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(54) **Thin sheet feeding apparatus.**

(57) A rotating drum (29) employed in this thin sheet feeding apparatus sucks the topmost one of stacked thin sheets, shifts it to a predetermined position, and then feeds it in the tangential direction of outer circumference of rotating drum (29). A pair of belts (71, 72) running on both sides of tangential direction form a V-shaped area (74) which is wide at the side of receiving the thin sheets fed from the drum but becomes narrower as it advances toward the tangential direction, thus allowing the thin sheets fed from the drum (29) to be guided to a thin sheet holding portion (73) which is formed by belts (71, 72) and to be conveyed to a predetermined place with the thin sheets held in the thin sheet holding portion (73). All of pulleys (64, 66, 67) for guiding belts (71, 72) have diameters smaller than that of the rotating drum (29) and axes parallel to that (35) of the rotating drum (29), and are arranged eccentrically relative to the rotating drum (29). Belts (71, 72) are driven at a speed substantially equal to the maximum circumferential speed of the rotating drum (29).

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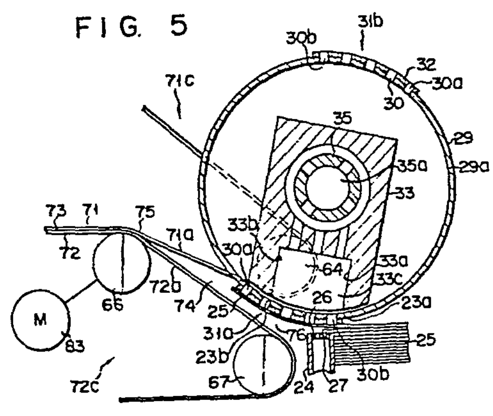

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Thin sheet feeding apparatus

The present invention relates to an apparatus for feeding thin sheets comprising a rotating drum arranged in a manner of facing the surface of topmost one of sheets of thin sheets stacked as a pile and rotating while repeating predetermined periodical, acceleration and deceleration, said drum having at least one suction area on the circumferential wall thereof where a plurality of suction holes are arranged to suck the topmost thin sheet; means for rotating the drum; negative pressure applying means for applying negative pressure to suction holes only when suction holes are positioned by the rotation of the drum between pre-determined suction starting and stopping points to suck and move the topmost thin sheet only by a predetermined distance and then to allow the topmost thin sheet to be fed in a predetermined direction; and belt conveyor means arranged axially on both sides of the drum and each of said belt conveyor means having a pair of belts for conveying thin sheets and a plurality of pulleys for defining the running paths of the belts, the running path being provided with a thin sheet holding portion where each thin sheet fed by the drum is held between the belts and conveyed to a predetermined place.

The thin sheet or sheet includes photographic film made of resin as well as one made of paper.

The sheets of various type, data cards, for example, are stored in a piled condition. For the purpose of using informations recorded on these cards is needed a device for picking up these cards one by one and feeding them to the reader. Figs. 1 and 2 show schematically a main portion of conventional thin sheet feeding apparatus. Numeral 101 represents a case whose upper end is opened and housing above the bottom thereof a pushing plate 103 always urged upwards by a spring 102. Sheets of paper, data cards, for example, are piled on the pushing plate 103 in the case 101. The right upper end of case 101 is provided with a stopping edge 105 and the topmost one of data cards piled on the pushing plate 103 is usually held at a certain position by the action of the stopping edge 105 and the spring 102. Above the left side of the case 101 is arranged, not contacted, a rotating cylindrical drum 106 with its both ends closed and its rotating axis crossing perpendicular to the surface of the drawing Fig. 1. Two suction holes 107 are formed opposite to each other in the circumferential wall of the drum 106 and a suction nozzle 108 having a suction chamber 108a adjacent and opposite to the inner face of the drum 106 is arranged in the drum 16 to be stationary relative to the case 101, as shown in Fig. 2. The suction nozzle 108 is communicated with a suction pump (not shown). Above the left side of the case 101 and below the drum 106 is arranged an ejection nozzle 109 communicated with a discharge pump (not shown) and air is ejected through the ejection nozzle 109 to the side of the data cards stacked. A shielding member 110 is arranged adjacent to the ejection nozzle 109 and extending to the drum 106 and the space between the shielding member 110 and the drum 106 is set to have a value larger than the thickness of one sheet of the data card but smaller than that of two sheets thereof. Above the left side of case

101 and adjacent to the drum 106 are further arranged conveyor belts 111 and 112 which run substantially in upward and downward directions and which are stretched around respective groups of pulleys including guide pulleys 111a and 112a. Pulleys 111a and 112a are positioned in such a way that running belts 111 and 112 are partially overlapped with each other to form a data card holding portion 113 where data cards are successively held and fed between overlapped running belts 111 and 112.

When the drum 106 is rotated in the direction shown by an arrow and a suction pump and a discharge pumps are operated, the left end portion of the topmost data card is sucked by the drum 106 every time when either of suction holes 107 formed in the drum 106 comes to the front of suction chamber 108a of suction nozzle 108, that is, when either of the suction holes 107 comes above the left end portion of the topmost data card 104, so that the data card 104 sucked is shifted to the left by the rotation of the drum 106. The card shifted is held between belts 111 and 112 and fed to the card reading device, for example. Even if the drum 106 sucks two or more sheets of data card, the shielding member 110 serves to cause only the topmost one to be shifted.

This conventional device is useful but still has something to be improved. Namely, the positioning of shielding member 110 is difficult. Since the topmost data card is shifted to the position of belts with its front end portion only sucked, the front end portion of the data card must be kept sucked until the reliable shift of the card to the belts is attained. Therefore, if the opening of suction nozzle 108 facing the inner face of drum 106 is made large and the amount of air leakingly entering from outside into the suction chamber 108a becomes large the degree of vacuum inside the suction chamber 108a is reduced, thus making it impossible to suck and shift data cards when high speed feeding of the data cards is intended, for example. In addition, since the data card is sucked only at the front end portion thereof, the other portion thereof is left free and vibrated to cause positional displacement in the horizontal direction and sound at the time of high speed shift. Further, the data card is held between belts 111 and 112 after the front end portion of data card is released from the outer circumference of the drum 106 and dropped onto the belt 112, so that the front end portion of the data card is bent or rumpled when dropped onto the belt 112 to thereby cause jam.

To overcome these drawbacks, it is proposed that a plurality of suction holes 107 are respectively arranged at areas spaced from each other to have an angle of 180°. It is also proposed that the running way of one of belts 111 and 112 is changed to form a V-shaped area which defines a skirt portion progressively narrowing toward the data card holding portion 113 so as to smoothly guide and feed the data card sucked by the drum 106 to the data card holding portion 113. However, because the pulley 111a for guiding the belt which is changed in its running path to form the skirt portion is attached around the outer circumference of the drum itself or the outer circumference of bearing portion of drum or the outer wheel of roller bearing is employed as the pulley 111a, for example, the device thus formed is not suitable for high speed operation. In addition, the roller bearing or the like employed as the pulley inevitably becomes bulky and obstacles such as dust generated from the sheets are allowed to easily enter into the comparatively wide clearance between outer and inner wheels, thus causing accidents often. Accordingly, it has been desired that a device for conveying thin sheets and capable of overcoming these drawbacks is developed.

The object of the present invention is to provide an apparatus for feeding thin sheets and capable of reliably sucking and shifting the sheets one by one at a predetermined pitch without causing any of the sheets to be bent at the front end portion thereof, jam, positional displacement and vibration sound to be occurred even at the time of high speed operation.

To attain this object in an apparatus of this invention the above-mentioned belts have first and second running sections which form a V-shaped area for receiving the thin sheet fed from the drum and guiding it to the thin sheet holding portion; that the first and second running sections form a wide skirt portion on the side of receiving thin sheets and a tip portion which becomes narrower as it comes nearer to the thin sheet holding portion, and that the pulley for defining the first running section to form the skirt portion has a diameter smaller than that of said drum and an axis parallel to that of the drum and is arranged eccentrically relative to the drum, the axis is a different one arranged independently on that of the drum.

When the apparatus of the present invention having such an arrangement as described above is used, many advantages are obtained.

First, the small size of the pulley produce some successive good results that the bearings of the pulley is also small, that grease in the bearing does not break out of the bearing because of the small centrifugal force applied to the pulley, therefor the apparatus of this invention comes to be adapted for high speed operation, that the load of the bearing is decreased; and that as the circumferential length is short, incoming dust from the outside is prevented resulting the apparatus to be suitable for high speed operation.

Second, the fact that the pulley has a different and independently arranged shaft produce some good effects that in case of interchanging the construction parts of the pulley, easy interchange of the parts accordingly easy inspection, maintenance and assembly of the pulleys defining the V-shaped area is obtained without a process of disassembling the unrelated construction member such as the drum.

Third, in this apparatus as the V-shaped area is provided and the traveling speed of the belt is determined higher than that of the periphery of the drum, crumples of the sheet supplied into the V-shaped area are smoothed by the rubbing up action of the belts until the thin sheet is pulled into the data card holding portion thereby bending and vibration of the data card is effectively prevented.

This invention can be more fully understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

Fig. 1 is an explanatory view showing a main portion of conventional thin sheet feeding apparatus;

Fig. 2 is a sectional view taken along a line 2-2 in Fig. 1;

Fig. 3 is a front view showing a thin sheet feeding apparatus according to the present invention;

Fig. 4 is a sectional view taken along a line 4-4 in Fig. 3;

Fig. 5 is a sectional view taken along a line 5-5 in Fig. 4;

Fig. 6 is a sectional view taken along a line 6-6 in Fig. 4;

Fig. 7 is a sectional view taken along a line 7-7 in Fig. 3;

Fig. 8 is a graph showing relations between the rotating angle θ of a planetary-type gear shown in Fig. 6 and the rotating speed H of the drum and between the rotating angle θ of planetary-type gear and the rotating acceleration K of the drum;

Figs. 9A to 9E show how the topmost sheet is sucked from the pile of the thin sheets and fed by the drum to the sheet holding portion; and

Figs. 10, 11 and 12 show various positions of pulley for positioning the running paths of belts to form the V-shaped area.

An embodiment of the present invention will be now described with reference to the drawings.

Fig. 3 is a view showing a main portion of an embodiment of the thin sheet feeding apparatus according to the present invention.

