



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11)

EP 1 199 274 A2

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
24.04.2002 Bulletin 2002/17

(51) Int Cl.7: **B65H 27/00**

(21) Application number: **01124694.9**

(22) Date of filing: **16.10.2001**

(84) Designated Contracting States:
**AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU
MC NL PT SE TR**
Designated Extension States:
AL LT LV MK RO SI

(72) Inventors:
• **Yoshid, Yuma**
Kasugai-shi, Aichi-ken, 486-0838 (JP)
• **Wago, Yoshihiro**
Kani-shi, Gifu-ken, 509-0258 (JP)

(30) Priority: **16.10.2000 JP 2000314668**

(74) Representative: **Frankland, Nigel Howard**
FORRESTER & BOEHMERT
Pettenkoferstrasse 20-22
80336 München (DE)

(71) Applicant: **Tokai Rubber Industries, Ltd.**
Komaki-shi, Aichi-ken, 485-8550 (JP)

(54) **Sheet feed roller**

(57) A less expensive sheet feed roller of a non-ground surface type for use as a pickup roller or a sheet feeding roller in a sheet feeder. The sheet feed roller is virtually free from adhesion of paper dust during use thereby providing an excellent friction coefficient sustainability. The sheet feed roller comprises a roller body and a shaft extending axially through the roller body, the

roller body having a textured roller surface comprising a multiplicity of island portions (10) and a sea portion (11) recessed from the island portions, the island portions and the sea portion each having a multiplicity of fine projections (12). The ratio S_1/S_2 of the total area S_1 of the island portions to the area S_2 of the sea portion preferably is 0.25 to 0.70. The fine projections preferably each have a height of 3 to 25 μ m.

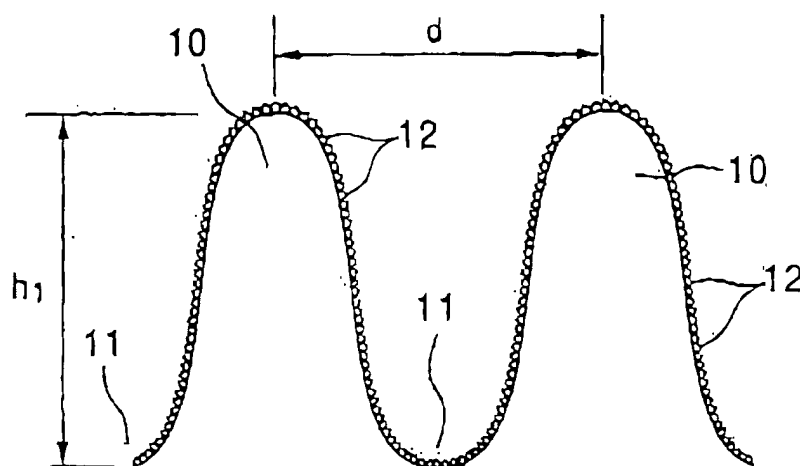


Fig. 1

Description**BACKGROUND OF THE INVENTION****Field of the Invention**

[0001] The present invention relates to a sheet feed roller for use in a sheet feeder of a copying machine, a facsimile machine, a printer or the like.

Description of the Art

[0002] In sheet feeders for use in a copying machine, a facsimile machine and a printer, sheets from a sheet tray are fed into a sheet separator by a pickup roller where the sheets are separated from each other and fed out on a one-by-one basis. The sheet separator of the sheet feeder is generally provided with a multiple-sheet-feeding prevention mechanism of an FRR (Feed and Reverse Roller) type or an FR (Friction Retard) type so that the sheets assuredly can be separated from each other for the one-by-one sheet feeding.

[0003] In a sheet feeder having a multiple-sheet-feeding prevention mechanism of the FRR type, as shown in Fig. 4, a pickup roller 3 feeds a sheet 1 from a sheet tray 2 into a sheet separator, where a retard roller 5 disposed in abutment against a sheet feeding roller 4 prevents multiple sheet feeding. When two or more sheets 1 are fed into the sheet separator, the retard roller 5 is not influenced by the friction of the sheet feeding roller 4, so that a friction torque applied to the retard roller does not reach the threshold of a torque limiter 6. Therefore, the retard roller 5 stops rotating, or rotates in a reverse direction, to stop excess sheets, such that only the uppermost sheet 1 is fed out in contact with the sheet feeding roller 4.

