

S P E C I F I C A T I O N

TITLE OF THE INVENTION:

PAPER FEED APPARATUS EQUIPPED WITH FEED BELT
SUPPORTERS

BACKGROUND OF THE INVENTION:

This invention relates to a paper feed apparatus equipped with feed belt supporters which reduces sliding resistance between a feed belt and a belt receiver over which the feed belt is set at the time of travelling of the feed belt and reduces the torque necessary for the rotation of a driving sprocket.

The terms "paper feed side" of the feed belt and "counter paper feed side" used in this specification means portions of the feed belt during travelling having velocity components in a paper feed direction and in a direction opposite to the former, respectively.

The terms " linear travelling portion" and "curved travelling portion" of the feed belt mean the portions where the feed belt travels in the linear form and in the curved (arcuate) form, respectively.

DESCRIPTION OF THE PRIOR ART:

The basic construction of a paper feed apparatus comprises a pair of side frames disposed in such

a manner as to face each other with a predetermined gap between them, a driving sprocket supported rotatably at one of the end portions of the pair of side frames, a hook member disposed at the other end of the pair of side frames and an endless feed belt disposed between the pair of said frames and set over the driving sprocket and the hook member with a predetermined slack, and the feed belt is circulatingly run by the rotation of the driving sprocket so as to feed paper.

The hook member for carrying the feed belt in cooperation with the driving sprocket can be classified broadly into the following two types: The first one has a rotary structure consisting of a rotary member such as a pulley and a sprocket which is supported rotatably between a pair of side frames and the other has a fixed structure such as a belt receiver disposed integrally on the side frames.

The paper feed apparatus shown in Figs. 14 and 15 uses a belt receiver 33 disposed integrally with the side frames 35 as the hook member for carrying an endless feed belt 32 in cooperation with the driving sprocket 31.

The endless feed belt 32 is arranged in a ring-

like form as shown in Fig. 13. This feed belt 32 is run by the driving rotation of the driving sprocket 31. In order to reduce as much as possible the rotation torque of the driving sprocket 31 necessary for running the feed belt 32, the feed belt 32 is provided with a predetermined slack under the state where the feed belt 32 is passed around the driving sprocket 32 and the belt receiver 33.

The paper feed side of the feed belt 32 functions as the paper pull side and at the same time, it is pressed by a paper support cover 34 after a sheet of paper is placed on it. Therefore, it is kept substantially horizontally but its counter paper feed side serves as a slack side, so that the slack of the feed belt 32 gathers at this portion and a swell occurs as shown in Fig. 15. The swell portion of the feed belt vibrates at the time of travelling of the belt and this vibration is propagated up to the linear travelling portion of the feed belt on its paper feed side and this portion causes resonance. As a result, paper feed accuracy drops. When this paper feed apparatus is assembled into equipment such as a printer, it must be assembled while securing a sufficient clearance or a space lest this swell portion of the feed belt

comes into contact with surrounding components. This impedes the reduction of the size of equipment.

If the hook member for carrying the feed belt 32 in cooperation with the driving sprocket 31 is a rotary member such as a pulley or a sprocket, the resistance of the rotary member at the time of travelling of the feed belt becomes the rotary resistance but there is no problem because this rotary resistance is not much great. In contrast, if the hook member is the belt receiver 33 disposed integrally on the side frames 35 such as described above, however, the portion of this belt receiver 33 becomes the bent portion of the feed belt 32 in its travelling direction, and the feed belt 32 is pulled by the driving sprocket 31 and travels while sliding on the upper surface of the belt receiver 33. Accordingly, the sliding resistance becomes great between the feed belt 32 and the belt receiver 33 and the torque necessary for the rotation of the driving sprocket 31 becomes great.

Since a small motor having a small output is used as the driving motor for rotating this driving sprocket 31, a large load will be applied to the small driving motor if the rotary torque of the driving sprocket 31 becomes great.

It is a first object of the present invention to reduce the rotary torque of the driving sprocket necessary for driving the feed belt by reducing the sliding resistance between the feed belt and the belt receiver in a paper feed apparatus of the type which uses the belt receiver of the fixed structure as the hook member for carrying the feed belt in cooperation with the driving sprocket.

It is a second object of the present invention to improve paper feed accuracy by preventing the propagation of the vibration resulting from the slack of the feed belt to the linear travelling portion on the paper feed side of the feed belt.

These and other objects of the present invention will become more apparent from the following description.

