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(54) Forms feed tractor.

(57) Printers and copiers have paper handling mechanisms that incorporate form feeding tractors (20, 100) to move a continuous form or web (12, 22) having edge holes (402, 452, 458). It has been found that the web can be driven at a high acceleration yet uses a small number of pins (28, 112, 304, 305, 328, 330, 350, 352, 400, 450, 456, 460, 462, 464, 466) by setting the pin pitch of the tractor being greater than the pitch of the edge holes (402, 452, 458).

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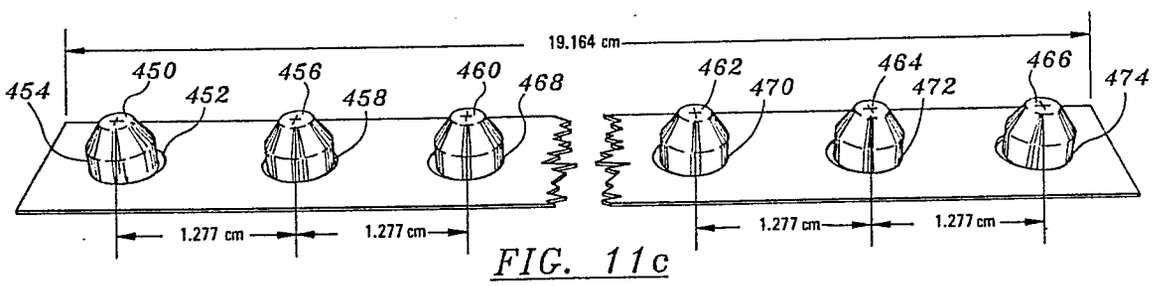


FIG. 11c

FORMS FEED TRACTOR

This invention relates to a forms feed tractor for a paper handling apparatus and, more particularly to a continuous forms feed tractor for moving a web or record medium such as paper having edge holes, through a printer, copier or other similar apparatus operating on the record medium. More particularly, the invention relates to pins and belts useful in such paper handling mechanisms.

Prior art forms feed tractors are disclosed in United States Patent Nos. 4,226,353 to Blaskovic et al. and 4,453,660 to Cornell et al. and in United States Patent Application Serial No. 209,767 of applicant.

In dot band printers, such as the IBM 4234, the continuous forms or web is moved one dot row at a time. The user applications for such a printer require very high through-put rates of 600 lines/minute. This translates into accelerations on the paper of approximately (812.8 m/s^2). This high rate of acceleration directly relates to a force that is imparted to the form. This force deforms the holes of the forms, the amount of deformation being dependent on how many tractor pins are in contact with the form. It is known that more pins contacting the paper at one time lessens the amount of hole deformation. This, however, requires larger and hence more expensive tractors. Larger tractors require larger motors, more complex electronics and a bigger box to house it in, all of which, results in a more expensive product. Hence, it is highly desirable to use small, light weight, inexpensive tractors while avoiding the hole deformation problem.

It is a principle object of this invention to provide an economical forms feeding tractor that avoids the problems associated with hole deformation.

These and other objects are solved in principle by the features of the independent claims 1, 4, 7. Advantageous embodiments of this basic solution are described in the relevant subclaims.

The afore-mentioned disadvantages are overcome by providing a belt for a forms feeding tractor adapted for feeding a record medium having drive holes along at least one edge. The belt comprises a thin flexible band and a plurality of pins affixed to the band and arranged for engaging the drive holes of the record medium. The pins are spaced from one another by a distance greater than the distance between the drive holes of the paper.

The forms feed tractor in accordance with the invention is described in detail below with reference to drawing which illustrate specific embodiments of the invention in which

Fig. 1 depicts a record medium with undeformed holes and tractor pins of the prior art;

Fig. 2 depicts a record medium with holes deformed by the tractor pins;

Fig. 3 shows a pair of forms feed tractors as part of a paper handling system;

Fig. 4 is a forms feed tractor with the door raised;

Fig. 5 is a cut-away view of the forms feed tractor of Fig. 4 taken along the line A-A;

Fig. 6 is a belt having the unique pin pitch of the invention;

Figs. 7 through 9 are different embodiments of tractor belts incorporating the invention;

Fig. 10 shows the dimensional relationship between adjacent pins of the belts; and

Fig. 11 illustrates the operation of the pins of the present invention.