[0004] Exemplary materials for the pickup roller 3 and the sheet feeding roller 4 (hereinafter referred to generally as a "sheet feed roller") for use in the sheet feeder are rubber materials including olefin rubbers such as EPDM, natural rubbers, polynorbornene rubbers, urethane rubbers, and urethane foams. These rollers are generally produced by: (1) cutting a cylindrical roller body from a solid rubber material or urethane foam, inserting a metal shaft into the cylindrical roller body, and grinding the surface of the roller body; or (2) molding or foam-molding a cylindrical roller body around a shaft in a mold, and grinding the surface of the roller body.

[0005] Since the conventional sheet feed roller for use in the sheet feeder requires a grinding process in production thereof as described above, the costs of the grinding process account for a high percentage of the production costs, thereby preventing cost reduction. Therefore, attempts conventionally have been made to develop a roller requiring no grinding process in production thereof. One example of such a roller is a roller having a textured roller surface similar to the ground roller surface as proposed in Japanese Unexamined Patent Publication Nos. 5-221059 (1993) and No. 8-108591 (1996).

[0006] However, the textured surface of the conventional roller to be brought into contact with a paper sheet is like a mirror surface, so that paper dust generated during the sheet feeding does not easily slip away, but rather is liable to adhere on the surface of the roller. This adhered dust makes it difficult for the roller to stably maintain a sufficient friction coefficient during prolonged use.

[0007] In the production of the conventional textured surface roller (the non-ground surface roller), an interior surface of a mold for formation of the textured surface is subjected to a shot blasting process or a chemical etching process. However, the shot blasting process fails to produce deep undulations on the interior surface of the mold, and the chemical etching process merely produces relatively smooth undulations (pseudo-mirror surface) on the interior surface of the mold. Therefore, the conventional textured surface roller has a difficulty in providing a performance comparable to the ground surface roller. Even if the surface configurations resulting from the shot blasting process and the chemical etching process are employed in combination, it still is difficult to provide a roller having a satisfactory sheet feeding performance.

[0008] Since the conventional textured surface roller fails to offer a performance comparable to the ground surface roller, the ground surface roller is currently commercially employed as the sheet feed roller.

[0009] In view of the foregoing, it is an object of the present invention to provide a less expensive sheet feed roller of the non-ground surface type which is virtually free from adhesion of paper dust generated during sheet feeding and thereby has a long-term friction coefficient sustainability comparable to the ground surface roller.

SUMMARY OF THE INVENTION

[0010] In accordance with the present invention to achieve the aforesaid object, there is provided a sheet feed roller for use in a sheet feeder, which comprises a roller body and a shaft extending axially through the roller body, the roller body having a textured roller surface comprising island portions and a sea portion recessed from the island portions,

the island portions and the sea portion each having fine projections.

[0011] On the roller surface of the roller body of the inventive sheet feed roller, the ratio S_1/S_2 of the total area S_1 of the island portions to the area S_2 of the sea portion is preferably 0.25 to 0.70. The fine projections on the island portions and the sea portion preferably each have a height of 3 to 25 μm . Further, the island portions on the roller surface preferably each have a height of not smaller than 10 μm , and are preferably spaced from each other by a peak-to-peak distance of not greater than 1.0 mm.