The present invention provides a paper feed apparatus comprising: a pair of side frames disposed face to face with a gap between them; a driving sprocket rotatably supported at one of the ends of the side frames; a non-rotary belt receiver disposed at the other end of the side frames, and an endless feed belt, having feed pins for feeding correspondingly apertured paper, disposed between the side frames and set over the driving sprocket and the belt receiver with a predetermined slack, the feed belt being circulated by rotation of the driving sprocket; wherein the counter feed side of the paper feed apparatus has a feed belt

support, adapted to support the feed belt by directly and constantly contacting the outer surface of, or the feed pins on, the linear travelling portion of the counter paper feed side of the feed belt, so that, in use, the feed belt support prevents gathering of the feed belt, which would otherwise occur due to the slack thereof, along the linear travelling portion on the counter paper feed side thereof so as to reduce friction between the non-rotary belt receiver and the feed belt.

Accordingly a limited clearance is defined between the arcuate belt receiver and the feed belt and a winding angle of the feed belt with respect to the belt receiver becomes small, so that the sliding resistance or friction between the belt receiver and the feed belt is reduced. In consequence, the rotary torque of the driving sprocket for driving the feed belt is reduced and the load to the small driving motor for rotating the driving sprocket is reduced.

Since the slack of the feed belt does not gather at the linear travelling portion on the counter paper feed side, vibration does not occur on the feed belt travelling past this portion. Accordingly, this vibration is not transmitted to the linear travelling portion of the feed belt on the paper feed side and paper feed accuracy can be improved.

Further features and advantages of the present invention will be apparent from the following description and the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS:

Figs. 1 to 12 are drawings which are useful for explaining the present invention, wherein:

Fig. 1 is a central, longitudinal sectional view of a paper feed apparatus F_1 equipped with feed belt supporter 16 in accordance with the present invention;

Figs. 2 and 3 are sectional views taken along line II - II and along line III - III of Fig. 1, respectively;

Fig. 4 is a partial perspective view of the paper feed apparatus F_1 when viewed from below;

Fig. 5 is an enlarged, partial sectional view taken along line V - V of Fig. 2;

Fig. 6 is a sectional view showing the state where a feed belt 11 is supported by another feed belt supporter 16';

Fig. 7 is a partial perspective view of the paper feed apparatus F_1 equipped with still another supporter 16" when viewed from below;

Fig. 8 is a sectional view showing the state where the feed belt 11 is supported by this feed belt supporter 16";

Fig. 9 is a central, longitudinal sectional view of a paper feed apparatus F_2 equipped with

a feed belt supporter 23;

Fig. 10 is a sectional view taken along line X - X of Fig. 9;

Fig. 11 is a partial perspective view of the paper feed apparatus when viewed from below;

Fig. 12 is a transverse sectional view of the portion of a feed belt supporter 27 of a paper feed apparatus F_3 equipped with auxiliary frames 26;

Figs. 13 to 15 are explanatory views useful for explaining a conventional paper feed apparatus, wherein:

Fig. 13 is a front view of a feed belt 32 at the time of shaping;

Fig. 14 is a front view showing the state where a paper support cover 34 is removed and then a feed belt 32 is passed around a driving sprocket 31 and a belt receiver 33; and

Fig. 15 is a front view showing the state where a feed belt 32 of a linear travelling portion on the paper feed side is supported by the paper support cover 34 and the slack of the feed belt 32 gathers at the linear travelling portion on the counter feed side.

DESCRIPTION OF THE PREFERRED EMBODIMENTS:

Hereinafter, the present invention will be

explained in further detail with reference to embodiments thereof in the cases where a paper feed apparatus is used while it is disposed either horizontally or substantially horizontally.

Figs. 1 to 5 show the paper feed apparatus F_1 of the first embodiment of the present invention.

A pair of side frames 1a and 1b are assembled integrally to face each other with a predetermined gap between them, and a belt receiver 2 is integrally disposed on the inner side surface of one 1a of the side frames. This belt receiver 2 consists of linear portions 2a and 2b that are disposed horizontally with a predetermined gap between them in a vertical direction and an arcuate curved portion 2c.

A driving sprocket 3 has a large number of outer gears 5 disposed on the outer peripheral surface of a sprocket main body 4 and fitting portions 6 project from both of its side surfaces. A sprocket hole 7 is bored at one of the ends of each of the pair of side frames 1a, 1b and the driving sprocket 3 is disposed between the pair of side frames 1a, 1b in such a manner that the fitting portions 6 projecting from both side surfaces of the driving sprocket 3 are fitted rotatably into the sprocket holes 7 of the pair of side frames 1a, 1b. A driving shaft 9

is fitted into a shaft hole bored at the center of the sprocket main body 4.

An endless feed belt 11 has inner gears 13 formed on the inner peripheral surface of the belt main body 12 and has also a large number of feed pins 14 projecting from its outer peripheral surface. This feed belt 11 is set over the driving sprocket 3 and the belt receiver 2 described above. The outer gears 5 and the inner gears 13 of the feed belt 11 mesh with one another at the portion of the driving sprocket 3.