Continuous forms have holes running along both sides which are spaced 1,270 cm (0.5 inch). All prior art tractors employing pins to feed forms have spaced the pins 1,270 cm (0.5 inch) apart as well. When a large amount of hole deformation is encountered a feeding problem is likely to occur in the paper handling apparatus. Fig. 1 depicts how normal form holes 2 and tractor pins 4 appear. It should be noted that the pin 4 impinges upon hole edge 6 of form hole 2 in the direction the form or record medium is traveling indicated by the arrow. In paper handling systems that have low acceleration, numerous pins or low forms tension, little hole deformation occurs. Where conditions of high acceleration, few pins or high forms tension exist, hole deformation can be so significant that the tractor jams destroying the form.

As can be seen in Fig. 2, when significant deformation occurs the form is displaced, in a direction opposite to that of the arrow, by an amount equal to the deformation of each hole. A feeding problem occurs when bottom pin 8 attempts to enter undeformed hole 10. Hole 10 would be the hole which is about to enter the tractor. With the forms displaced by the amount of deformation, pin 8 strikes the form 12 ahead of the hole 10. In the prior art, the pitch of the tractor pins 4 is always 1,270 cm (0.5 inch), but the pitch of the last deformed form hole 9 and the new undeformed hole 10 about to enter the tractor is greater than 1,270 cm (0.5 inch) by the amount of deformation, shown in Fig. 2 as the distance between pin base 14 and edge 16 of hole 10. When pin 8 interferes with the form 12 two things happen. First, the pin deforms the hole; and second, the pin pushes the form upward, away from pin base 14 and toward tip 18. The combination of hole deformation and pushed up form creates a condition leading to a paper jam in the form feeding apparatus.

A principle of this invention is to increase the pin pitch of the tractor to compensate for the deformation

of the forms holes so that the pin does not interfere with the new hole coming into the tractor. Increasing the pin pitch does not change the amount of hole deformation experienced by the forms; it simply allows the pin to enter the forms hole without interference.

Referring to Fig. 3, a pair of forms feed tractors 20 are shown as they would be mounted in a paper handling apparatus such as would be used in a printer or copier. Web 22 is shown as conventional computer paper having edge holes 24, however, web 22 could also be multi-part continuous forms or other material for forming images on the surface thereof. The web 22 is loaded into the tractors by opening the hinged door 26, placing the web perforations over the drive pins 28, and closing the door. Web 22 is driven by pins 28 of forms feed tractor 20 which engage the web at edge holes 24. The web is pressed onto the pins 28 by door 26 also known as a lid. In other embodiments, there can be a gap as is known in the prior art. Tractor 20 is held in position by means of guide shaft 30 and drive shaft 32. The pins 28 of tractor 20 are rotated in either a forward or reverse direction by drive shaft 32 which is driven by a suitable drive means 34 such as either a stepper motor or DC servo motor.

Referring to Figs. 4 and 6, a form feed tractor 100 has an outer side frame 102 and an inner side frame 104. The two side frames are held together by locking member 106. Belt 108 is mounted between frames 102 and 104 and rides along a shoulder 110. Belt 108 has pins 112, drive teeth 114 which are affixed to belt 108 at drive tooth base 116. Drive aperture 118 and guide shaft aperture 120 are for receiving drive shaft 32 and guide shaft 30 (Fig. 3) respectively. Door 122 is mounted on outer side frame 102 at hinges 124 and 126 with spring 128 provided to maintain pressure on the record medium so that the forms are positioned near base 130 of pin 112.