[0012] In the present invention, the term "sheet feed roller" means a pickup roller or a sheet feeding roller for use in a sheet feeder, and the term is intended to exclude a retard roller employed for the prevention of multiple sheet feeding.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

Fig. 1 is a sectional view schematically illustrating the surface configuration of a sheet feed roller according to the present invention;

Fig. 2 is a sectional view schematically illustrating the surface of the sheet feed roller of Fig. 1 on a greater scale;

Fig. 3 is a schematic plan view illustrating a distribution of island portions in a sea portion on the surface of the sheet feed roller; and

Fig. 4 is a side view schematically illustrating a sheet feeder.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] As schematically illustrated in Fig. 1, a sheet feed roller according to the present invention has a textured roller surface which comprises a multiplicity of island portions 10 and a sea portion 11 recessed from the island portions 10. The island portions 10 and the sea portion 11 on the textured surface each have a multiplicity of fine projections 12. Fig. 2 illustrates a portion of an island portion 10 on the textured surface shown in Fig. 1 on a greater scale for easy understanding of the fine projections 12.

[0015] In the inventive sheet feed roller having the aforesaid surface configuration, as shown in Fig. 3, the area ratio S_1/S_2 of the total area S_1 of the island portions 10 to the area S_2 of the sea portion 11 on the textured surface preferably is $0.25 \leq S_1/S_2 \leq 0.70$. The total area S_1 of the island portions 10 and the area S_2 of the sea portion 11 are determined in the following manner. An ink or the like is applied onto the roller surface, and transferred from the roller surface onto a paper sheet with a load of 300 gf. Then, the total area of ink transferred portions on the paper sheet and the area of a blank portion on the paper sheet are measured by means of an image processing apparatus, and defined as S_1 and S_2 , respectively.

[0016] If the area ratio S_1/S_2 is smaller than 0.25, the resulting sheet feed roller tends to have a reduced total contact area with respect to a paper sheet and, hence, has a smaller initial friction coefficient and may have an insufficient sheet transporting ability. Therefore, a sheet feeding failure is liable to occur. On the other hand, if the area ratio S_1/S_2 is greater than 0.70, the resulting sheet feed roller tends to have an increased total contact area with respect to a paper sheet and, hence, may have a greater initial friction coefficient. Therefore, paper dust generated during the sheet feeding is less liable to slip away thus more likely to adhere on the roller surface, so that the roller may fail to maintain a sufficient friction coefficient. Thus, the roller initially provides a good sheet feeding performance, but may fail to stably ensure the sheet feeding performance during prolonged use.

[0017] Other requirements for the configuration of the roller surface are as follows. As shown in Fig. 2, the fine projections 12 preferably each have a height h ; of 3 to 25 μm ($3\mu\text{m} \leq h_2 \leq 25\mu\text{m}$). If the height h_2 is smaller than 3 μm , the roller surface tends to be like a mirror surface, so that paper dust is likely to adhere on the roller surface so as to significantly reduce the friction coefficient of the roller. On the other hand, if the height h_2 is greater than 25 μm , the roller surface tends to have an excessively great roughness and, hence, the resulting roller has a smaller initial friction coefficient and an insufficient sheet transporting ability.

[0018] As shown in Fig. 1, the island portions 10 on the textured roller surface preferably each have a height h_1 of not smaller than 10 μm as measured from the bottom of the sea portion 11 to the peak of the island portion 10. If the height h_1 is smaller than 10 μm , the resulting roller may not stably maintain a sufficient sheet feeding performance during prolonged use because the island portions 10 become worn down. Further, the height h_1 is higher than the height h_2 ($h_1 > h_2$).

[0019] The island portions 10 preferably are spaced from each other by a peak-to-peak distance d of not greater than 1.0 mm. If the peak-to-peak distance d is greater than 1.0 mm, the resulting roller tends to have insufficient strength (block rigidity) and, hence, tends to have an insufficient wear resistance. In addition, the island portions 10 are liable to deform, so that the resulting roller may fail to provide a stable sheet feeding performance.

[0020] The height h_1 and peak-to-peak distance d of the island portions 10 and the height h_2 of the fine projections

12 may be determined by means of a surface roughness meter.

[0021] With the configuration of the roller surface as described above, the inventive sheet feed roller has a friction coefficient sustainability comparable to the conventional ground surface roller, because paper dust generated during the sheet feeding is less likely to adhere on the roller surface. By properly selecting the parameters of the configuration of the roller surface, the initial friction coefficient of the roller easily can be set, and a reduction in friction coefficient during use easily can be estimated. Therefore, the roller can more flexibly be designed for various types of sheet feeders.

