding transmission gear 71. The paper feeding transmission gear 70 is locked so as not to be rotated by means of a pin 3d provided on the side frame 3. A paper feeding gear 72 has an internal gear (invisible in Figure 2) engaging with a gear 71b of the paper feeding transmission gear 71, the paper feeding gear 72 being rigidly secured to the paper feeding shaft 10. A reduction mechanism is composed of the eccentric shaft 21b of the paper feeding driving plate 21, the paper feeding transmission gears 70, 71, and the paper feeding gear 72. A paper feeding knob 73 is fixed to the paper feeding shaft 10 and coupled to the paper feeding gear 72 through a slippage clutch (not shown) which prevents transmission of the torque when the load exceeds a certain level.

A head clutch gear 18 is rigidly secured to the head cam shaft 8, the latter having three grooves on the outer periphery thereof. The head clutch gear 18 has a gear 18a and a ratchet wheel 18b. A head clutch plate 27 is formed on the outer periphery thereof with two types of cutouts 27a, 27b and is rigidly secured to the head cam shaft 8. The cutouts 27a, 27b constitute differently shaped first and second abutment means which are respectively engageable by a clutch control member constituted by a trigger lever 31. A head cam driving plate 29 is fixed

to the head cam shaft 8, and a shaft 29a of the head cam driving plate 29 extends through an aperture 27c formed in the head clutch plate 27. A head clutch pawl 26 which is engageable with the ratchet wheel 18b, is rigidly secured to the shaft 29a. The cutouts 27a, 27b of the head clutch plate 27 are arranged to divide the outer periphery thereof into three equal parts, each of which is itself unequally divided into two ranges corresponding respectively to a small rotating angle  $\theta_1$  (projections 27e-27f) and a large rotating angle  $\theta_2$  (projections 27f-27g) (see Figure 4). A head clutch spring 28 has one end thereof fixed to the head cam driving plate 29 and the other end thereof attached to a shaft 26a of the head clutch pawl 26. The shaft 26a extends into an aperture 27d formed in the head clutch plate 27, thus urging the head clutch pawl 26 in the direction of an arrow B.

A second clutch (head cam clutch) 30 is composed of the head clutch gear 18, the head clutch pawl 26, the head clutch plate 27, the head clutch pawl spring 28 and the head cam driving plate 29.

The trigger lever 31 serves as a clutch control member which has one end 31a thereof engageable with the cutout 27a of the head clutch plate 27 and the other end 31b thereof engageable with the cutout 20a of the paper feeding clutch plate 20. The trigger lever 31 is rigidly secured to the carriage shifting shaft 7 so as to be urged in the direction

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of an arrow C by a spring 32.

An electromagnet 33, which serves as an electromagnetic member is fixed to the side frame 3. The electromagnet 33 has an armature 33a engageable with a part 31c of the trigger lever 31. A switching lever 34 serves as a locking member and is rigidly secured to a shaft 3c on the side frame 3. The switching lever 34 has one end 34a thereof engageable with the cutouts 27b of the head clutch plate 27 and the other end 34b thereof engageable with the cutouts 20b of the paper feeding clutch plate 20. A switching pin 35 is inserted in an aperture 34c in the switching lever 34, the switching pin 35 being urged in the direction of an arrow D by means of a leaf spring 36 fixed to the switching lever 34 (Figure 2). The switching pin 35 is engaged with the end face cam 15a of the shifting gear 15, the latter serving as a locking control member.

Figures 7 and 8 are sectional views taken along the line E - E in Figure 1, and showing the parts thereof in different relative positions, and Figure 9 is a top plan view of the carriage 4.

A head mounting member or head lever 41, together with the thermal head 5 which is mounted thereon, is rigidly secured to pins 4a, 4b of the carriage 4. A head cam 42, which is held between parts 4c and 4d of

the carriage 4, is unrotatably but slidably fitted on the head cam shaft 8. The head cam 42 has a cam portion on the outer periphery thereof which is engaged with the head lever 41. A head pushing rod 43 is mounted on the carriage 4 so as to be slidable in the direction of an arrow F. The head pushing rod 43 is urged in the direction of an arrow F. The head pushing rod 43 is urged in the direction of the arrow F by means of a compression spring 44 which is disposed in a part 4e of the carriage 4. The head pushing rod 43 has one end thereof engaging with the head lever 41 and the other end thereof engaging with a part 48a of a winding lever 48. The thermal head 5 may be pushed against a platen sheet 45 with a thermal ribbon 6a and printing paper 49 or other record sheet interposed therebetween.