Arcuate wall portions 15 are disposed at the end portions of the inner side surfaces of each side frame 1a, 1b on the side of the driving sprocket 3 in such a manner as to face each other, and these wall portions prevent the feed belt 11 that travels in the curve form past these portions from moving away by a distance exceeding a predetermined distance in the radial direction of the driving sprocket 3. In this manner the outer gears 5 of the driving sprocket 3 and the inner gears 13 of the feed belt 11 are prevented from mismeshing from each other.

Feed belt supporters 16 are disposed integrally at the centers of the lower end portions of the side

frames 1a, 1b, respectively, in such a manner as to face each other. The length of each feed belt supporter 16 in the travelling direction of the feed belt 11 and its projection length from the inner side surface of each side frame 1a, 1b are L_1 and L_2 , respectively. The projection length (L_2) of each feed belt supporter 16 from the inner side surface of each side frame 1a, 1b is determined so as not to come into contact with the feed pin 14 of the feed belt 11. As shown in Figs. 2 and 4, the belt main body 12 of the feed belt 11 travelling the linear travelling portion on the counter paper feed side is supported by the support surface 16a of the feed belt supporter 16 and travels while keeping a gentle contact with it.

Incidentally, reference numeral 17 in the drawings represents paper; 18 does a support shaft for fitting a pair of paper feed apparatus F_1 with a gap corresponding to the width of paper 17; and 19 does a paper support cover.

The feed belt 11 is caused to travel in the direction represented by arrow 21 by the rotation of the driving sprocket 3 and paper 17 is delivered by the feed belt 11 that travels past the linear travelling portion on the paper feed side.

Here, the feed belt supporter 16 is disposed integrally at the lower end portion of each side frame 1a, 1b, the feed belt 11 travelling past the linear travelling portion on the counter paper feed side comes into gentle contact with the belt supporter 16 at its both end portions in the transverse direction of the belt main body 12 and it is supported from below (from outside the feed belt 11) by the length (L_1) in the travelling direction of the feed belt 11 and is lifted up. Accordingly, if the feed belt supporter 16 is not disposed, the slack of the feed belt 11 gathers at the linear travelling portion on the counter paper feed side and swell occurs in the feed belt travelling past this portion. Due to the function of the feed belt supporter 16 described above, however, the slack of the feed belt 11 either gathers at the curved travelling portion on the side of the belt receiver 2 or is dispersed to this curved travelling portion and to the linear travelling portion on the counter paper feed side.

As a result, a limited clearance 22 is defined between the outer peripheral surface of the curved portion 2c of the belt receiver 2 and the inner gears 13 of the feed belt 11 travelling past this

portion and the winding angle of the feed belt 11 to the curved portion 2c of the belt receiver 2 becomes small, so that the sliding resistance between the belt receiver 2 and the feed belt 11 becomes small. In other words, the rotary torque of the driving sprocket 3 necessary for driving the feed belt 11 becomes small. Since the slack of the feed belt 11 does not gather at the linear travelling portion on the counter paper feed side, vibration does not occur in the feed belt 11 travelling past this portion. As a result, no vibration is transmitted to the feed belt 11 travelling past the linear travelling portion on the paper feed side and therefore resonance does not occur, and eventually, paper feed accuracy can be improved.

Further, the present apparatus is free from a large swell of the feed belt 11 travelling past the linear travelling portion on the counter paper feed side, unlike the conventional paper feed apparatuses. Accordingly, it is not necessary to secure a space for avoiding interference with surrounding components when the apparatus is assembled in equipment such as a printer and hence the equipment can be designed compactly.

In the feed belt supporter 16' shown in Fig. 6,

both of its end portions along the travelling direction of the feed belt on its support surface 16'a are curved so as to make smooth the contact with the feed belt. Further, in the feed belt supporter 16" shown in Figs. 7 and 8, the support surface 16"a itself is curved so as to reduce the contact area with the belt main body 12.

Figs. 9 to 11 show the paper feed apparatus F_2 in accordance with the second embodiment of the present invention.

All of the feed belt supporter 16, 16', 16" disposed in the paper feed apparatus F_1 of the first embodiment have the structure wherein the linear travelling portion on the counter paper feed side is brought into contact with the belt main body 12 of the travelling feed belt 11 and this portion is lifted up from below, but the feed belt supporter 23 of the paper feed apparatus F_2 of the second embodiment has a structure wherein the feed belt 11 is lifted up from below by bringing the linear travelling portion on the counter paper feed side into contact with the top of the feed pins 14 of the feed belt 11.