[0022] Next, an explanation will be given to methods for producing the inventive sheet feed roller. In one method, a cylindrical roller material is molded or foam-molded in a mold, and cut into a predetermined size for formation of a roller body. Then, the roller body is press-fitted around a shaft. Alternatively, a roller body may be molded around a shaft in a mold.

[0023] To impart the sheet feed roller with the previously described textured surface which comprises the island portions and the sea portion each having the fine projections, the interior surface of the mold for formation of the textured roller surface may be subjected to an electric discharge machining. In this process, larger undulations complementary to the island portions and the sea portion are formed on the mold surface and, at the same time, smaller undulations complementary to the fine projections are formed on the larger undulations. Alternatively, the mold surface may be subjected to an ordinary chemical etching process for formation of the larger undulations thereon, and then to a shot blasting process for formation of the smaller undulations on the larger undulations.

[0024] Thus, there is no need to perform a grinding process for texturing the surface of the sheet feed roller, so that significant cost reductions can be achieved by a reduction in machining costs. The sheet feed roller, although having a non-ground surface, has surface properties comparable to the ordinary ground surface roller.

[0025] Usable as a material for the roller body of the inventive sheet feed roller are rubber materials such as polyurethane, EPDM and polynorbornene rubbers, which are typically used for conventional rollers. Particularly, a polyurethane material, e.g., a polyether polyurethane material, is desirably used since it is superior in wear resistance so as to ensure stable properties for a long period of time.

[0026] The inventive sheet feed roller preferably has a hardness of 40 to 60 °. The roller hardness is measured by means of a durometer of Type A, and herein defined as a reading taken three seconds after a probe of the durometer is pressed against the roller surface.

Embodiments

[0027] A urethane prepolymer was prepared from an ether polyol and an isocyanate. The urethane prepolymer was mixed with a glycol cross-linking agent, and the mixture was filled in a mold for molding a cylindrical roller body structure of a urethane polymer. The roller body structure was cut into a predetermined length for formation of a roller body. Then, the roller body was press-fitted around a resin shaft. Thus, a sheet feed roller having a textured roller surface was produced without performing a grinding process.

[0028] It is noted that the interior surface of the mold was preliminarily subjected to an electric discharge machining so as to be imparted with a texture which was complementary to the desired textured roller surface of the sheet feed roller. By employing a plurality of molds each having differently textured interior surfaces, sheet feed rollers were produced which had differently textured roller surfaces, i.e., having different island-to-sea area ratios S_1/S_2 , different island peak-to-peak distances d , different island heights h_1 and different fine projection heights h , as shown in Tables 1 and 2. The area ratios S_1/S_2 each were determined by applying an ink on a roller surface, transferring the ink from the roller surface onto a paper sheet with a load of 300 gf, and measuring the total area of transferred ink portions on the paper sheet by means of an image processing apparatus SPICCA II available from Japan Avionics Co., Ltd. The heights h_1 and h_2 and the distances d were each measured by means of a surface roughness meter SURFCOM 550A available from Tokyo Seimitsu Co., Ltd.

[0029] Sheet feeders of the FRR type respectively were assembled by employing the sheet feed rollers thus produced both as pickup rollers and sheet feeding rollers thereof. An ordinary retard roller was incorporated in each of the sheet feeders, the retard roller adapted to stop when a plurality of sheets were fed thereto. With the use of the sheet feeders, an evaluation test for each feeder was performed by continuously feeding paper sheets at a sheet feeding speed of 150 mm/sec. In each evaluation test, the friction coefficient of each of the sheet feeding rollers was measured initially and after 200,000 sheets were fed. In addition, the occurrence of a sheet feeding failure and the wear resistance were evaluated.

[0030] Sheet feed rollers of Samples No. 1 to No. 6 having different area ratios S_1/S_2 are shown in Table 1, and sheet feed rollers of Samples No. 7 to No. 12 having different fine projection heights h_2 , etc., are shown in Table 2. In Tables 1 and 2, the evaluation results are indicated by ○ (good), Δ (intermediate), and × (bad).