Numeral 15 represents a frame, to which upper and lower bearings 16a and 16b, opposite to each other, are fixed through support members. A screw rod 17 is freely rotatably supported by these bearings 16a and 16b. The upper end portion of screw rod 17 is connected to the rotating shaft of a motor 19 through a speed reduction mechanism 18. A nut 20 is threaded onto the screw rod 17 and to this nut 20 is horizontally fixed a table plate 21 on which thin sheets such as data cards 25 are stacked. Above the table plate 21 is arranged a position detector 22 consisting of a limit switch or the like, which applies an off-signal when the topmost one of data cards stacked on the table plate 21 contacts with the position detector 22 but an on-signal when not contacts. The motor 19 is rotated by the on-signal so as to elevate the nut 20 in the direction shown by an arrow. Therefore, the topmost data card is always kept to a certain level. The motor 19 is controlled by external operation to be reversed and stopped selectively.

On the left side of the table plate 21 is arranged a suction cylinder 24 of rectangular shape to define the left side of the data cards 25 stacked on the table plate 21. The upper end of suction cylinder 24 is positioned substantially same level as the topmost data card 25 and closed by a plate 26 as shown in Fig. 7. The plate 26 is provided with suction holes 27 which are arranged in five lines and three columns, for example. The lower end of suction cylinder 24 is connected to a suction pump P1. On both upper sides of the suction cylinder 24 are arranged a pair of ejection cylinders 28a and 28b with the upper portion of suction cylinder 24 and the left end portion of stacked data cards 25 interposed therebetween. Each of walls of ejection cylinders 28a and 28b facing stacked data cards 25 is provided with ejection nozzles H which are arranged in a line in the direction in which data cards 25 are stacked. Ejection cylinders 28a and 28b are connected to a compressor C1.

Above the left end portion of the table plate 21, that is, above the suction cylinder 24 is arranged a rotating drum 29 with its axis crossing transversely and perpendicular to the surface of the drawing (Fig. 3). The rotating drum 29 is rotated in the direction shown by an arrow and formed to have a width smaller than that of the data card 25 as shown in Fig. 4. Friction members 32 are respectively fixed on the outer circumference 29a of the drum 29 at two positions spaced by 180 degrees from each other as shown in Fig. 5. A plurality of suction holes 30 are distributed axially and along the outer circumference of the drum 29 passing through each of friction members 32 and the circumferential wall 29a of the drum 29, said suction holes 30 being arranged in a matrix and forming a group of suction holes at two positions, respectively. Friction members 32 are made of rubber, plastics or the like which has a large coefficient of friction relative to the data cards 25. Areas where suction holes 30 are formed will be hereinafter referred to as suction areas 31a and 31b, and suction holes 30 bored at most leading position with respect to the rotating direction of the drum 29 will be hereinafter referred to as a front end suction hole 30a while suction holes 30 at most lagging position will be hereinafter referred to as a back end suction hole 30b.

As shown in Figs. 4 and 5, a suction nozzle 33 is stationarily housed in the drum 29. The suction nozzle 33 has a suction chamber 33c which is opened adjacent to the inner face of a circumferential wall 29a of the drum 29. The width of the suction chamber 33c in the rotating direction of the drum 29 is defined by a suction start wall 33a and a suction stop wall 33b which extend substantially parallel to each other toward the circumferential wall 29a. Points at which straight lines extending from the suction start wall 33a and the suction stop wall 33b cross the inner circumferential wall 29a will be hereinafter referred to as suction start point 23a and suction stop point 23b, respectively. The suction start point 23a is positioned 3 - 8 mm remote from the left side end of the stacked data cards 25 in a direction reverse to the rotating direction (which will be hereinafter referred to as positive direction) of the drum 29. The suction stop point 23b is also positioned to be on a side reverse to the positive direction from a point at which a belt 71, which will be described later, crosses the circumferential wall 29a of the drum 29.

Providing in the drum 29 and the suction nozzle 33 positioned as described above that the circumferential length along which the inner face of circumferential wall 29a of the drum 29 is moved during a time period when all of suction holes 30 in a group pass from the suction start point 23a to the suction stop point 23b is ℓ_1 mm, the whole circumferential length of rotating drum 29 is L mm and the radius ratio of a sun gear 48 to planet gears 49, 50 is n, the relation between the circumferential length ℓ_1 mm and the length ℓ_2 mm along the inner face of the drum 29 from the suction start point 23a to the suction stop point 23b is designed as follows:

$$\frac{1}{4}\,\frac{L}{n} \leq \ell_1 \leq \frac{5}{12}\,\frac{L}{n}$$

$$\frac{1}{2}\,\frac{L}{n} + 3 \leq \ell_1 + \ell_2 \leq \frac{1}{2}\,\frac{L}{n} + 8$$

This relation is a necessary condition under which rotating speed and acceleration of the drum shown in Fig. 8 are obtained.

The suction nozzle 33 is key-fixed to a fixed hollow shaft 35 and a cover 29b is attached by means of screws to the side of the suction nozzle 33 (see Fig. 4). To the left end of the fixed hollow shaft 35 is attached a sealing member 34 to close a hollow portion 35a of the shaft 35. The hollow portion 35a is communicated with a suction pump P2, which sucks air from outside through the hollow portion 35a, suction chamber 33c and suction holes 30 to achieve the suction of data cards.

As shown in Fig. 4, a housing 38 is freely rotatably fitted onto the fixed hollow shaft 35 through the bearings 36 and 37. The housing 38 includes a cylindrical portion 39 and a collar portion 40, and a pulley 41 is fixed by a key 41a on the outer circumference of the cylindrical portion 39. Around the pulley 41 is stretched a timing belt 79, which is driven by a motor 90. To the collar portion 40 is attached a planet gear mechanism shown in detail in Fig. 6. In the collar portion 40 are formed holes 42 and 43 symmetrically to the axial center line of the collar portion 40, and rods 46 and 47 are freely rotatably supported in holes 42 and 43 through bearings 44 and 45, respectively. Planet gears 49 and 50 which are engaged with the sun gear 48 are attached to rods 46 and 47, respectively. Flanges 51 and 52 are further attached to the rods 46 and 47, respectively, and have pins 53 and 54 each positioned on one of the pitch circles of the planet gears 49 and 50, respectively, as shown in Fig. 6. These pins 53 and 54 are eccentrically connected to a crank shaft 59, which is fixed to the drum 29, through connecting bars 55, 56 and pins 57, 58. The diameter of each of the planet gears 49 and 50 is set to be half the diameter of the sun gear 48 and the drum 29 is rotated by the rotation of planet gears 49 and 50 following the rotation of housing 38. Gears and members associated with these gears are formed in such a way that the drum 29 is temporarily stopped to such the topmost data card when its front end suction hole 30a arrives at a position corresponding to the left end portion of the topmost data cards 25 passing over the suction start point 23a and coming by 3 - 8 mm into the opening of the suction nozzle 33 (see Fig. 9A).

As shown in Fig. 4, a support member 61 extending from both sides of the drum 29 is attached to the frame 15 and two pulleys 64 arranged opposite to one and the other sides of the drum 29 respectively are attached to the support member 61 by means of bearings 62 and 63. Each shaft of the pulleys 62 and 63 is provided independently with the hollow shaft 35, wherein pulleys 62 and 63 are arranged coaxially with each other, but eccentrically with the hollow shaft 35. These pulleys 64 are arranged adjacent to the drum 29 and the distance between outer edges of two belts 71 which are stretched around pulleys 64, respectively, is set to be larger than the width of data card 25. Same thing can be said to belts 72 arranged opposite to belts 71. The diameter of the pulleys 64 is smaller than that of the drum 29, and pulleys 64 are arranged eccentric to the drum 29. With this embodiment, pulleys 64 are arranged to be in the outer circumference of the drum 29 when viewed in the axial direction of the drum 29.

Belt conveyor means 71c and 72c including a pair of belts 71 and a pair of belts 72, respectively, are arranged above and on the left side of the table plate 21 and on both sides of the drum 29. Belts 71 and 72 run in directions shown by arrows in Fig. 3 at a velocity approximately equal to the maximum circumferential velocity of the drum 29 and are overlapped with each other on the way or path of their run to form a thin sheet holding portion or a data card holding portion 73 where data cards 25 are successively held between overlapped belts 71 and 72 to be fed to a predetermined place. As shown in Fig. 5, the upper one 71 of the belts 71 and 72 is guided by pulleys 65, 64 and 66 to run on one side of drum 29, while the lower one 72 is guided by pulleys 67 and 66 to run on the left side of stacked data cards 25, and they are overlapped with each other on the pulley 66 to form the data cards holding portion 73. As already described above, the distance between outer edges of belts 71 and also the distance between outer edges of belts 72 are set to be larger than the width of data card 25, and each data card 25 fed by the drum 29 is conveyed with its both side portions held between overlapped belts 71 and 72 arranged on both sides of the drum 29. As shown in Fig. 3, the pulley 66 is driven by a motor 83 and the rotation of pulley 66 causes belts 71 and 72 to run. A V-shaped area 74 is formed by a first running section 71a of the upper belt 71 linearly running from the pulley 64 to the pulley 66 and a second running section 72a of the lower belt 72 linearly running from the pulley 67 to the pulley 66. The V-shaped area 74 has a sharp tip portion 75 and a skirt portion 76, said sharp tip portion being formed by overlapping both running sections 71a and 72a one upon the other on the pulley 66 and becoming wider in the direction reverse to the moving direction of data cards 25 to form the skirt portion 76 at which data cards 25 fed from the drum 29 are received. The area 74 is connected to the data card holding portion 73 at its sharp tip section 75 adjacent to the pulley 66. Sizes and positions of pulleys 64, 66 and 67 which define the V-shaped area 74 will be described in detail explaining the operation of this embodiment.

The apparatus of this embodiment is operated as follows: The motor 19 is driven to move the table plate 21 to its lowest position and data cards 25 are stacked on the table plate 21 as shown in Fig. 3. Motors 80 and 83 (see Figs. 3 and 4) are turned onto rotate the drum 29 and to start the running of belts 71 and 72 while, rendering suction pumps P1, P2 and the compressor C1 operative, the motor 19 is now reversely rotated to elevate the table plate 21. The suction pump P1 sucks air through suction holes 27 formed in the upper end face of suction cylinder 24 (see Fig. 7), the suction pump P2 sucks air through suction holes 30 and negative pressure applying means including the fixed hollow shaft 35 and the suction nozzle 33, and the compressor C1 ejects air through nozzles H of the ejection cylinders 28a and 28b. When the table plate 21 is elevated by the motor 19 and the topmost data card 25 is contacted with the position detector 22, the motor 19 is stopped to stop the upward motion of the table plate 21. Therefore, the topmost data card 25 is always kept to be at a certain level.