A paper feeding roller 46 is fixed to the paper feeding shaft 10. A paper holding roller 47 is pushed against the paper feeding roller 46 with the printing paper 49 or other record sheet interposed therebetween. A carriage shifting worm 50 is held between parts 4f and 4g of the

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carriage 4 and is splined on the carriage shifting shaft  
7 so as to be axially movable on the latter but non-  
rotatable with respect thereto. The worm 50 has an  
external helical groove 50a which is engageable with a row  
5 of equally spaced apart fixed carriage shifting pins 1a  
which are fixed to the case 1 and are arranged axially  
of the carriage shifting shaft 7. The winding lever 48, which  
constitutes a ribbon take-up driving member, is rigidly  
secured to a shaft 4h of the carriage 4 and is urged  
10 in the direction of an arrow G by means of a spring 52  
which is attached at one end thereof to a part 4i  
of the carriage 4. A winding

drive gear 51, which engages with a rack 1b of the case 1, is rigidly secured to a shaft 48b provided on the winding lever 48. A winding gear 53 is engaged with the winding drive gear 51 and is rigidly secured to the shaft 4h. The winding gear 53 has projections on the outer periphery thereof and is frictionally engaged with a winding shaft 54 which is itself engaged with a winding hub or take-up member 6b for the thermal ribbon 6a.

The operation of the printer will be described below.

1. Initial Setting

When the motor 11 is switched ON to rotate it in the direction of an arrow H, rotation of the motor 11 is transmitted through the motor gear 12, the reduction gears 13a, 13b and the transmission gear 17 to rotate the shifting gear 15, the paper feeding clutch gear 16 and the head clutch gear 18 in the direction of arrows I, J and K, respectively (Figure 3). Rotation of the shifting gear 15 in the direction of the arrow I causes, as shown in Figure 4, the part 34b of the switching lever 34 to engage with the cutout 20b of the paper feeding clutch plate 20, thereby locking the paper feeding clutch plate 20. In the initial state, when the head clutch plate 27 is in the standby state, there are two possibilities, namely that the part 31a of the trigger lever 31 is engaged with the cutout 27a at the right hand end of the range corresponding

to the small rotating angle  $\theta_1$  as shown in Figure 4 or at the right hand end of the range corresponding to the large rotating angle  $\theta_2$  as shown in Figure 10. The standby position of the head clutch plate 27 shown in Figure 4 corresponds to the position of the head cam 42 shown in Figure 7, i.e. the state where the thermal head 5 is spaced from the platen sheet 45, while the standby position of the head clutch plate 27 shown in Figure 10 corresponds to the position of the head cam 42 shown in Figure 8, i.e. the state where the thermal head 5 is pushed against the platen sheet 45 (namely the printing state). To effect normal printing, the thermal head 5 requires to be initially disposed in the position in which it is spaced from the platen sheet 45 as shown in Figure 7, prior to the start of the printing.

As will be clear from Figure 4, when the electromagnet 33 is energized, the armature 33a is turned about its pivot 33b in the direction of an arrow L so as to rotate the trigger lever 31 in the direction opposite to the arrow C, so that the part 31a of the trigger lever 31 is disengaged from the projection 27e of the head clutch plate 27 and the part 31b thereof is disengaged from a projection 20e of the paper feeding clutch plate 20 (Figure 5). When the head clutch plate 27 is released from being locked by the trigger lever 31, the head clutch pawl 26 is rotated