Table 1

Samples	1	2	3	4	5	6
Surface configuration of roller						
S_1/S_2	0.15	0.2	0.25	0.45	0.70	0.75
h_2 (μm)	10	10	10	10	10	10
d (mm)	0.5	0.5	0.5	0.5	0.5	0.5
h_1 (μm)	50	50	50	50	50	50
Friction coefficient μ						
Initial	1.2	1.3	1.5	1.6	1.7	1.7
After 200k sheet feeding	1.1	1.2	1.4	1.4	1.4	1.2
Sheet feeding failure						
Initial	Δ	Δ	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$
After 200k sheet feeding	$\times$	Δ	$\bigcirc$	$\bigcirc$	$\bigcirc$	Δ
Wear resistance	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$	$\bigcirc$

Table 2

Samples	7	8	9	10	11	12
Surface configuration of roller						
S_1/S_2	0.45	0.45	0.45	0.45	0.25	0.45
h_2 (μm)	1	3	25	30	10	3
d (mm)	0.5	0.5	0.5	0.5	1.0	0.5
h_1 (μm)	50	50	50	50	50	10
Friction coefficient μ						
Initial	1.7	1.6	1.5	1.3	1.6	1.6
After 200k sheet feeding	1.1	1.3	1.4	1.2	1.3	1.3
Sheet feeding failure						
Initial	○	○	○	△	○	○
After 200k sheet feeding	×	△	○	△	○	○
Wear resistance	○	○	○	○	△	△

[0031] For comparison, conventional sheet feeders were respectively produced by employing rollers (Sample No. 13) each having a mirror-like roller surface, rollers (Sample No. 14) each having a conventional ground surface, and rollers (Sample No. 15) each having a conventional simple textured surface, as pickup rollers and sheet feeding rollers of the feeders, and then the aforesaid evaluation tests were performed. The results are shown in Table 3.

Table 3

Samples	13	14	15
Type of roller surface	Mirror	Ground (Prior art)	Textured (Prior art)
Surface configuration of roller			
S_1/S_2	*	*	0.45
h_2 (μm)	*	*	≤ 1
d (mm)	*	*	0.5
h_1 (μm)	*	*	50
Friction coefficient μ			
Initial	2.5	1.6	1.9
After 200k sheet feeding	0.8	1.4	0.9
Sheet feeding failure			
Initial	○	○	○
After 200k sheet feeding	×	○	×
Wear resistance	○	○	○

*: Impossible to measure

[0032] As can be understood from the above results, the sheet feed rollers of Samples No. 3 to No. 5, No. 8 and No. 9, each having an area ratio S_1/S_2 of $0.25 \leq S_1/S_2 \leq 0.70$ and a fine projection height h_2 of $3\mu\text{m} \leq h_2 \leq 25\mu\text{m}$, each had a moderate initial friction coefficient, which was reduced to a smaller extent after the test, and were excellent in wear resistance.

[0033] However, the sheet feed rollers of Samples No. 1 and No. 2, each having an area ratio S_1/S_2 of smaller than 0.25, each had a lower initial friction coefficient, so that sheet feeding failures occurred. The sheet feed roller of Sample No. 6, having an area ratio S_1/S_2 of greater than 0.70, had a higher initial friction coefficient, but was poor in friction coefficient sustainability because paper dust generated during the sheet feeding apparently adhered on the roller surface.

[0034] The sheet feed roller of Sample No. 7, having a fine projection height h_2 of smaller than $3\mu\text{m}$, though satisfying the requirement for the area ratio S_1/S_2 , had a mirror-like roller surface, so that the friction coefficient was reduced to a greater extent due to adhesion of paper dust. The sheet feed roller of Sample No. 10, having a fine projection height h , of greater than $25\mu\text{m}$, had an excessively large surface roughness and, hence, had a reduced initial friction coefficient and an insufficient sheet transporting ability.