When the pulley 41 and then the housing 38 are rotated following the running of the belt 79 driven by the motor 80 in Fig. 4, this rotation is transmitted via rods 46 and 47 to planet gears 49 and 50. As the result, planet gears 49 and 50 revolve both round the sun gear 48 and on their own axes. Similarly, flanges 51 and 52 revolve both round the sun gear 48 and on their own axes. Pins 53 and 54 are attached to flanges 51 and 52 at those positions which correspond to the pitch circles of the planet gears 49 and 50 and connected to the crank shaft 59 through connecting bars 55, 56 and pins 57, 58, respectively. Therefore, the drum 29 rotates following the rotation of flanges 51 and 52 and stops temporarily every half rotation. The drum 29 rotates at the highest speed in the middle point between its temporary stops.

Providing now that the ratio of the radius of the sun gear 48 to the radius of the planet gears 49, 50 is n, the radius of planet gears 49 and 50 is b, the length of connecting bars 55 and 56 between pins 53 or 54 and 57 or 58 is ℓ, the length of the crank shaft 59 between the pin 57 or 58 and the center of the stationary shaft 35 is r, and the rotating angle of planet gears 49 and 50 round their rods 46 and 47 is θ, then angular velocity $d\phi/dt$ and angular acceleration $d^2\phi/dt^2$ of crank shaft 59 are expressed as follows:

$$\frac{d\phi}{dt} \cong \left[\frac{1}{n}(n+2)(1-\cos\theta) - \frac{(b^2\lambda-r^2+\ell^2)\sin\theta}{[4r^2\ell^2-(b^2\lambda-r^2-\ell^2)^2]^{1/2}}\right]\lambda^{-1}(n+1)\frac{d\theta}{dt}$$

$$\frac{d^2\phi}{dt^2} \cong \Big[n(n+1)(n+2)\lambda^{-2}\sin\theta$$

$$+ \frac{2(r^2-\ell^2)^3\lambda^{-2}-6b^2(r^4-\ell^4)\lambda^{-1}+2b^4(3r^2-\ell^2)-2b^6\lambda}{[4r^2\ell^2-(b^2\lambda-r^2-\ell^2)^2]^{3/2}}(n+1)^2\sin^2\theta$$

$$- \frac{(b^2\lambda-r^2+\ell^2)\lambda^{-1}}{[4r^2\ell^2-(b^2\lambda-r^2-\ell^2)^2]^{1/2}}(n+1)\cos\theta\Big]\left(\frac{d\theta}{dt}\right)^2$$

wherein $\lambda = (n+1)^2+1-2(n+1)\cos\theta$. On the other hand, providing that the radius of the drum 29 is R, velocity v and acceleration α of suction holes 30 formed in the circumferential wall of the drum 29 can be expressed as follows:

$$v = R\frac{d\phi}{dt} = R\frac{d^2\phi}{dt^2}$$

When shown by a graph plotting the rotation angle θ of planet gear 49 on the abscissa, velocity v and acceleration α of suction holes 30 are represented on the ordinate by H and K in Fig. 8.

The following relation between the rotation angle θ of the gears 49 and 50, that is, the rotation angle θ of rods 46 and 47 and the rotation angle φ of the drum 29 is established:

$$\phi = \tan^{-1}\frac{(n+1)\sin\frac{1}{n}\theta-\sin(1+\frac{1}{n})\theta}{(n+1)\cos\frac{1}{n}\theta-\cos(1+\frac{1}{n})\theta} + \cos^{-1}\frac{b^2[(n+1)^2+1-2(n+1)\cos\theta]+r^2-\ell^2}{2br[(n+1)^2+1-2(n+1)\cos\theta]^{1/2}}$$

Therefore, in the case of this embodiment in which the teeth ratio or gear ratio n relating to the sun gear 48 and the planet gears 49, 50 is 2, the drum 29 rotates half rotation (φ = 180°) when each of planet gears 49 and 50 rotates one rotation (the angle θ at which planet gears 49 and 50 rotate round their own axes equal to 360°). Accordingly, groups of suction holes 30 formed in the circumferential wall 29a of drum 29 at two opposite positions, is stopped, accelerated, decelerated and stopped according to the operation pattern shown in Fig. 8 during the half rotation of the drum 29. As shown in Fig. 8, curves H and K are asymmetrical with respect to the ordinate drawn at a point of θ = 180°, and the maximum value of velocity v of suction holes 30 is generated after passing the middle point (θ = 180°) between both stop positions θ = 0°, 360°). Therefore, suction holes 30 are slowly accelerated departing from the stop position to the highest velocity position and then relatively strongly decelerated to reach another stop position. As the result, by using the apparatus of the present invention 20% reduction of the highest velocity v is obtained as compared with the conventional mechanism in which velocity and acceleration curves are symmetrical with respect to the ordinate at the point of $\theta = 180°$. This reduction of acceleration prevents the sucked data card 25 from falling off the drum 29 because of its inertial force. Time loss caused by the reduction of acceleration can be compensated by the increase of deceleration. Therefore, the time during which a sheet of data card is shifted by the drum from the table plate to the belt conveying means is not increased. In Fig. 8, M is a point of intersection of the curve H and an ordinate correspond to $\theta = 180°$. At this point M data card 25 is delivered by hand from the drum 29 to the belts 71 and 72, and the peripheral speed of the drum 29 is approximately equal to the traveling speed of the belts 71 and 72.

As described above, it is arranged that the drum 29 is temporarily stopped when the front end suction hole 30a of the drum 29 advances 3 - 8 mm from the suction start point 23a in the positive direction. Therefore, the suction chamber 33c sucks air from outside through at least one suction hole 30 positioned within the range of 3 - 8 mm, and the left end portion of topmost one of stacked data cards 25 is stably and reliably sucked onto the outer circumference of the drum 29. A pair of ejection nozzles 28a and 28b arranged at the left upper end portion of data cards 25 stacked on the table plate 21 and eject air on both sides of the drum 29 (see Figs. 3 and 7) to separate the topmost data card from the other ones, so that the topmost data card 25 is easily sucked onto the outer circumference of the drum 29 and shifted in the left direction as indicated in Fig. 3. Even if the data card under the topmost one is about to move together with the topmost one because of some causes, the suction cylinder 24 has larger suction force relative to the lower data card, so that the lower data card is sucked onto suction holes 27 of suction cylinder 24 as shown in Fig. 7 and separated from the topmost one. Only the topmost data card 25 is therefore shifted following the movement of the drum 29. Since members 32 having a large coefficient of friction are attached to the outer circumference of the drum 29, no slide of data card 25 is caused on the outer circumference of the drum 29, thus allowing the data card 25 sucked by the drum 29 to be reliably shifted to the left at same speed as the circumferential speed of the drum 29.

Figs. 9A to 9E are views showing how the topmost data card 25 is sucked by the drum 29, shifted by the rotation of the drum, and held by the data card holding section 73. Only necessary main components are shown in these Figs. 9A to 9E. Figs. 9A to 9E show the front end suction hole 30a, back end suction hole 30b and some suction holes bored between the two holes 30a and 30b. Fig. 9A shows a condition where the rotation of the drum 29 is stopped at the position where the front end suction hole 30a advances 3 - 8 mm from the suction start point 23a, and the topmost one of data cards 25 is sucked at the left end portion thereof to the outer circumference of the drum 29. Fig. 9B shows a condition where the drum 29 with the data card 25 sucked through the front end suction hole 30a and the other ones starts to rotate in the direction shown by an arrow and is being accelerated. The data card 25 is not sucked by the back end suction hole 30b yet. The data card 25 sucked by the drum 29 is being shifted toward the sharp tip portion 75 of area 74 and between first and second running sections 71a and 72a which form the V-shaped area 74. Fig. 9C shows a condition where the drum is under acceleration, the front end suction hole 30a and successive some ones have passed through the suction stop point 23b. The data card 25 is not sucked at its front end and relatively long front end portion is separated from the drum 29 and in a free condition from the drum 29. The data card 25 is only sucked by the suction holes 30 which are passing across the suction chamber 33c. The front end portion of data card 25 left free now enters deeply into the area 74. In this state, the front end of the data card 25 contacts with the first and second running sections 71a and 72a. However, as the traveling speed of the running section 71a and 72a is higher than the circumferential speed of the drum 29, the front end of the data card 25 is rubbed up by the running section 71a and 72a for causing the crumples of the data card 25 to be smoothed out.

Fig. 9D shows a condition where the drum 29 is further rotate under acceleration, the back end suction hole 30b has passed over the suction stop point 23b and the suction of data card 25 by the drum 29 has been ceased. Under this condition, the data card 25 has already been nearest to the tip portion 75 of V-shaped area 74, and circumferential speed of the drum 29 has been reached to an almost equal value to the traveling speed of the belts 71 and 72, then the front end of the data card 25 is grasped by the belts 71 and 72. Therefore, even when the data card 25 is made free from the drum 29, it is smoothly held between first and second running sections 71a and 72a and fed to the data card holding portion 73. The planet gear mechanism 48a shown in Fig. 6 and including the sun gear 48, planet gears 49, 50, connecting bars 55, 56, crank shaft 59 and pins 53, 54, 57, 58 stops the rotation of drum 29 when the front end suction hole

30a advances 3 - 8 mm passing over the suction start point 23a, and then rotates the drum 29 under acceleration. The planet gear mechanism 48a also makes the rotation speed of drum 29 fastest at the same time when the back end suction hole 30b has passed over the suction stop point 23b and then decelerates the drum 29 to a position at which the drum 29 finishes its 180° rotation from the position shown in Fig. 9A and is stopped temporarily.

Fig. 9E shows a condition where the data card 25 is deeply fed into the data card holding portion 73 formed by belts 71 and 72 and only a part of its back end portion is left free in the V-shaped area 74. When the drum 29 is rotated by 180° from the position shown in Fig. 9A, the suction area 31b is moved above the next topmost data card 25 and the apparatus is brought under the condition shown in Fig. 9A to stat the shift of the next data card 25. Namely, the shift of data cards 25 is carried out every half rotation of drum 29.