Still referring to Fig. 4, the tractor door 122 is generally of the same size as tractor guiding surface 136. The body of the door is generally flat, or as shown in the Fig., includes a pair of ribs 138 extending downwardly therefrom, generally aligned and coextensive with the track of the pins or the guiding surface 136. In this embodiment, one rib is disposed on each side of the pins and together they define a slot 140 along which the pins move. The lower guiding surfaces 142 and 144 of the ribs are smooth to avoid snagging the web.

Door 122 is connected to the outer side frame by a pair of outwardly extending arms 146 with perpendicular protruding hinge pins 148 that are pivotally received in cradle 150 and bracket 152. An extension spring 128 has opposite ends stretched between door 122 and outer side frame 102 to hold door 122 in either its open loading position (Fig. 4) or in its closed driving position (Fig. 3). The door 122, when closed, is spaced from guiding surface 136 by a pair of stops 154.

Referring to Fig. 6, endless belt 108 is typically a strip of non-stretchable polyimide film, such as Kapton. In other embodiments the belt may be constructed of a polymer such as polyester. It includes a plurality of attached, uniformly spaced drive pins 112 that extend outwardly from the outer belt surface 132. In this invention that spacing should be 1,277 cm (0.503 inch), on centers, see Fig. 10. Drive teeth 114 may be integrally formed with the drive pin 112, and extend inwardly from the inner belt surface 134. Each drive tooth 114 has a cross sectional configuration that is complementary to the configuration of the axial slots of the sprockets (Fig. 5).

Whereas, the preferred embodiment calls for a pin pitch of at least 1,277 cm (0.503 inch), different embodiments might require different pin pitches. The appropriate pin pitch for a particular application is selected based on the amount of hole deformation. Because hole deformation is a function of many things such as acceleration, number of pins engaged and forms tension it is necessary to run tests to determine the relative performance of several pin pitches.

A test was devised whereby a paper handling apparatus having a specific number of pins, in this case fifteen, was run using belts with varying length corresponding to different pin pitches. The prior art would call for a 19,05 cm (7.5 inches) belt when using fifteen pins. The machine performance was rated using the following criteria: Rated 0 if failed before printing one sheet; rated 1 if failed before printing five sheets; rated 2 if failed before printing ten sheets; rated 3 if failed before printing 500 sheets; rated 4 if did not fail within eight hours but showed evidence of hole deformation; and, rated 5 if no failure or hole deformation within an eight hour period. An example showing the average machine performance for various pin pitches is displayed in Table A.

TABLE A

BELT LENGTH		AVERAGE PERFORMANCE
CM	(INCHES)	
18,986	(7.475)	2.0
18,999	(7.480)	2.9
19,011	(7.485)	3.0
19,024	(7.490)	3.1
19,037	(7.495)	3.6
19,050	(7.500)	3.7
19,062	(7.505)	3.8
19,075	(7.510)	3.9
19,088	(7.515)	4.0
19,100	(7.520)	4.1
19,113	(7.525)	4.1
19,126	(7.530)	4.6
19,138	(7.535)	4.8
19,151	(7.540)	4.7
19,164	(7.545)	5.0
19,177	(7.550)	5.0
19,189	(7.555)	5.0
19,202.	(7.560)	5.0

Referring to Fig. 5, tractor 20 is shown with lid 122 in a closed position. Belt 108 travels along a belt path defined by drive sprocket 200, idler sprocket 202 and ramps 204 and 206. Drive sprocket 200 and idler sprocket 202 have cogs 208 and slots 210. Drive teeth 114 of belt 108 fit in slots 210 and, as drive sprocket 200 is driven by drive shaft 32 and suitable motor means 34 (Fig. 3) belt 108 is caused to turn driving the web through the paper handling mechanism.

Figs. 7, 8 and 9 show belts having different pin/drive tooth profiles. Fig. 7 shows a belt 300 having a separate drive tooth 302 between adjacent pins 304, 305. Fig. 8 shows a belt 320 formed of molded rubber having three drive teeth 322, 324, 326 formed between adjacent pins 328, 330. Fig. 9 shows a belt 350 with each pin/drive tooth 352 formed by injection molding the pin/drive tooth through belt 350. The present invention can be employed regardless of pin profile, number of drive teeth or manufacturing method. The critical factor is to make the pin pitch greater than the pitch of the form holes.