[0035] A comparison between the sheet feed rollers of Samples No. 3 and No. 11, having different island peak-to-peak distances d , indicates that the wear resistance of the sheet feed roller deteriorates as the island peak-to-peak distance d increases. A comparison between the sheet feed rollers of Samples No. 8 and No. 12, having different island heights h_1 , indicates that the wear resistance deteriorates as the island height h_1 decreases.

[0036] The sheet feed roller of Sample No. 14, having the ground surface, provided good results. In the case of the sheet feed roller of Sample No. 13, having the mirror-like roller surface, and the sheet feed roller of Sample No. 15, having the conventional textured surface, the friction coefficient was reduced to a greater extent, making it impossible

to ensure a stable sheet feeding performance.

[0037] According to the present invention, the sheet feed rollers are less expensive since there is no need for performing a grinding process in production thereof, and is virtually free from adhesion of paper dust. Thus, the subject sheet feed rollers have a long-term friction coefficient sustainability comparable to conventional ground surface rollers.

[0038] By selecting the configuration and roughness of the roller surface, the initial friction coefficient of the roller easily can be set, and a reduction in friction coefficient during use can be easily estimated. Therefore, the subject sheet feed rollers can more flexibly be designed for various types of sheet feeders.

Claims

1. A sheet feed roller for use in a sheet feeder, the roller comprising a roller body and a shaft extending axially through the roller body, the roller body having a textured roller surface comprising a multiplicity of island portions and a sea portion recessed from the island portions, the island portions and the sea portion each having a multiplicity of fine projections.
2. A sheet feed roller as set forth in Claim 1, wherein a ratio S_1/S_2 of a total area S_1 of the island portions to an area S_2 of the sea portion on the roller surface is 0.25 to 0.70.
3. A sheet feed roller as set forth in Claim 1 or Claim 2, wherein the fine projections each have a height of 3 to 25 μm .
4. A sheet feed roller as set forth in any one of Claim 1 to Claim 3, wherein the island portions on the roller surface each have a height of not smaller than 10 μm , and are spaced from each other by a peak-to-peak distance of not greater than 1.0 mm.