When the area at which suction holes 30 are to be formed is elongated in the circumferential direction of the drum 29, the length of suction chamber 33c which is opened along the circumferential wall 29a of drum 29 can be shortened to reduce the amount of air leakingly entering into the suctionchamber 33c and to enhance the degree of vacuum in the suction chamber 33c.

As the pulley 64 defining a traveling path of the belt 71 which together with the belt 72 forms the V-shaped area 74 is designed to have a shaft different form the hollow shaft 35 of the drum 29 and to be positioned eccentrically with the drum 29, the pulley 64 may be formed with a diameter extremely smaller than that of the drum 29.

A table shown below explain difference of the performance of two pulleys. The pulley cooperate with a drum whose external diameter is of 130 mm. Numerals described in the column (I) shows a data when the pulley 64 is arranged eccentrically with the drum 29, and numeral in the column (II) shows a data when the pulley 64 is arranged coaxially with the drum 29. In the table, OD, ID and W represent outer diameter, inner diameter and width of the pulley 64 respectively. PRPM and PPS means a permisible rotation speed per minute and permissible peripheral speed of the pulley 64. PPS value is shown as a non dimensional value which is obtained from the division of

$$\frac{\text{Permissible peripheral speed (m/sec)}}{\text{Predetermined certain peripheral speed (m/sec)}}.$$

From the table, it is clearly understood that PPS of the pulley 64 described in the column (I) is six times larger than that of the PPS described in the column (II). Accordingly, table show the fact that by using the system corresponding to the column (I) a high speed thin sheet feeding apparatus can be obtained.

	(I)	(II)
OD (mm)	32	120.65
ID (mm)	15	101.6
W (mm)	13	13
PRPM (rpm)	13.60	1,000
PPS	3	0.5

According to the thin sheet feeding apparatus, which has been described in detail referring to the embodiment, the drum 29 can reliably suck thin sheets during its temporary stop. In addition, the rotation speed of drum 29 can be progressively accelerated until a sheet is held in the sheet holding portion and then quickly decelerated to stop. Therefore, sheets or data cards can be reliably fed to the sheet or data card holding portion without falling off from the drum 29 because of their inertial force and increasing the time during which the sheet or data card is picked up from the table plate 21.

The positional relation between the drum 29 and puleys 64, 66, 67 which is necessary to realize the operation of apparatus as shown in Figs. 9A to 9E is as follows in this embodiment. The position of pulley 64 having a diameter smaller than that of the drum 29, an axis parallel and eccentric with that of the drum 29, and being arranged in the circle of the drum 29 when viewed in Fig. 5 is set in such a way that the front end of the data card released from the drum 29 is inside the skirt portion of V-shaped area 74. In other words, the position at which the first running section 71a crosses the circumferential wall 29a of drum 29 in Figs. 9A to 9E is on the positive directional side of suction stop point 23b.

The position of pulley 66 is determined in such a way that when the condition as shown in Fig. 9D is established, namely, when the suction of data card 25 by the drum is completely stopped, the front end of data card is carried nearest to the sharp tip portion 75 of V-shaped area 74 at which first and second running sections 71a and 72a are overlapped with each other, and subjected to frictional action by both first and second running sections in the traveling direction.

The position of pulley 67 is set in such a way that the front end portion of data card 25 released from the drum 29 is already being frictionally supported by both opposite surfaces of first and second running sections 71a and 72a which form an extremely narrow angle at the tip porrtion 75 of V-shaped area 74, and that the data card 25 completely made free from the drum 29 is immediately held between the running sections 71a and

72a and fed to the data card holding portion 73.

Belt conveyor means 71c and 72c including pulleys 64, 66, 67 positioned as described above and belts 71, 72 are arranged axially on both sides of the drum 29 and serve to convey data cards fed from the drum 29 to the predetermined place. These belt conveyor means 71c and 72c allow the pulley 64 to be small-sized regardless of size of the drum 29 and the running speed of the belts 71 and 72 to be selected independently of rotation speed of the drum 29. Accordingly, drawbacks of conventional devices can be eliminated.

Although two suction areas 31a and 31b are arranged, opposite to each other, on the circumferential wall of drum 29, they may be one, three or more. The number of suction areas depends upon the radius ratio n between the sun gear and planet gears. Namely, when n = 2, it may be two, and when n = 3, it may be three. The position detector 22 (Fig. 3) for detecting the topmost data card is arranged in this embodiment and serves to keep the topmost data card at a certain level by driving the motor 19 by its output for controlling the level of the table plate 21 and whole data cards. However, it may be achieved by a spring and a stopper, said spring usually urging upwards thin sheets or data cards on the table plate and said stopper positioning the topmost data cards at a certain level.

The position of pulley 64 is not limited to the one employed in the above-described embodiment. It may be positioned, as shown in Fig. 10, partially projecting from the circumferential wall face of drum 29 toward the pulley 66 when viewed in the axial direction of drum 29. It may also be positioned slightly above the lower circumferential wall face of drum 29 as shown in Fig. 11. Pulleys 81 and 82 may be employed to guide the belt 71 to travel along a path extending in the back of the drum 29 as shown in Fig. 12. However, in any case of Figs. 10, 11 and 12, it is necessary that the first running section 71a or the line extending from the first running section 71a (Fig. 10) crosses the circumferential wall 29a of drum 29 on the positive directional side of suction stop point 23b. It is also necessary that the front end portion of the data card 25 is contacted with first and second running sections 71a and 72a just before all of suction holes 30 in a group pass over the suction stop point 23b and that the data card 25 is moved to the data card holding portion 73 due to the frictional force generated by its contact with first and second running sections 71a and 72a when it is made free from the drum 29.

Although the present invention has been described about the case where data cards are stacked upwards, it may be applied to the case where data cards are stacked in the direction perpendicular to the gravity direction.

Claims:

1. A thin sheet feeding apparatus including:

a rotating drum (29) arranged in a manner of facing a surface of topmost one of thin sheets stacked as a pile and rotating while repeating predetermined periodical, acceleration and deceleration, said drum (29) having at least one suction area (31a, 31b) on the circumferential wall (29a) thereof where a plurality of suction holes (30) are arranged to such the topmost thin sheet (25);

means (80, 79, 41, 48a) for rotating the drum (29);

negative pressure applying means (P2, 35, 33, 29) for applying negative pressure to said suction holes (30) only when said suction holes (30) are positioned by the rotation of said drum (29) between predetermined suction starting and stopping points (23a, 23b) to suck and move the topmost thin sheet (25) only by a predetermined distance and then to allow the topmost thin sheet (25) to be fed in a predetermined direction; and

belt conveyor means (71c, 72c) arranged axially on both sides of said drum (29) and each of said belt conveyor means (71c, 72c) having a pair of belts (71, 72) for conveying thin sheets (25) and a plurality of pulleys (64, 65, 66, 67) for defining the running paths of said belts, said running path being provided with a thin sheet holding portion (73) where each of the thin sheets (25) fed by said drum (29) is held between said belts (71, 72) and conveyed to a predetermined place;

characterized in that said belts (71, 72) have first and second running sections (71a, 72a) which form a V-shaped area (74) for receiving the thin sheet (25) fed from the drum (29) and guiding it to the thin sheet holding portion (73), that said first and second running sections (71a, 72a) forming a wide skirt portion (76) on the side of receiving thin sheets and a tip portion (75) which becomes narrower as it comes nearer to the thin sheet holding portion (73), and that the pulley (64) for defining the first running section (71a) to form the skirt portion (76) has a diameter smaller than that of said drum (29) and an axis parallel to that of said drum (29) and is arranged eccentrically relative to said drum (29), said axis is a different one arranged independently on that of the drum (29).

2. An apparatus according to claim 1 characterized in that the running speed of said belts (71, 72) is substantially equal to the circumferential speed of said rotating drum (29).

3. An apparatus according to claim 1 characterized in that said negative pressure applying means have a suction chamber (33c) which is arranged stationary in the drum (29), opened facing the inner face of the circumferential wall (29a) of said drum (29), and has negative pressure applied from a suction pump (P2), and that said suction chamber (33c) has suction start and stop walls (33a, 33b) parallel to each other and extending toward the circumferential wall (29a).

4. An apparatus according to claim 1 characterized in that said suction holes (30) in each of said suction areas (31a, 31b) are arranged in a matrix distribution in which the holes (30) are bored in circumferential directions and in axial directions.

5. An apparatus according to claim 1 characterized in that said means for rotating the drum (29) including a housing (38) arranged coaxially with the drum (29) and rotatably connected to the drum (29); a sun gear (48) fixed to the housing 938); a plurality of planet gears (49, 50) engaged with the sun gear and driven in such a way that they rotate both round the sun gear (48) and on their own axes; connection bars (55, 56) for connecting the eccentric positions of said planet gears (49, 50) to

that of said drum (29); and means (80, 79, 41, 38) for driving said planet gears (49, 50) at a constant speed.

6. An apparatus according to claim 5 characterized in that the highest value of circumferential speed of said drum (29) is set to be substantially equal to the running speed of said belts (71, 72).