Referring to Fig. 11, the operation principles of this invention will be explained. In Fig. 11a, a forms hole spacing of 1,27 cm (0.500 inch) is shown with tractor pins also spaced at 1,27 cm (0,500 inch). The pins and forms of Fig. 11 are being fed in the direction shown by the arrow. Each pin 400 impinges on the forward edge 404 of each hole 402. Fig. 11b shows the belt of Fig. 11a with standard tolerances of 0,005 cm (0.002 inch) non-cumulative. A non-cumulating tolerance means that over the entire belt length, the cumulative error may not exceed the specified tolerance. Fig. 11c shows the present invention with the spacing of pins on a belt at 1,277 cm (0.503 inch) and that the cumulative length of the belt, based on a fifteen pin belt, would be 19,164 cm (7.545 inches). Fig. 11c also shows how pin 450, in hole 452, abuts against the trailing edge 454 whereas in the prior art (Fig. 11a or 11b) the pin strikes the leading edge. As the form moves through the tractor, the pin migrates in the hole. See pin 456 and hole 458. Finally, pins 460, 462, 464 and 466 strike the respective leading edges 468, 470, 472 and 474 thus driving the form.

Claims

1. A belt (108, 112, 114) for a forms feeding tractor (20, 100) adapted for feeding a record medium (12, 22) having drive holes (402, 452, 458) along at least one edge thereof, said belt comprising:
a thin flexible band; and
a plurality of pins (28, 112, 304, 305, 328, 330, 350, 352, 400, 450, 456, 460, 462, 464, 466) affixed to said band and arranged for engaging said drive holes (402, 452, 458) of said record medium (12, 22), said pins

being spaced from one another by a distance greater than the distance between said drive holes.

2. The belt of Claim 1 wherein each of said pins is spaced greater than 1,27 cm (0.500 inch).

3. The belt of Claim 1 wherein the distance between said pins is greater than 1,277 cm (0.503 inch).

4. A forms feed tractor (20, 100) comprising: a frame (102, 104); a drive sprocket (200) mounted in said frame and drivingly engaging a drive shaft (32); and an endless flexible belt (108, 112, 114) in driven engagement with said drive sprocket, having a plurality of pins (28, 112, 304, 305, 328, 330, 350, 352, 400, 450, 456, 460, 462, 464, 466) aligned in a row arranged for engaging a plurality of drive holes (402, 452, 458) of a record medium, said pins in said row spaced apart by a distance that is greater than the distance separating said drive holes of said record medium (12, 22).

5. The forms feed tractor of Claim 4 wherein each of said pins is spaced apart by a distance greater than 1,27 cm (0.500 inch).

6. The forms feed tractor of Claim 4 wherein each of said pins is spaced apart by a distance greater than 1,277 cm (0.503 inch).

7. A paper handling apparatus for a printer or the like comprising:
a pair of side walls having a guide shaft (30) mounted therebetween;
at least one pair of forms feeding tractors (20, 100), mounted on said guide shaft (30) between said side walls, for feeding a continuous form (12, 22) having a plurality of drive holes (402, 452, 458) separated by a distance D;
each of said tractors (20, 100) having a frame, (102, 104), a sprocket (200) mounted in said frame for drivingly engaging a drive shaft (32), and a belt (108, 112, 114) in driven engagement with said sprocket having a plurality of pins (28, 112, 304, 305, 328, 330, 350, 352, 400, 450, 456, 460, 462, 464, 466) for engaging said drive holes (402, 452, 458) each of said pins separated by a distance greater than D; and
a drive means (34) coupled to said drive shaft (32) for driving said shaft.

8. The paper handling mechanism of Claim 7 wherein said distance D is equal to 1,27 cm (0.500 inch) and each of said pins is separated by a distance greater than 1,27 cm (0.500 inch).