in the direction of an arrow B together with its part 26a  
by reason of the fact that the head clutch plate 27 is rotated  
in the direction of an arrow K through the action of the  
head clutch spring 28 (Figure 2). The head clutch pawl 26  
5 thus comes into engagement with the head clutch ratchet  
wheel 18b, such rotation of the head clutch ratchet wheel  
18b being transmitted to the head cam driving plate 29 and  
the head cam shaft 8 through the pin 29a. At this time,  
when the energization time of the electromagnet 33 is set  
10 to be longer than the rotation time for the small rotating angle  
 $\theta_1$  but shorter than that for the large rotating angle  $\theta_2$ ,  
the trigger lever 31 is returned back to the standby state by  
means of the spring 32 (Figure 2) after a projection 27f  
of the head clutch plate 27 has passed the part 31a of the  
15 trigger lever but before a projection 27g reaches the  
part 31a, so that the projection 27g is locked by the part  
31a to stop further rotation of the head clutch plate 27.  
When rotation of the head clutch plate 27 is stopped, the head  
clutch pawl 26 is disengaged from the head clutch ratchet  
20 wheel 18b, whereby transmission of torque to the head cam  
driving plate 29 and the head cam shaft 8 is interrupted.  
In other words, the head clutch plate 27 is set at the right  
hand end of the range corresponding to the small rotating  
angle  $\theta_2$  in Figure 4 and the thermal head 5 is set in the  
25 position in which it is spaced from the platen sheet 45, as

shown in Figure 7.

When the head clutch plate 27 is locked in its standby position at the right hand end of the range corresponding to the large rotating angle  $\theta_2$  as shown in Figure 10, the trigger lever 31 is operated upon energization of the electromagnet 33 and the locking of the projection 27f by the part 31a is released, so that the head clutch 30 is rotated in the direction of the arrow K. Because the energisation time of the electromagnet 33 is shorter than the rotation time for the large rotating angle  $\theta_2$ , the trigger lever 31 is already returned back to the standby state before the projection 27g of the head clutch plate 27 passes the part 31a, whereby the projection 27g is locked by the part 31a to interrupt transmission of torque to the head clutch 30. In other words, the head clutch plate 27 is set at the right hand end of the range corresponding to the small rotating angle  $\theta_1$  shown in Figure 4 and the thermal head 5 is set in the position in which it is spaced from the platen sheet 45 as shown in Figure 7.

The situation described above is illustrated graphically in Figure 10A.

As described above, irrespective of whether the thermal head 5 is in the position in which it is pushed against the platen sheet 45 or is in the position in which it is spaced therefrom in the initial state, it is always possible to initially set the thermal head 5 in the position in which it is spaced from the platen sheet 45 because the head clutch

plate 27 is divided into unequal parts and the energisation time of the electromagnet 33 may be selected to be longer than the rotation time for  $\theta_1$  but shorter than that for  $\theta_2$ . It is to be noted that, when the trigger lever 31 is rotated in the direction opposite to the arrow C upon energization of the electromagnet 33, the part 31b of the trigger lever 31 is also disengaged from the projection 20e of the paper feeding clutch plate 20, but the paper feeding clutch plate 20 does not rotate since it is locked by the switching lever 34. When the initial setting of the thermal head 5 has been completed, the carriage 4 is returned back to the standby position (the left hand end in Figure 1) by means described below, thus completing the whole of the initial setting.

15 2. Printing

When the motor 11 is rotated in the direction of the arrow H to turn the carriage shifting shaft 7 in the direction of the arrow I, the carriage 4 is moved in the direction of an arrow M (Figure 9) by means of the engagement between the carriage shifting worm 50 mounted on the carriage shifting shaft 7 and the carriage shifting pins 1a. At this time, the thermal head 5 is in the position in which it is spaced from the platen sheet 45 as shown in Figure 7 as the result of the initial setting. In this state, the head pushing rod 43 is pushed by the part 41a of the head lever 41 in the direction opposite to the arrow F so

that the parts 43a of the head pushing rod 43 turns the winding lever 48 in the direction opposite to the arrow G, as a result of which the winding drive gear 51 is disengaged from the rack 1b (two-dot chain lines in Figure 9). Thus, even when the carriage 4 is moved, winding of the thermal ribbon 6a is not effected.

When the carriage 4 reaches the position where printing is to be made on the printing paper 49, the electromagnet 33 is energized. The switching lever 34 is disposed in the position shown in Figure 4, as explained below. The energization time on this occasion is set shorter than the rotation time of the head clutch plate 27 for the small rotating angle  $\theta_1$ . More specifically, it becomes possible to rotate the head clutch 30 one division at a time by returning the trigger lever 31 after the latter has been rotated to disengage the part 31a from the projection 27g of the head clutch plate 27 and the head clutch 30 has been operated thereupon, but before the projection 27f passes the part 31a. The head clutch 30 is rotated in the direction of the arrow K through one division upon energization of the electromagnet 33, so that the head cam 42 comes into the position shown in Figure 8 and the thermal head 5 is pushed against the platen sheet 45, thus permitting printing to occur. When the thermal head 5 is energized in this state, ink in the thermal ribbon 6a is melted so as to be transferred onto the printing paper 49 to effect printing.