FIG. 1

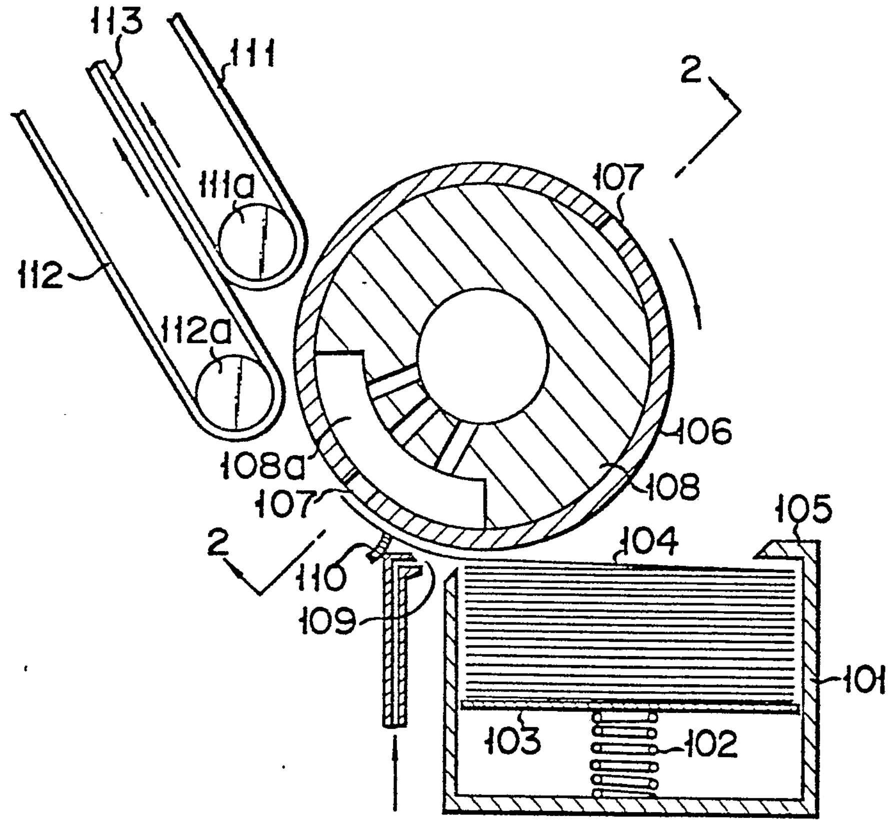

113
111
111a
112
112a
2
107
106
108a
107
108
105
104
2
110
109
101
103
102

FIG. 2

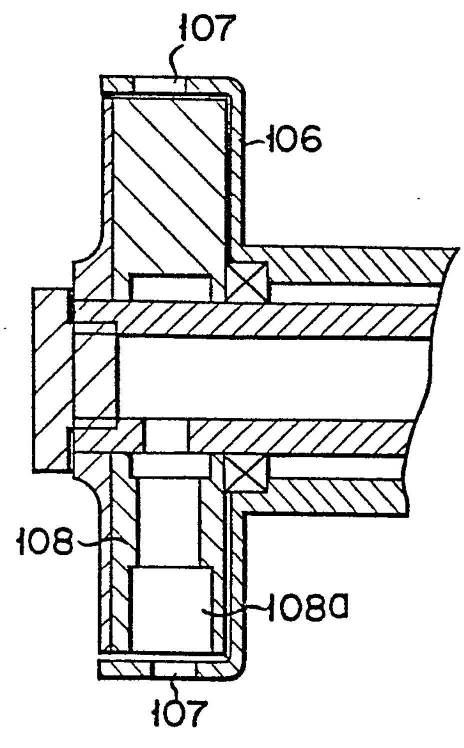
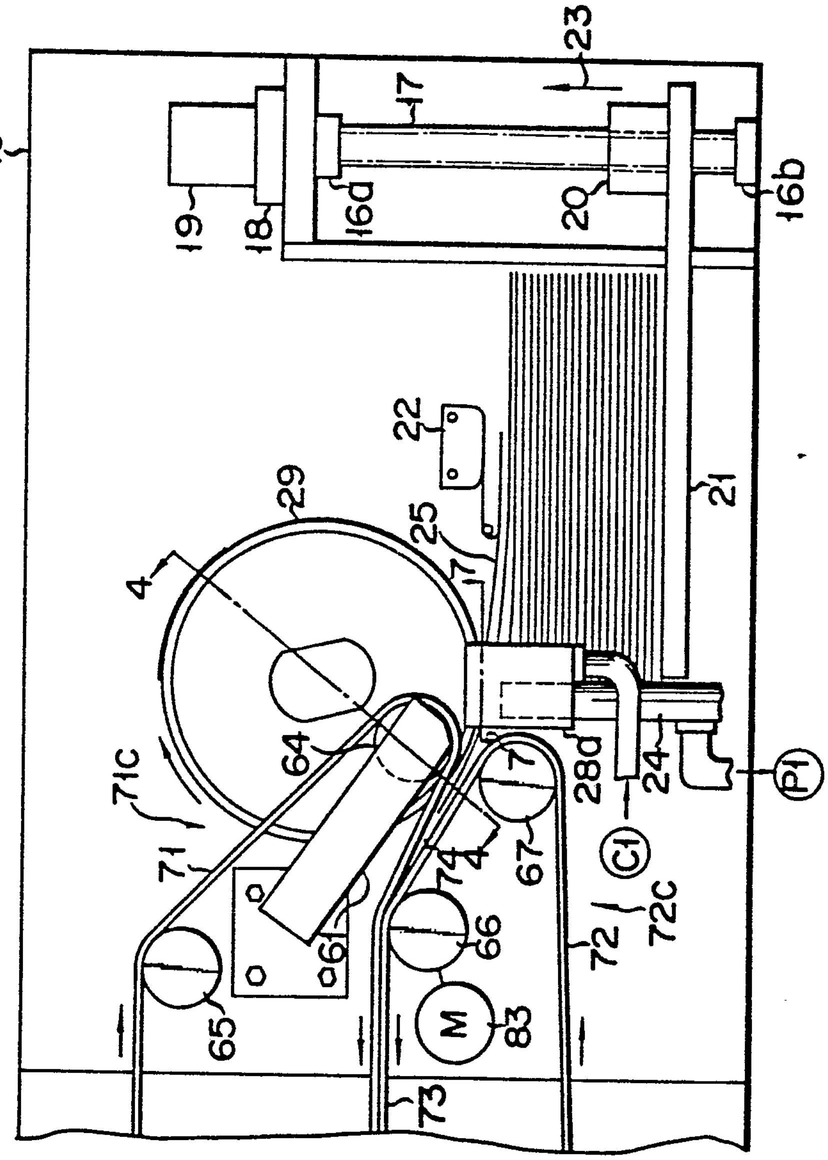

107
106
108
108a
107

FIG. 3


15
19
18
16a
17
23
20
16b
21
22
29
25
17
4
28a
24
P1
C1
71c
71
64
74
4
67
72c
72
66
6
65
M
83
73
7

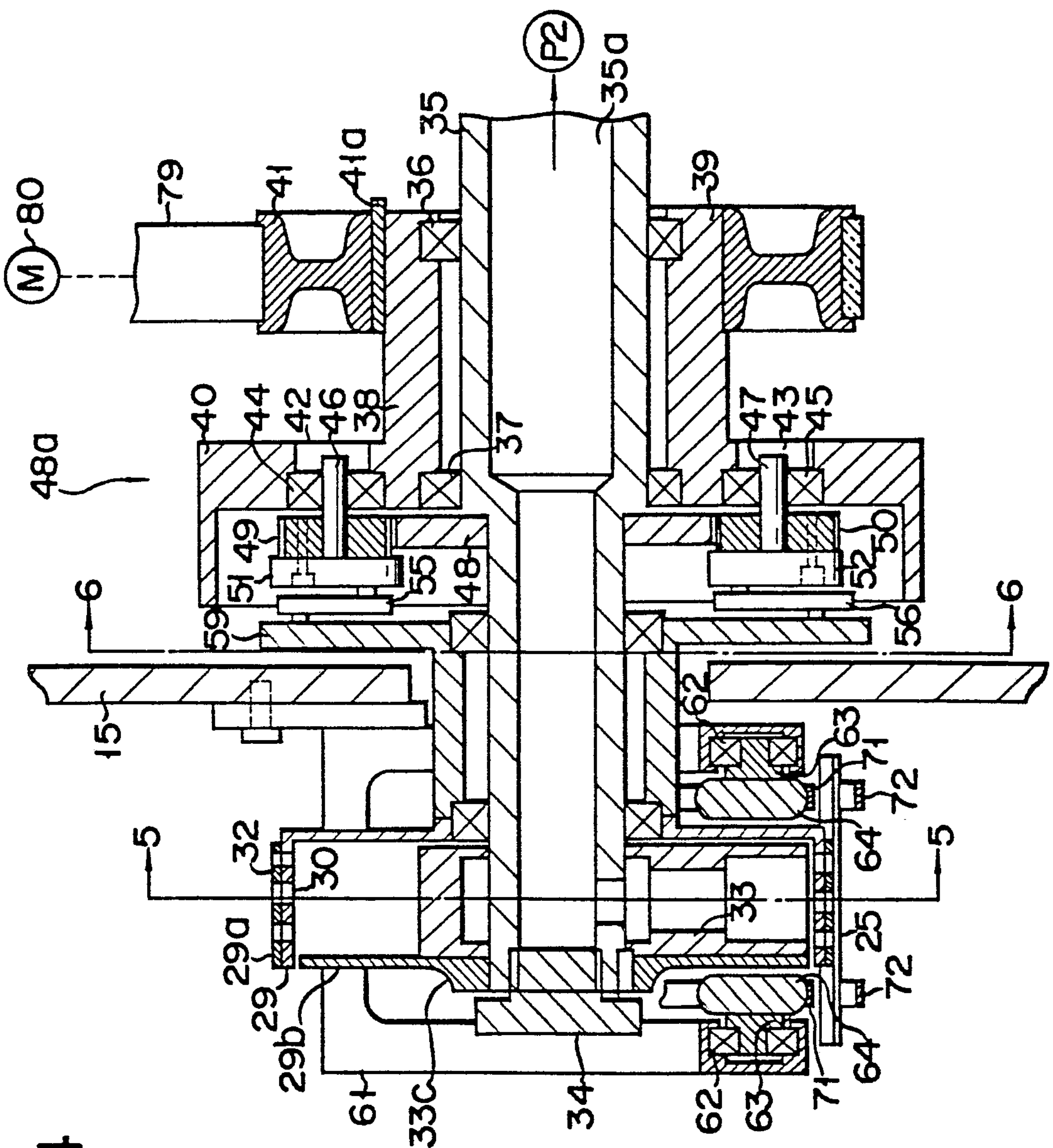

M
80
79
41
41a
36
35
P2
35a
39
40
44
42
46
38
37
47
43
45
48a
49
51
55
48
50
52
56
59
6
6
15
62
63
71
72
64
5
5
32
30
33
25
29a
29
29b
61
33c
34
62
63
71
72
64