9. The paper handling mechanism of Claim 7 wherein said distance D is equal to 1,27 cm (0.500 inch) and each of said pins is separated by a distance greater than 1,277 cm (0.503 inch).

10. The paper handling mechanism of Claim 7, 8 or 9 wherein said drive means (34) is a stepper motor or DC servo motor.

Fig. 1

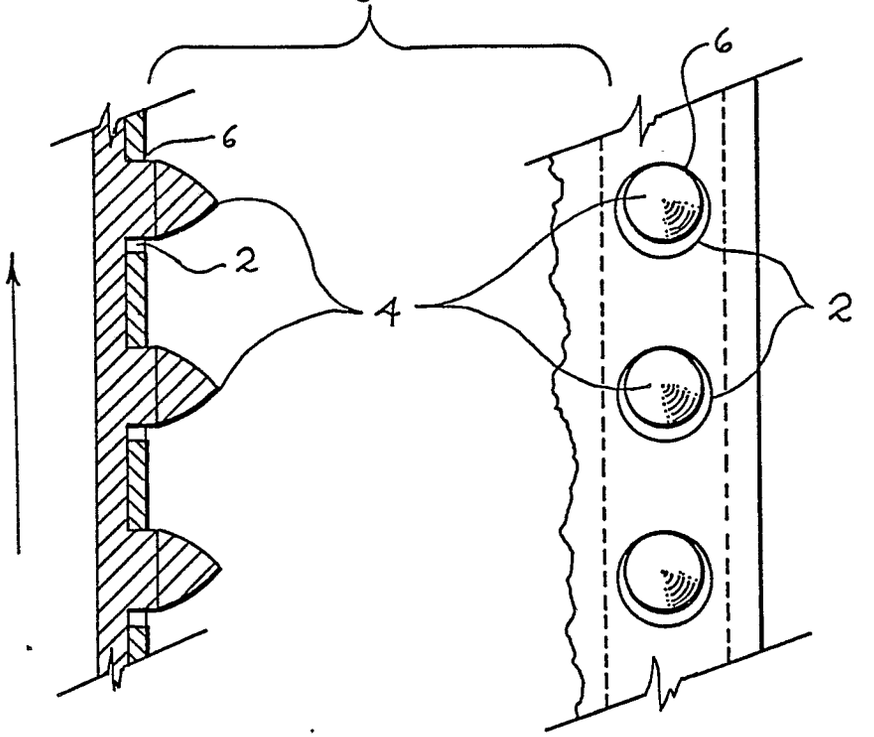


Fig. 2

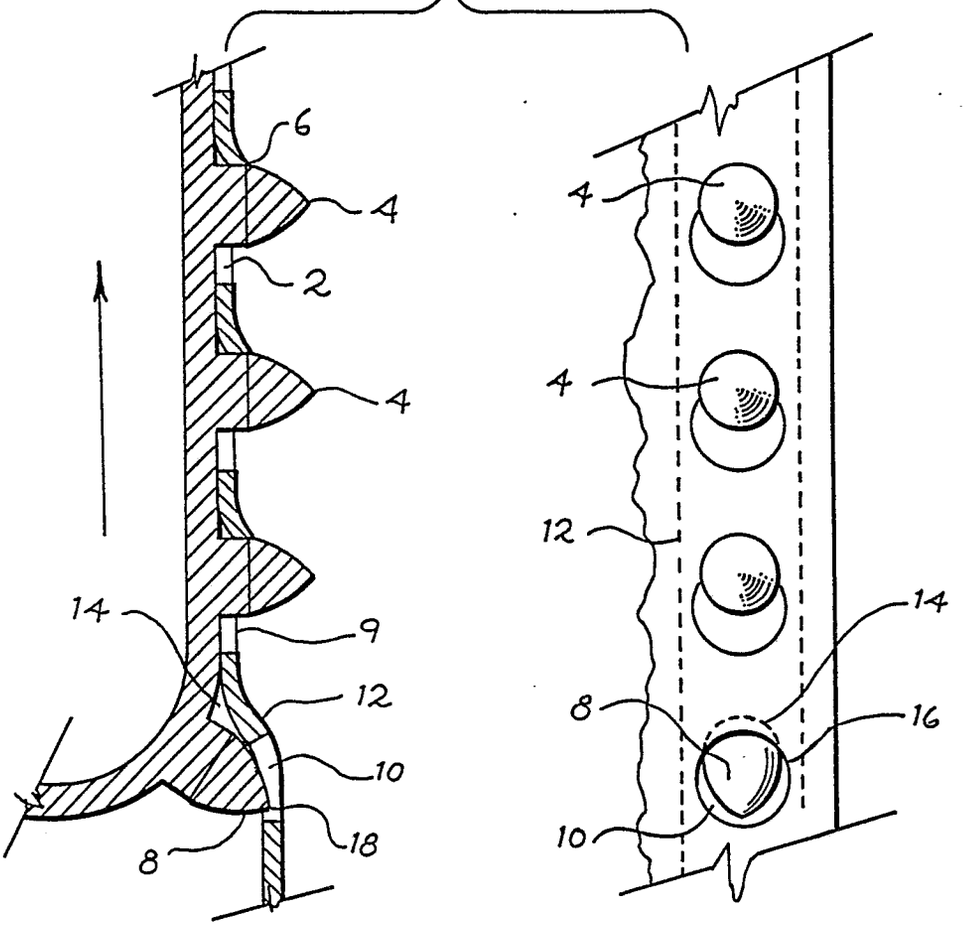
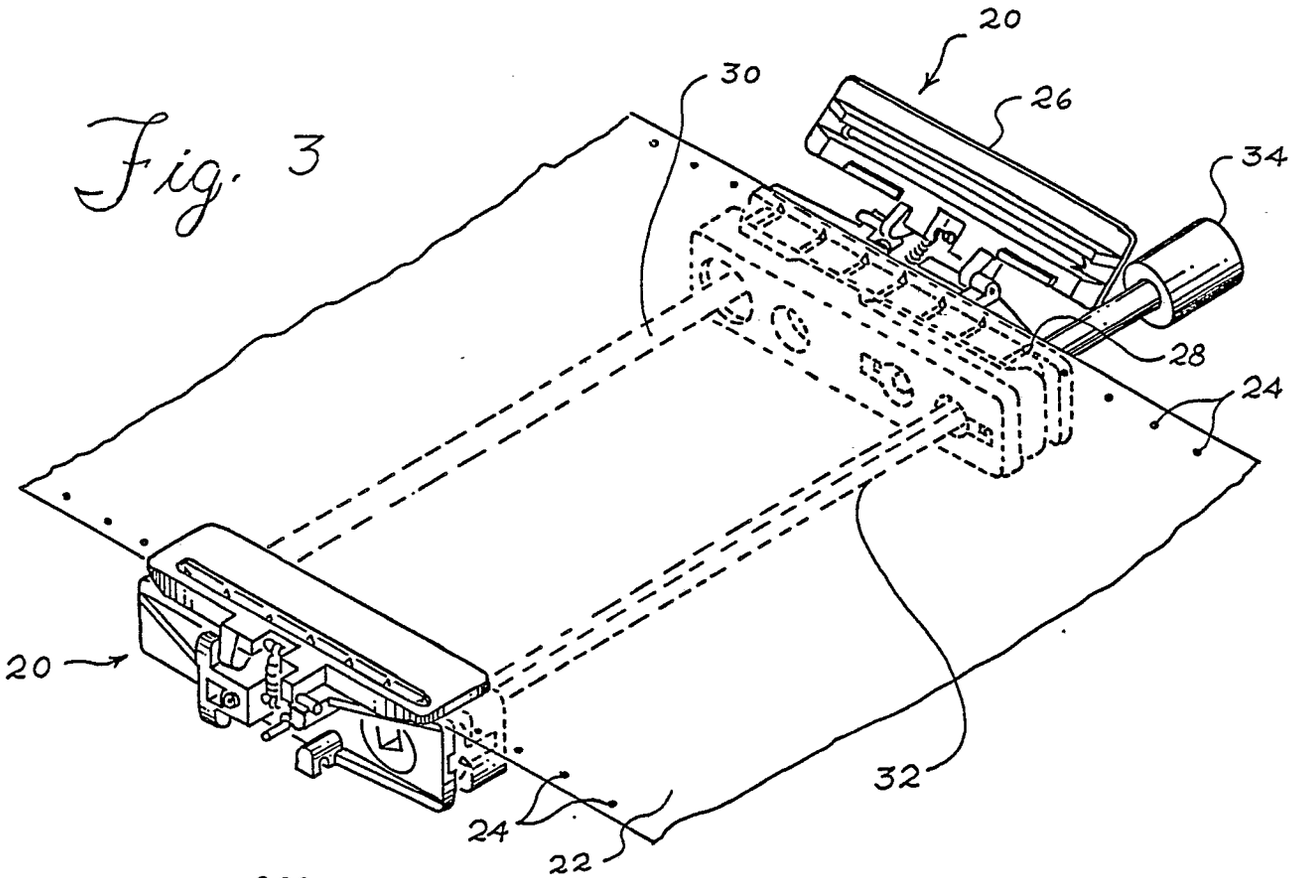