On the other hand, because the head pushing rod 43 is moved in the direction of the arrow F while being pushed by the thermal head 5, the winding lever 48 is turned in the direction of the arrow G by virtue of the spring 52 so as to engage the winding drive gear 51 with the rack 1b. When the winding drive gear 51 is engaged with the rack 1b and the carriage 4 is moved in the direction of the arrow M, the winding gear 53 and the winding shaft 54 are both rotated in the direction opposite to the arrow G to wind up the thermal ribbon 6a. As long as the characters, etc. to be printed are present, the carriage 4 continues to move in the direction of the arrow M in the state described above.

If a blank portion larger than a certain extent continually appears in one line on which printing is to be made, the electromagnet 33 is energized so that the head clutch 30 is operated to rotate by one division, the head cam 42 comes into the position shown in Figure 7, the thermal head 5 comes into the spaced position and the winding drive gear 51 is disengaged from the rack 1b, as a result of which the carriage 4 is moved at the same time as winding of the thermal ribbon 6a is stopped.

If there are again the characters, etc. to be printed, the electromagnet 33 is energized to rotate the head clutch by one division, whereby the thermal head 5 is pushed against the thermal sheet 45 for printing.

When printing of one line is completed through a repetition of the above operations, the thermal head 5 is always set in the spaced position as shown in Figure 7.

5      3. Paper Feeding and Carriage Returning.

When the printing is completed, the polarity of energization of the motor 11 is switched so as to rotate it in the backward direction (opposite to the arrow H). Upon backward rotation of the motor 11, the shifting gear 15, the carriage shifting shaft 7 and the carriage shifting worm 50 are all rotated also in the backward direction (the direction of an arrow O, Figure 4). The backward rotation of the carriage shifting worm 50 causes the carriage 4 to move in the direction opposite to the arrow M and return back to the standby position. When the shifting gear 15 is rotated backwards (in the direction of the arrow O), the switching lever 34 is turned in the direction of an arrow P through the switching pin 35 and the stepped portion 15e of the end face cam 15a (Figure 4, Figure 11(a)), so that the part 34a is engaged with the cutout 27b of the head clutch plate 27 to lock the head clutch plate 27 (Figure 6). Meanwhile, the paper feeding clutch plate 20 is disengaged at the cutout 20b thereof from the part 34b of the switching lever 34. When the electromagnet 33 is energized in this state, the trigger lever 31 is turned in the direction opposite to the arrow C so that the parts 31a and

31b thereof are respectively disengaged from the projection 27e of the head clutch plate 27 and the projection 20e of the paper feeding clutch plate 20, but the head clutch plate 27 is not driven because it is locked by the switching lever 34.

When the paper feeding clutch plate 20 is released from its locked state, the paper feeding pawl 19 is rotated in the direction of the arrow A by virtue of the spring 22 to be engaged with the paper feeding ratchet wheel 16a, so that rotation of the paper feeding ratchet wheel 16a in the direction of an arrow S is transmitted to the paper feeding driving plate 21 through the pin 21a. Rotation of the paper feeding driving plate 21 is transmitted to the paper feeding roller 46 (Figure 7) through the paper feeding transmission gears 22, 23, the paper feeding gears 24, the paper feeding knob 25 and the paper feeding shaft 10 (Figure 1), thereby feeding the printing paper 49. Energization of the electromagnet 33 is continued until the printing paper 49 is fed by a certain amount. When the motor 11 is rotated backwards, paper feeding is completed and then the carriage 4 is returned back to the standby position, and the motor power is turned OFF to stop the printer.

#### 4. Printing/Paper Feeding Subsequent to Second Line

The motor 11 is again energized to be rotated in

the direction of the arrow H, thus causing the carriage 4 to move in the direction of the arrow M. At the starting time of rotation of the motor 11, the switching lever 34 is locking the head clutch 30 as shown in Figure 6. When the  
5 shifting gear 15 is rotated in the direction of the arrow I, the switching lever 34 is turned in the direction opposite to the arrow P through the switching pin 35 and the stepped portion 15f of the end face cam 15a (Figure 6, Figure 11(b)), so that the paper feeding clutch 23 is locked and  
10 the head clutch 30 comes into the operable state (Figure 4). Thereafter, the printing and the paper feeding/returning as mentioned above will be repeated.