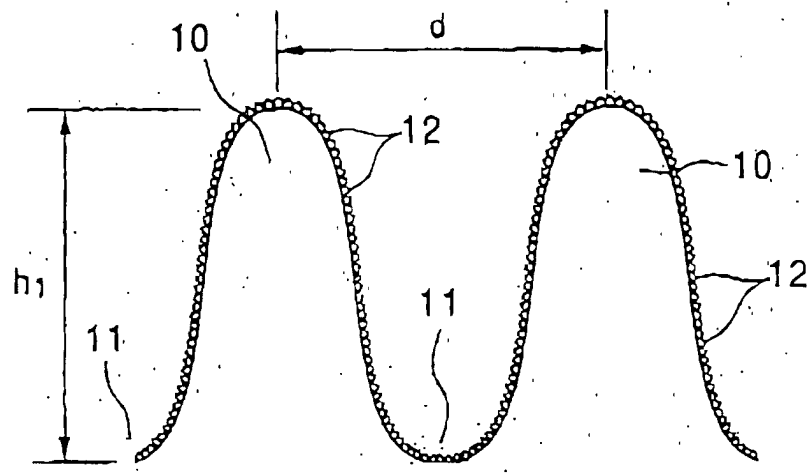


Fig. 1

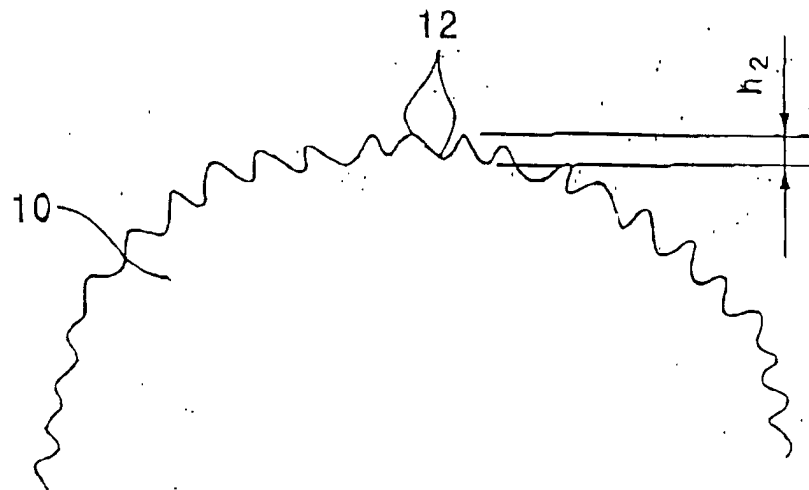


Fig. 2

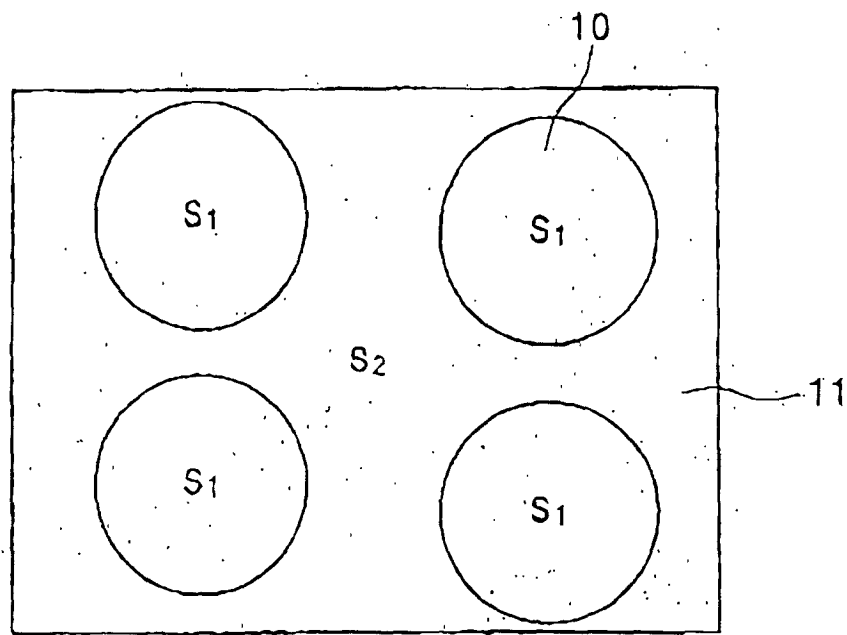


Fig. 3

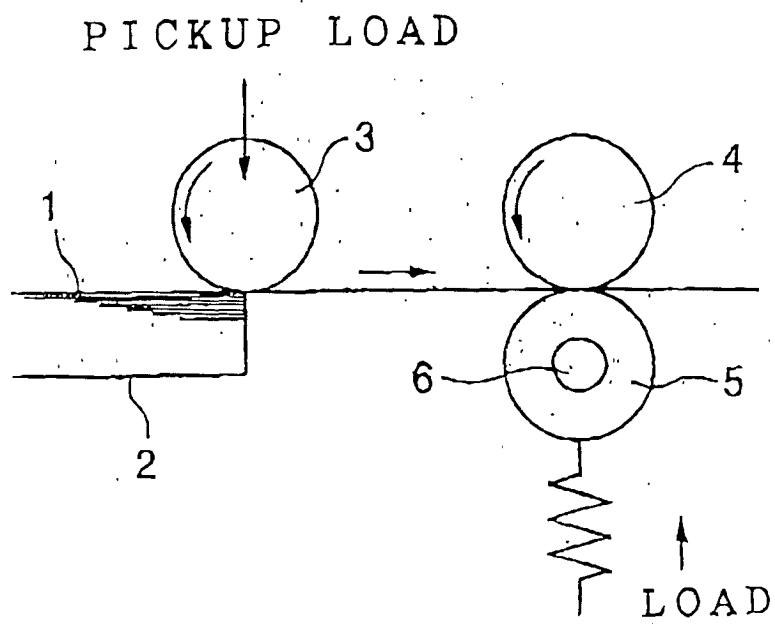


Fig. 4