Fig. 3



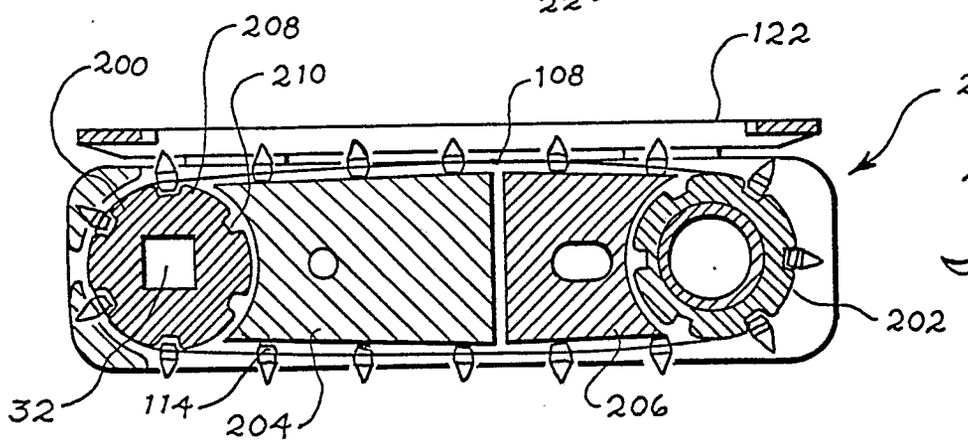


Fig. 5

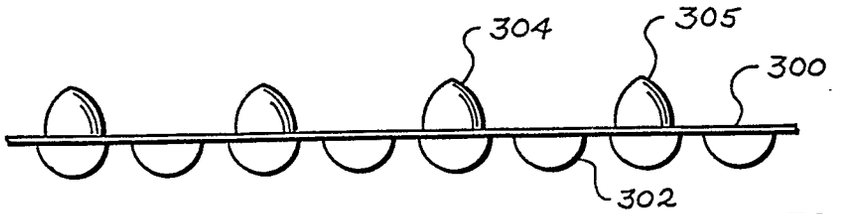


Fig. 7