A description relating to operation of the carriage 4 in the standby position was omitted above and is therefore  
15 provided below.

Figures 12(a) to 12(e) are views of the area T in Figure 1 as seen from the rear, and Figure 13 is a sectional view taken on the line V - V of Figure 12(d).

A shifting lever 101 is provided at one end thereof  
20 with a pin 101a engageable with the groove 50a of the carriage shifting worm 50, the pin 101a passing through an aperture 1c formed in the case 1. The shifting lever 101 is provided at the other end thereof with a pin 101b against which bears one end of a spring 102 for urging the pin 101b  
25 substantially axially of the carriage shifting shaft 7 in the direction of an arrow U, the shifting lever 101 being rotatably

mounted on a shaft ld provided on the case L. The shifting lever 101 is limited in its rotating range by virtue of the aperture lc in the case 1, and it is so set that, as shown in Figure 12(b), when turned as far as possible in the direction of the arrow U, the distance between the pin 101a and the most right hand shifting pin la is equal to  $2t_1$ . As will be appreciated, the pin 101a, in moving between its Figure 12(a) and Figure 12(c) positions, moves substantially axially of the carriage shifting shaft 7 so that it is always substantially aligned with the shifting pin la. The operation of this construction will be described below.

When the carriage shifting pins la are engaged with the helical groove 50a and the carriage shifting shaft 7 is rotated in the direction which occurs during paper feeding and returning, i.e. in the direction of the arrow O, the carriage shifting worm 50 is first moved towards the right, i.e. in the direction opposite to the arrow M by virtue of the engagement between the carriage shifting pins la and the helical groove 50a until the carriage shifting worm 50 reaches the position shown in Figure 12(a) in which its groove 50a ceases to be in drive engagement with the carriage shifting pins la but is in drive

engagement with the pin 10la which is at the right hand end, as seen in Figure 12(a), of the aperture 1c.

When the carriage 4 is moved rightwards in accordance with the engagement between the carriage shifting worm 50 and the fixed carriage shifting pins 1a, the slant face of the groove 50a of the carriage shifting worm 50 pushes against the fixed carriage shifting pin 1a in the direction of the arrow M and, due to reverse force, the carriage shifting worm 50 and the carriage 4 are moved in the direction opposite to the arrow M.

The operation will now be described with reference to Figures 12(a), 12(b), 12(c), 12(d) and 12(e).

Assuming that the carriage shifting worm 50 is rotated in the direction of the arrow O, Figure 12(a) shows the condition where the carriage shifting worm 50 is about to be disengaged from the most right hand carriage shifting pin 1a. When the carriage shifting shaft 7 is further rotated in the direction of the arrow O, the groove 50a of the carriage shifting worm 50 is released from engagement with the most right hand carriage shifting pin 1a, as shown in Figure 12(b). When the carriage shifting shaft 7 is still further rotated in the direction of the arrow O, the carriage shifting worm 50 cannot be moved rightwards from the position shown in Figure 12(b) since the force of the spring 102 for urging the pin 10la in the direction of the arrow U is smaller than the frictional

load on the carriage 4 in the direction of the arrow M.

The pin 10la is thus moved in the direction of the arrow M by reason of its engagement in the groove 50a. Then the pin 10la abuts against the left hand end of the aperture 1c and is thereby stopped. This state is shown in Figure 12(c).

When the carriage shifting shaft 7 is further rotated in the direction of the arrow O, the carriage shifting worm 50 is moved rightwards to the position shown in Figure 12(d), in which the pin 10la is at the left hand end of the helical groove 50a, due to the reverse force of the pin 10la.

Still further rotation of the carriage shifting shaft 7 merely allows the pin 10la to reciprocate between the positions shown by the solid lines and the broken lines in Figure 12(d). The carriage shifting worm 50 is thus now in idle rotation.

How the pin 1a is brought into drive engagement with the carriage shifting worm 50 by rotation of the carriage shifting shaft 7 in the direction of the arrow I is next described.