FIG. 4

FIG. 5

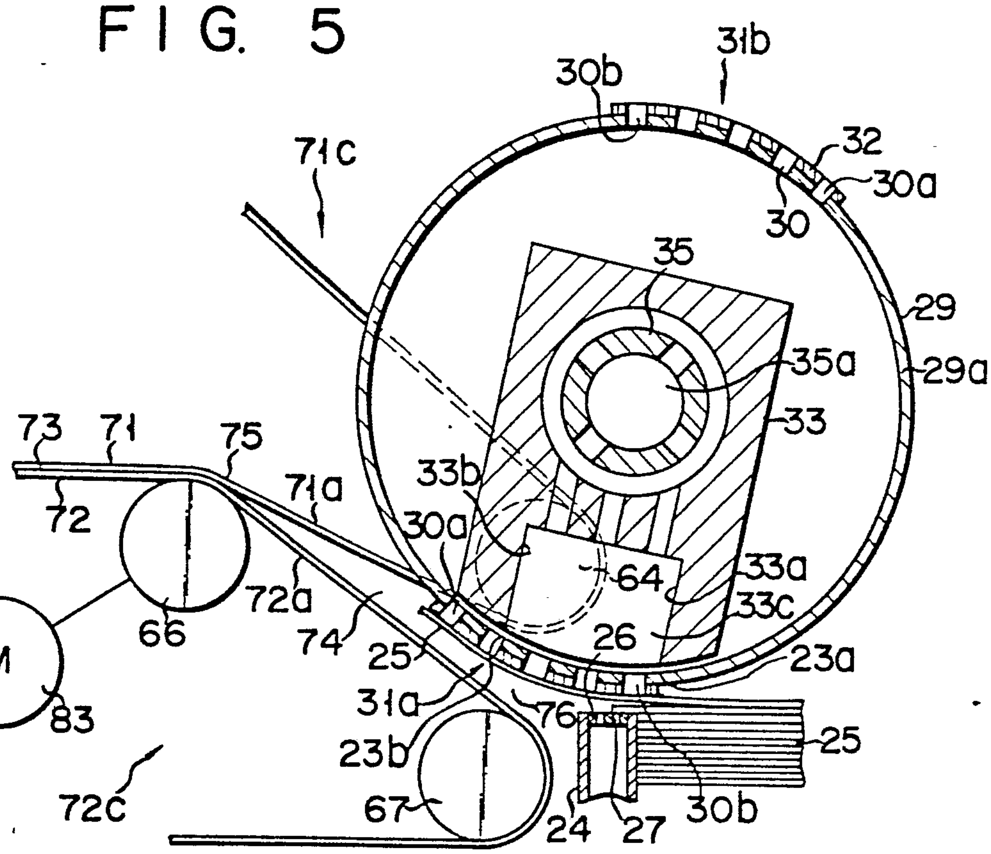

31b
30b
32
30a
71c
30
35
29
35a
29a
33
73
71
75
71a
33b
72
30a
33a
64
72a
33c
66
74
26
23a
25
M
31a
76
25
83
23b
67
72c
24
27
30b

FIG. 6

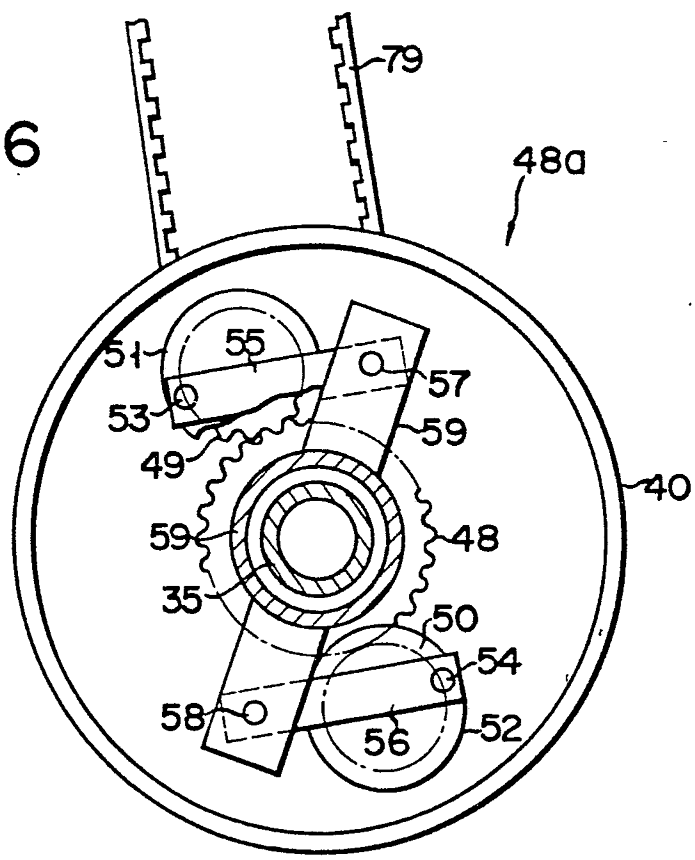

79
48a
51
55
57
53
59
49
40
59
48
35
50
54
58
56
52

FIG. 7

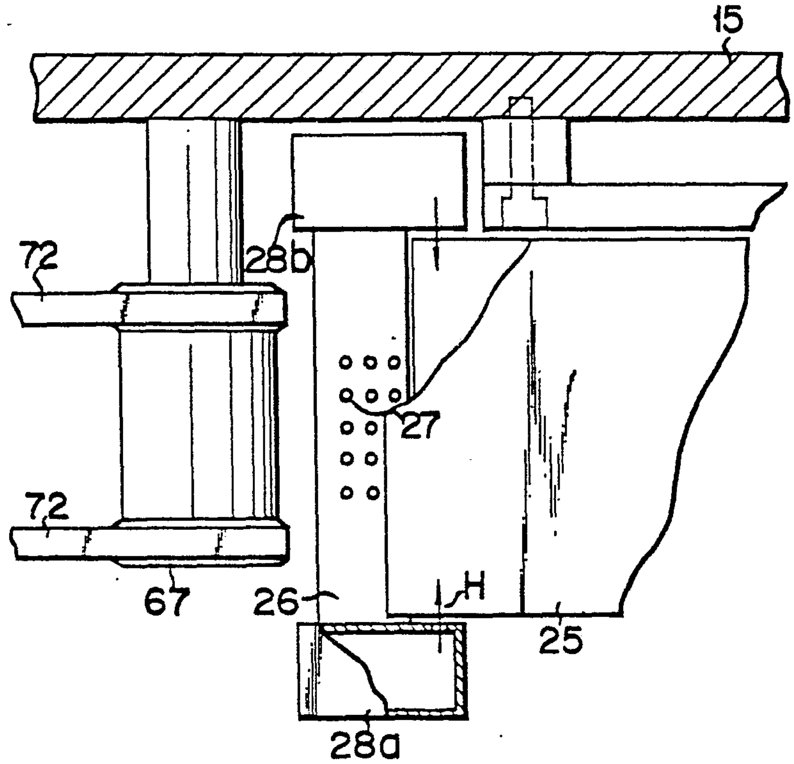

15
72
28b
27
72
67
26
H
25
28a

FIG. 8

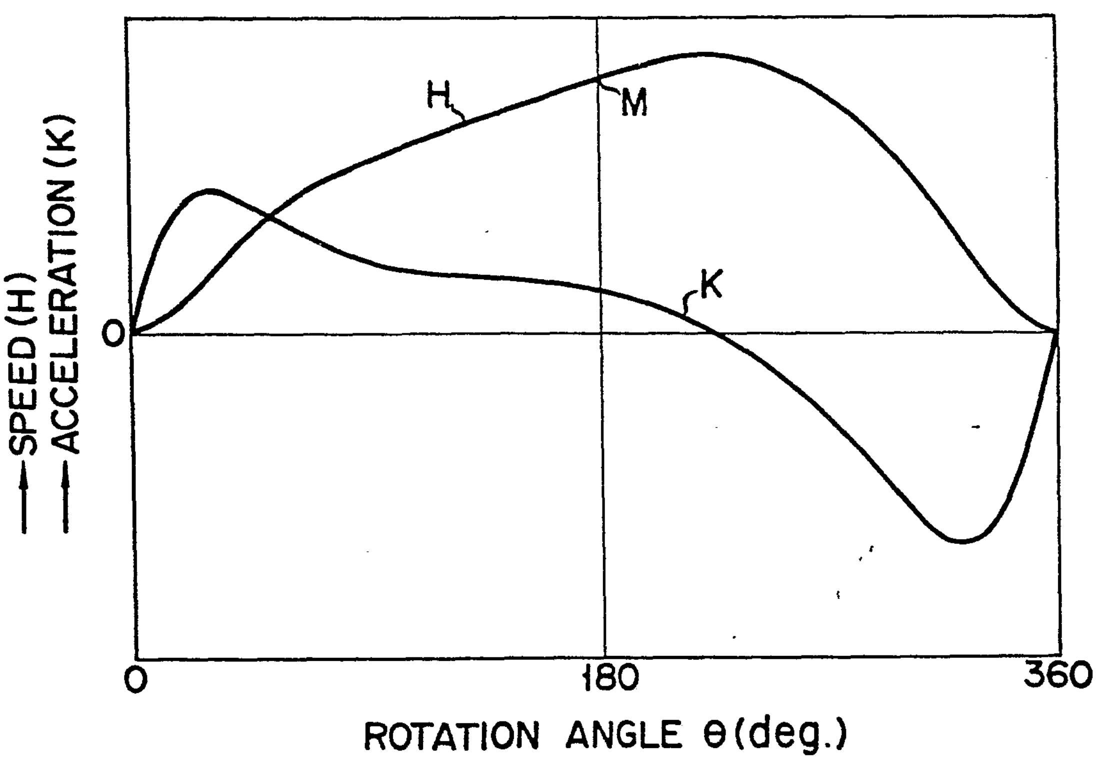

H
M
K
0
→SPEED (H)
→ACCELERATION (K)
0
180
360
ROTATION ANGLE θ(deg.)