In other words, a sheet-like feed belt supporter 23 is disposed horizontally at the lower end portion

of one 1a of the side frames to project inward over the full length in the longitudinal direction. Accordingly, the feed belt 11 travels while the top of the feed pins 14 of the feed belt 11 travelling past the linear travelling portion on the counter paper feed side is in gentle contact with the support surface 23a on the upper surface of the sheet-like feed belt supporter 23. Therefore, the slack of the feed belt 11 gathers at the curved travelling portion of the portion of the belt receiver 2 and a limited clearance is formed between the outer peripheral surface of the curved portion 2c of the belt receiver 2 and the inner gears 13 of the feed belt 11 travelling past this portion, so that the winding angle of the feed belt 11 to the curved portion 2c of the belt receiver 2 becomes small and the sliding resistance between the belt receiver 2 and the feed belt 11 becomes small.

In the paper feed apparatus F_3 of the third embodiment of the present invention shown in Fig. 12, a belt receiver 24 for carrying the feed belt 11 in cooperation with the driving sprocket 3 is a separate member from the side frames 1a, 1b.

In other words, an auxiliary frame 26 is fitted into an auxiliary frame groove 25 disposed on the

inner side surface of each side frame 1a, 1b in such a manner as to be capable of moving finely in the paper feeding direction and the belt receiver 24 is integrally disposed on this auxiliary frame 26. Further, the driving sprocket 3 is supported rotatably and both the belt receiver 24 and the driving sprocket 3 can move finely in the paper feeding direction integrally with each other. Accordingly, the center distance between the driving sprocket 3 and the curved portion of the belt receiver 24 does not change and paper feed accuracy is high.

In the paper feed apparatus F_3 having the structure such as described above, the belt supporter 27 is disposed integrally at the lower end portion of each auxiliary frame 26 so as to project inwardly. The belt main body 12 of the feed belt 11 travelling past the linear travelling portion on the counter paper feed side is supported from below by this feed belt supporter 27 and the feed belt 11 is in gentle contact with the support surface 27a and is lifted up.

In all the foregoing embodiments, the feed belt supporters 16, 23, 27 are disposed integrally on the side frames 1a, 1b or the auxiliary frames 26

but it is possible to employ the structure wherein a belt supporter having a separate structure is fitted to each side frame 1a, 1b.

Furthermore, the foregoing embodiments deal with the case where the paper feed apparatus is disposed either horizontally or substantially horizontally and is used. In the cases where the paper feed apparatus is used while being inclined greatly or in a vertical or approximately vertical state, the slack of the feed belt can be dispersed to the portion of the curved travelling portion by bringing the belt supporters into contact with the outside of the feed belt travelling the linear travelling portion on the counter paper feed side and supporting this feed belt. In this manner, the sliding resistance between the curved portion of the belt receiver and the feed belt travelling past this portion can be reduced.



Claims:

1. A paper feed apparatus comprising:

a pair of side frames disposed face to face with a gap between them;

a driving sprocket rotatably supported at one of the ends of the side frames;

a non-rotary belt receiver disposed at the other end of the side frames, and

an endless feed belt, having feed pins for feeding correspondingly apertured paper, disposed between the side frames and set over the driving sprocket and the belt receiver with a predetermined slack, the feed belt being circulated by rotation of the driving sprocket;

wherein the counter feed side of the paper feed apparatus has a feed belt support, adapted to support the feed belt by directly and constantly contacting the outer surface of, or the feed pins on, the linear travelling portion of the counter paper feed side of the feed belt, so that, in use, the feed belt support prevents gathering of the feed belt, which would otherwise occur due to the slack thereof, along the linear travelling portion on the counter paper feed side thereof so as to reduce friction between the non-rotary belt receiver and the feed belt.

2. A paper feed apparatus as claimed in claim 1,



wherein the feed belt support is integrally and non-movably fixed to one or both side frames.

3. A paper feed apparatus as claimed in claim 1, wherein the feed belt support is integrally and non-movably fixed with an auxillary frame fitted to said side frames.

4. A paper feed apparatus as claimed in claim 1, 2 or 3, wherein the feed belt support comprises a pair of supports, arranged longitudinally and face to face along the middle of the lower edges of the side frames so as to support the feed belt.

5. A paper feed apparatus as claimed in claim 1, 2 or 3, wherein the feed belt support is disposed longitudinally along the full length of the lower edges of the side frames and supports feed pins of the feed belt.

6. A paper feed apparatus substantially as hereinbefore described with reference to, and as shown in, figures 1 to 5, figure 6, figures 7 and 8, figures 9 to 11, or figure 12, of the accompanying drawings.