When the carriage shifting shaft 7 is rotated in the direction of the arrow I, the spring 102 causes the pin 10la to move along the groove 50a in the direction of the arrow U from the position shown in Figure 12(d) to the right hand end of the aperture 1c. In this state, the distance between the pin 10la and the most right hand

carriage shifting pin 1a is equal to  $2t_1$  or some other multiple of the pitch  $t_1$  (see Figure 12(e)).

5 The pin 101a abuts against the right hand end of the aperture 1c and is thereby stopped. Due to the reverse force, the carriage shifting worm 50 starts moving in the direction of the arrow M. The carriage shifting worm 50 is moved to the position shown in Figure 12(a) so that the groove 50a of the carriage shifting worm 50 is brought into engagement with the fixed carriage shifting pins 1a.  
10 Thereafter, the carriage shifting worm 50 is further moved in the direction of the arrow M.

Although the present invention has been described with reference to an embodiment in which it is applied to a thermal transfer printer, the invention is not limited to  
15 this embodiment and is also applicable to all apparatus in which power transmission is performed using clutches.

In the apparatus described above, two clutches can be independently controlled with the aid of the control of a locking member 34 effected by forward/backward rotation of  
20 a motor 11 and the provision of a single electro-magnetic

5 member 33. Thus it is not necessary to employ further electro-magnetic members which are expensive, have a large number of parts, and occupy a large amount of space. This enables the cost, size and weight of the power transmission apparatus itself and thus of the printer as a whole to be reduced.

C L A I M S

1. A power transmission apparatus comprising a rotatable clutch member having differently shaped first and second abutment means which are respectively engageable by a clutch control member to prevent rotation of the rotatable clutch member; an electromagnetic member for controlling the position of the clutch control member so as to permit or prevent movement of the rotatable clutch member, the clutch control member being respectively movable into and out of engagement with the first and second abutment means of the rotatable clutch member so as to permit the latter to be moved either through a relatively small angle  $\theta_1$  or a relatively large angle  $\theta_2$ , where  $\theta_1 + \theta_2 = 360/n$ ,  $n$  being a positive integer; and means for selectively setting the electromagnetic member in one of its two states either for a period shorter than that required for the rotatable clutch member to move through the angle  $\theta_1$  or for a period longer than that required for the rotatable clutch member to move through the angle  $\theta_1$  but shorter than that required for it to move through the angle  $\theta_2$ .
2. A power transmission apparatus as claimed in claim 1 in which the said one state of the electromagnetic member is energisation thereof.



3. A power transmission apparatus as claimed in claim  
1 or 2 comprising a motor arranged to rotate both in a  
first angular sense and in an opposite angular sense; first  
and second clutches which are drivingly connected to the  
5 motor, the said rotatable clutch member forming part of the  
said second clutch, the said clutch control member being  
movable between a first position in which it engages both the  
first and second clutches to prevent drive transmission  
therethrough and a second position in which it is spaced from  
10 both the first and second clutches so as to permit drive  
transmission therethrough, the said electromagnetic member  
being arranged to move the clutch control member between said  
positions; a locking member movable between a first position,  
in which it locks the first clutch to prevent drive transmission  
15 therethrough but not the second clutch, and a second position  
in which it locks the second clutch to prevent drive  
transmission therethrough but not the first clutch; and  
a position control member connected to said motor for controlling  
the position of the locking member, the arrangement being such that  
when the motor rotates in the said first angular sense, the  
20 position control member causes the first clutch to be locked  
by the locking member to prevent drive transmission therethrough,  
and when the motor is rotated in the opposite angular sense,  
the position control member causes the second clutch to be  
locked by the locking member to prevent drive transmission  
25 therethrough.



⑤

4. A power transmission apparatus as claimed in claim 3 in which the clutch control member is a trigger lever having arms which are respectively engageable with parts of the first and second clutches.
- 5 5. A power transmission apparatus as claimed in claim 4 in which the electromagnetic member has an armature which engages a said arm of the trigger lever, energisation of the electromagnetic member moving the trigger lever from one of its positions to the other.
- 10 6. A power transmission apparatus as claimed in any of claims 3-5 in which the position control member has a cam which engages a part of the locking member.
- 15 7. A power transmission apparatus as claimed in claim 4 or 5 and in claim 6 in which the trigger lever and the position control member are mounted on the same shaft, the position control member being a gear fixed to said shaft and driven by the motor.
- 20 8. A power transmission apparatus as claimed in any of claims 3-7 in which the locking member is a locking lever having arms which are respectively engageable with parts of the first and second clutches.
- 25 9. A power transmission apparatus as claimed in claim 7 in which the said shaft is a carriage shifting shaft which is rotatably mounted in fixed structure and which is arranged to shift a carriage linearly, the said carriage being carried by and movable with respect to the fixed structure.