FIG. 9A

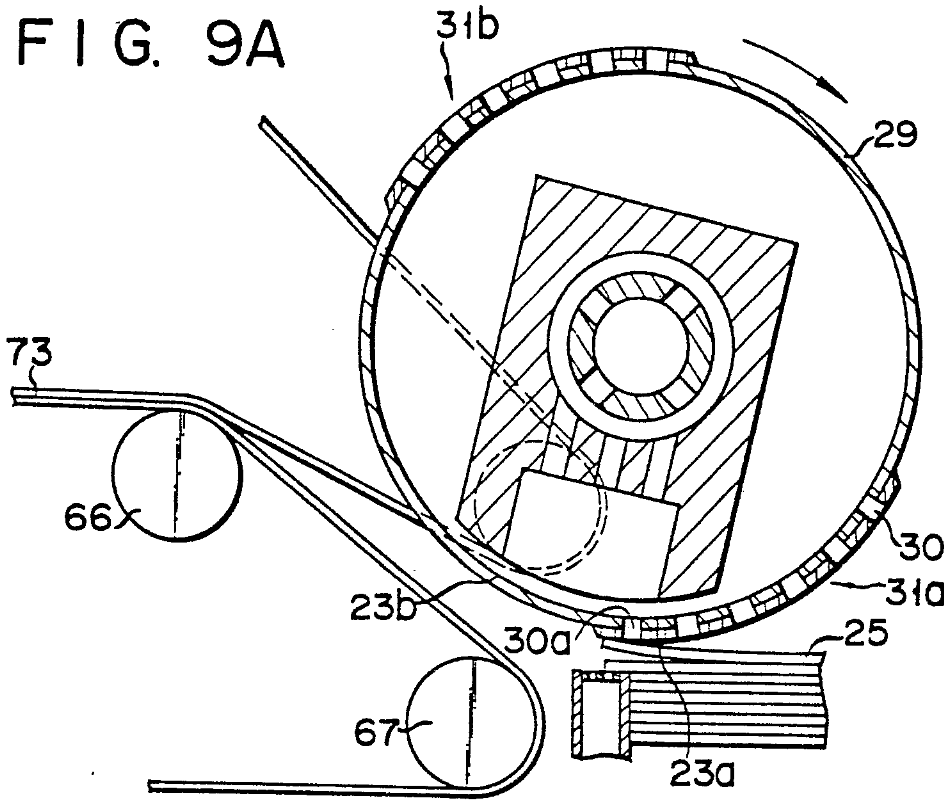

31b
29
73
66
30b
31a
23b
30a
25
67
23a

FIG. 9B

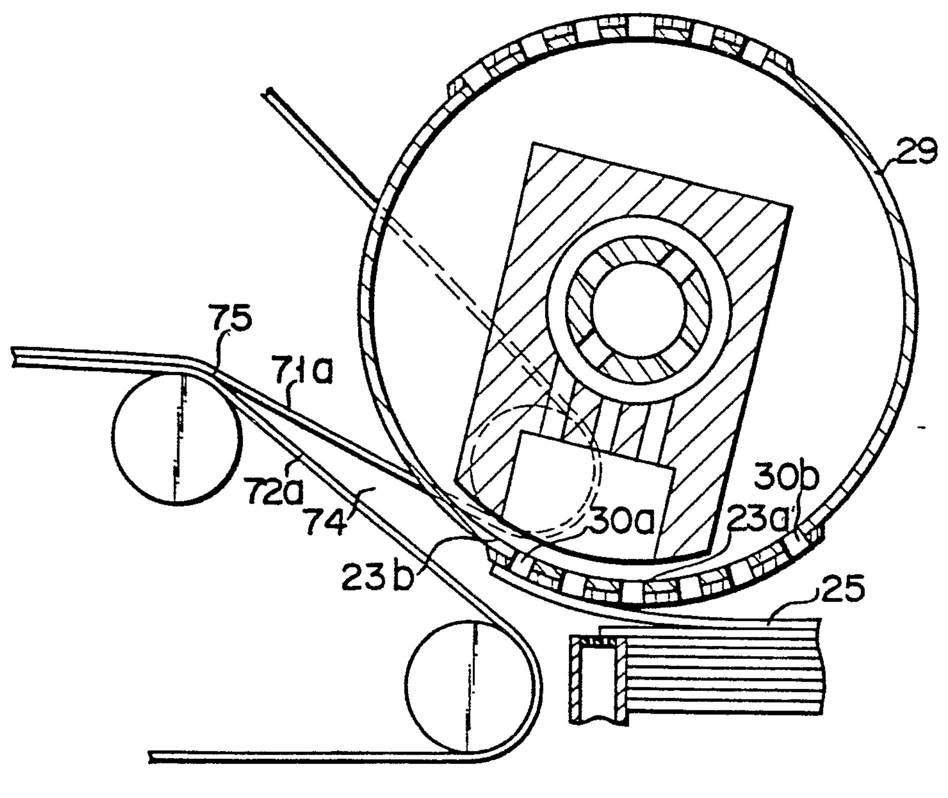

29
75
71a
72a
74
30a
30b
23a
23b
25

FIG. 9C

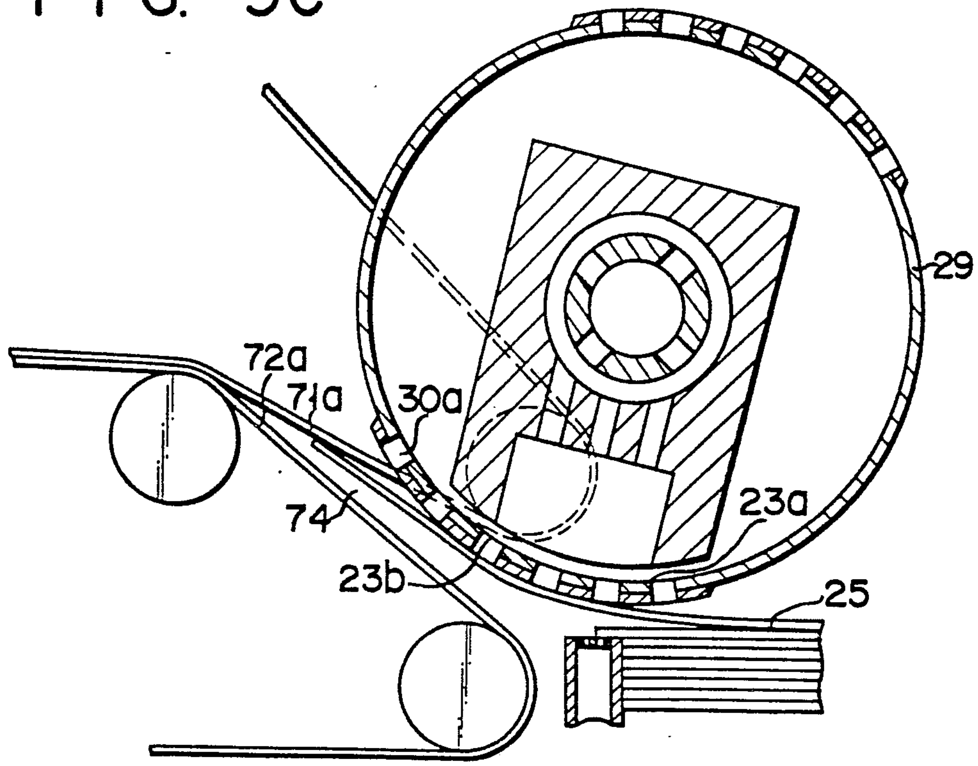


FIG. 9D

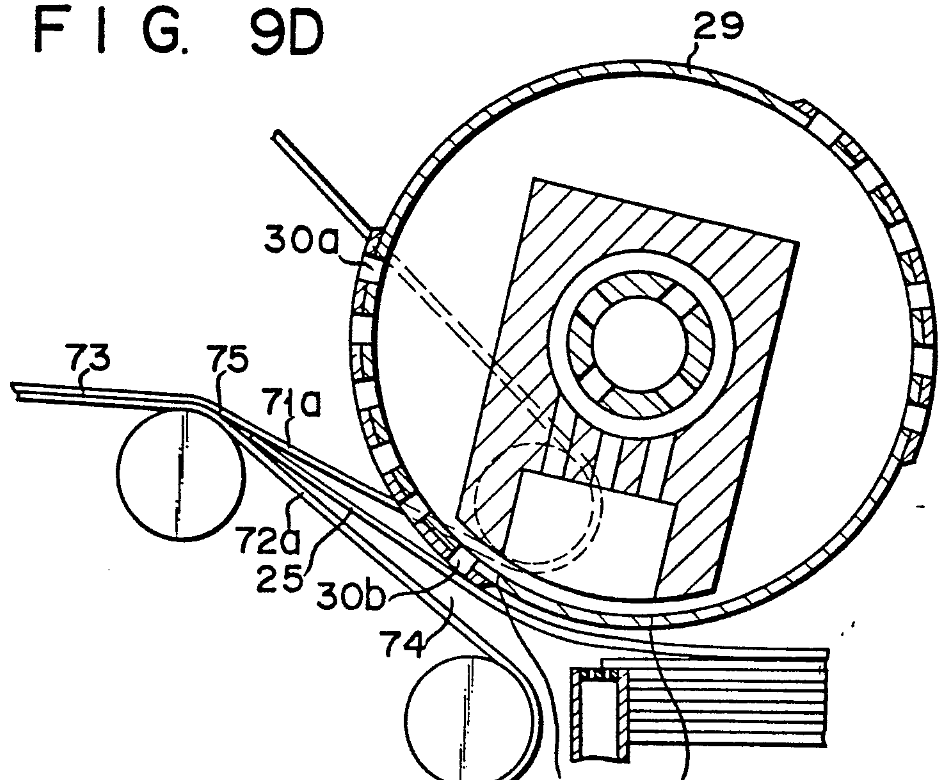


FIG. 9E

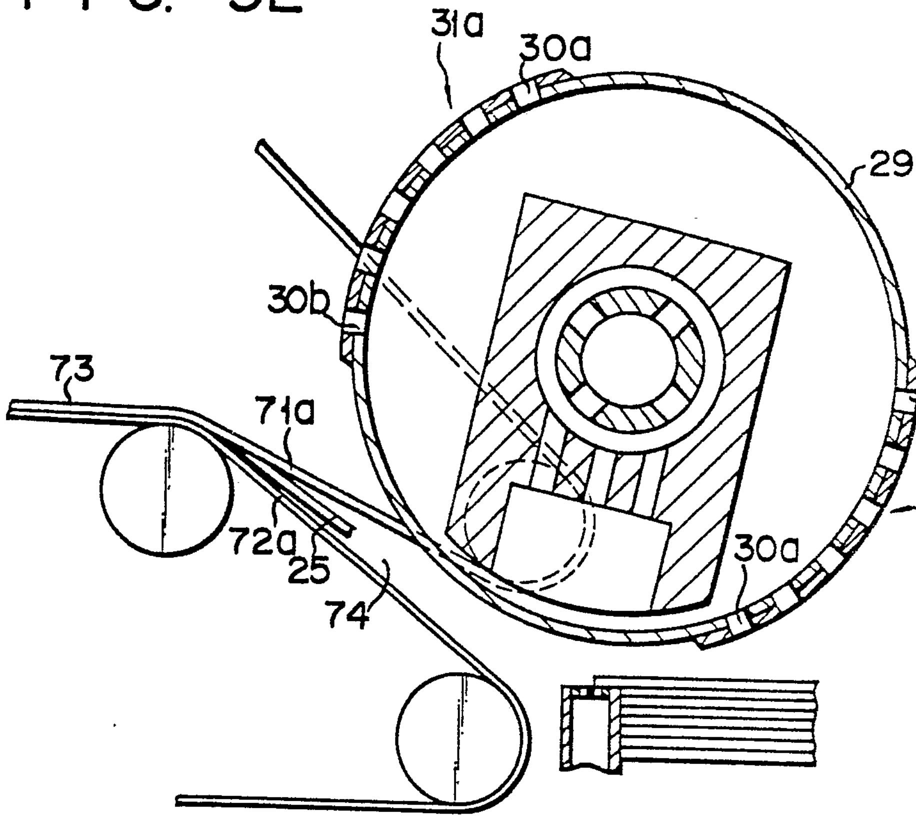

31a
30a
29
30b
73
71a
30b
72a
25
31b
30a
74

FIG. 10

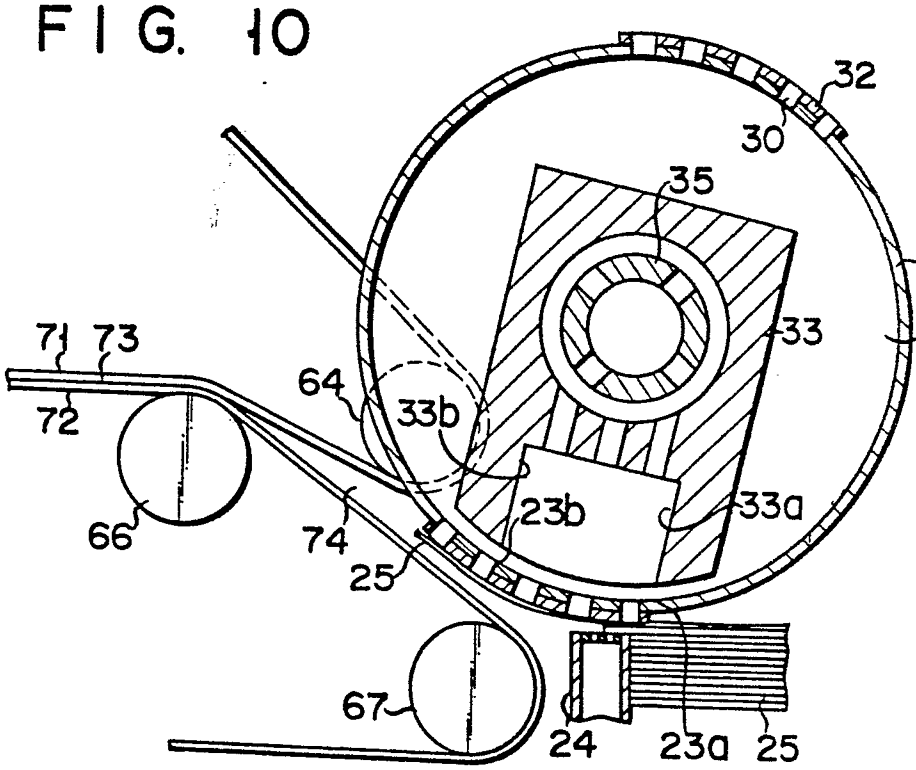

32
30
35
29a
71
73
33
29
72
64
33b
66
23b
33a
74
25
67
24
23a
25

FIG. 11

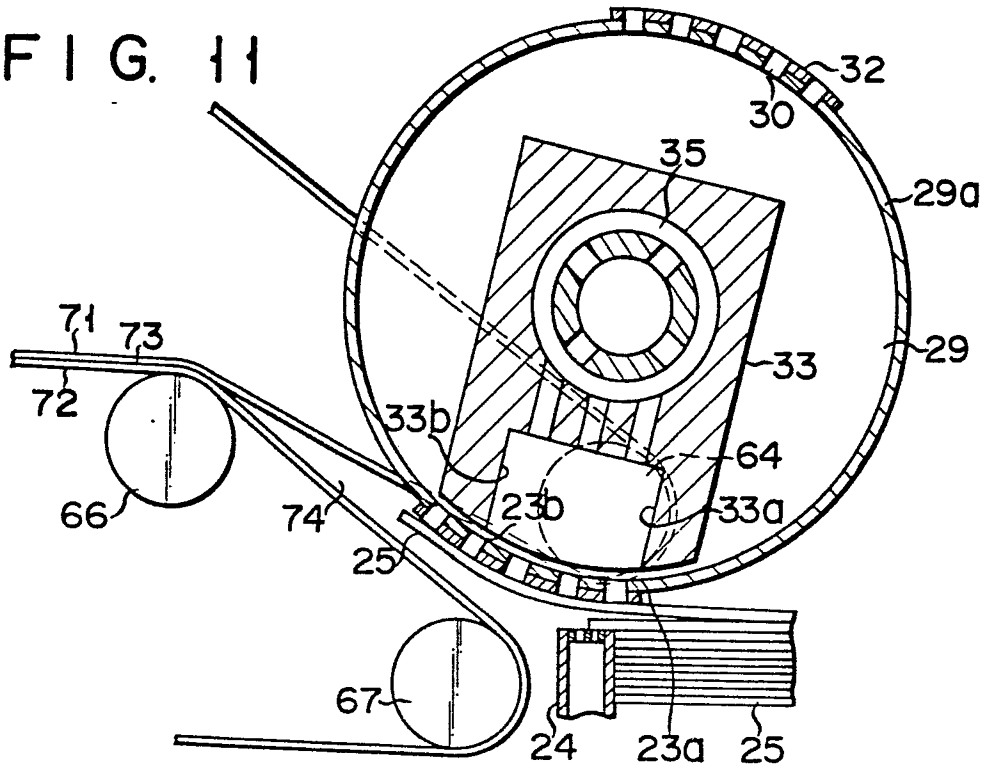
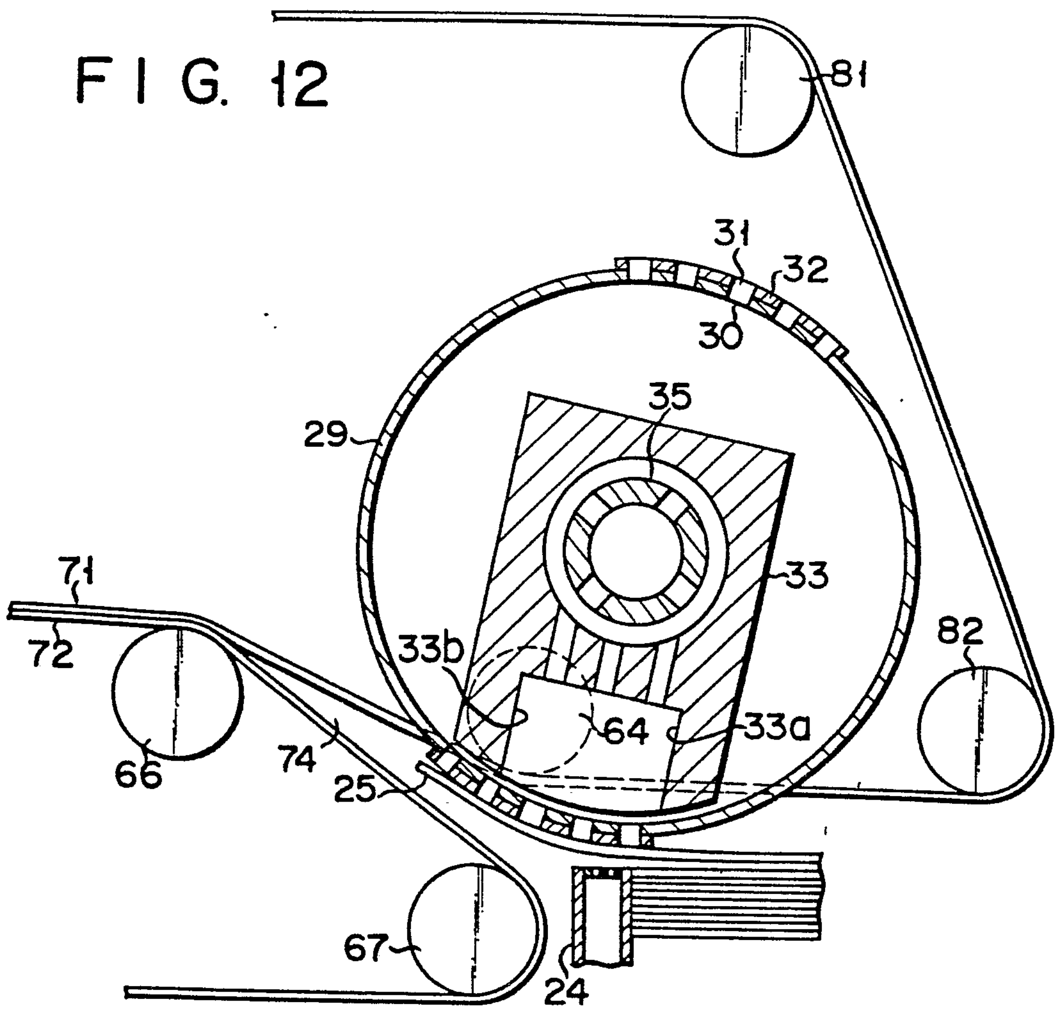

32
30
35
29a
29
33
71
73
72
33b
64
33a
23b
66
74
25
67
24
23a
25

FIG. 12


81
31
32
30
35
29
33
71
72
82
33b
64
33a
66
74
25
67
24

European Patent Office

EUROPEAN SEARCH REPORT

0047937

Application number

EP 81 10 6973.1

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
P	EP - A1 - 0 017 983 (TOKYO SHIBAURA DENKI) * fig. 4 *	1
A	US - A - 4 095 781 (KISTNER et al.)	
A	GB - A - 849 797 (IBM)	
A	DE - A1 - 2 926 136 (MARQUIP)	
A	DE - C - 1 007 340 (VEB FALZ- UND HEFTMASCHINENWERK LEIPZIG)	
A	DE - B - 1 273 541 (BELOIT CORP.)	

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

B 65 H 3/10

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

B 65 H 3/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
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P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Berlin	16-11-1981	KLITSCH

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