10. A power transmission apparatus as claimed in claim 9 comprising an axially movable member which is connected to said carriage and which is splined on said carriage shifting shaft so as to be axially movable thereon but non-rotatable with respect thereto, the axially movable member having an external helical groove, there being a row of equally spaced apart fixed shifting pins which are fixed to the fixed structure, are arranged axially of the carriage shifting shaft and are engageable with the said helical groove so that rotation of the carriage shifting shaft in a first angular sense causes the carriage to move in a given axial direction and rotation of the carriage shifting shaft in the opposite angular sense causes the carriage to move in the opposite axial direction.

11. A power transmission apparatus as claimed in claim 10 comprising a substantially axially movable shifting pin which is engageable with the said helical groove, urging means for urging said substantially axially movable shifting pin in a given axial direction, and means for limiting substantially axial movement of the substantially axially movable shifting pin in either axial direction.

12. A power transmission apparatus as claimed in claim 11 in which the arrangement is such that, when the carriage shifting shaft is rotated in a first angular sense and the said helical groove is engaged with the fixed shifting pins, the axially movable member will first move in the said



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given axial direction until it reaches a first position in which its helical groove ceases to be in drive engagement with the fixed shifting pins and in which the axially movable shifting pin is forced by the helical groove to its limiting position in the said opposite axial direction, further rotation of the said shaft in the said first angular sense causing the axially movable member to move further in the said given axial direction until the axially movable member reaches a second position in which its helical groove ceases to be in drive engagement with the substantially axially movable shifting pin, whereby the axially movable member will then be in idle rotation; rotation of the said shaft in the angular sense opposite to the first angular sense when the axially movable member is in the said second position first causing the substantially axially movable shifting pin to be moved by the urging means to its limiting position in the said given axial direction, the axially movable member then being caused to travel in the axial direction opposite to the said given axial direction so that the said helical groove is successively in drive engagement with the substantially axially movable shifting pin and the fixed shifting pins.

13. A power transmission apparatus as claimed in claim 11 or 12 in which the substantially axially movable shifting pin is carried by a shifting lever which is acted on by a spring to urge the substantially axially movable shifting pin in the said given axial direction.



14. A power transmission apparatus as claimed in any of claims 11 to 13 in which the substantially axially movable shifting pin is always substantially aligned with the fixed shifting pins.

5 15. A power transmission apparatus as claimed in any of claims 12-14 in which when the substantially axially movable shifting pin is in its limiting position in the said given axial direction it is spaced from the nearest fixed shifting pin by a distance equal to a multiple of the pitch  
10 of the fixed shifting pins.

16. A power transmission apparatus as claimed in any of claims 9-15 in which the apparatus forms part of a thermal printer, the linearly movable carriage carrying a head  
15 mounting member on which is mounted a thermal head, the head mounting member being movable between a printing position in which in operation the thermal head engages a platen with a record sheet, and a thermal ribbon interposed therebetween, and a non-printing position in which the thermal head is spaced from the platen, means being provided for moving the thermal  
20 head between the printing and non-printing positions.

17. A power transmission apparatus as claimed in claim 16 in which there is a ribbon take-up driving member having a take-up gear which is engageable with a fixed rack substantially throughout the linear distance throughout which  
25 the carriage can be moved, rotation of the take-up gear effecting take-up of the thermal ribbon; the ribbon take-up driving member being movable by said head mounting member

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so that the take-up gear engages the fixed rack only  
when the head mounting member is in its printing position.

18. A power transmission apparatus as claimed in claim  
17 in which the head mounting member is engaged by a push  
5 member which urges the thermal head towards the printing  
position, the head mounting member also being engageable  
by a head cam which is rotatable between positions in which  
the push member is respectively permitted to push and prevented  
from pushing the thermal head into the printing position, the  
10 push member engaging a part of the ribbon take-up driving  
member.

19. A power transmission apparatus substantially  
as hereinbefore described with reference to and as shown  
in the accompanying drawings.