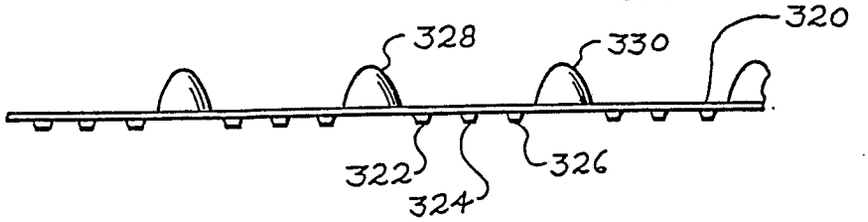


Fig. 8

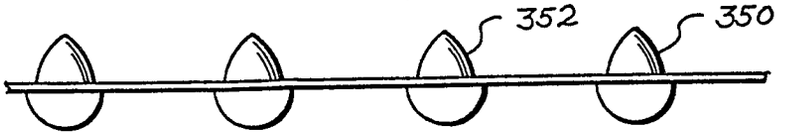
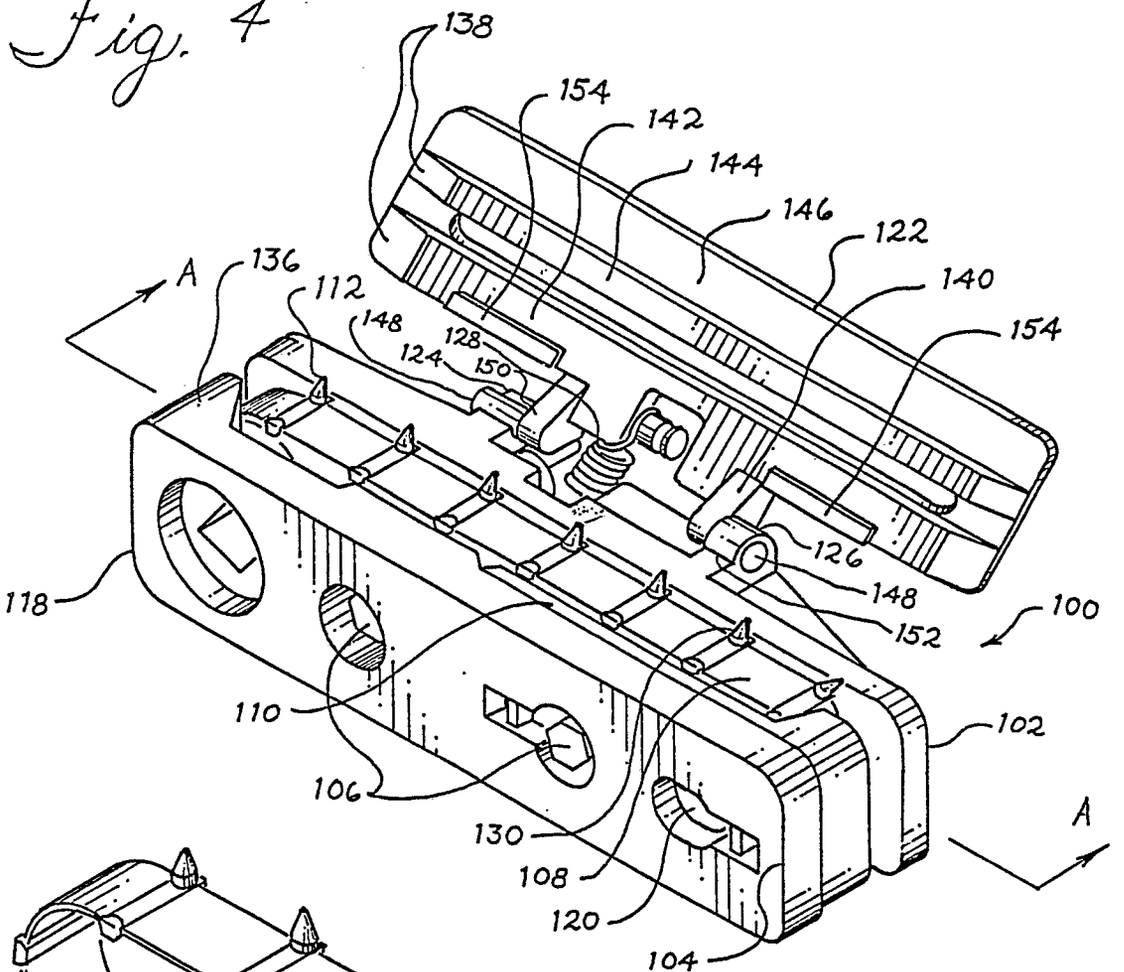


Fig. 9

Fig. 4



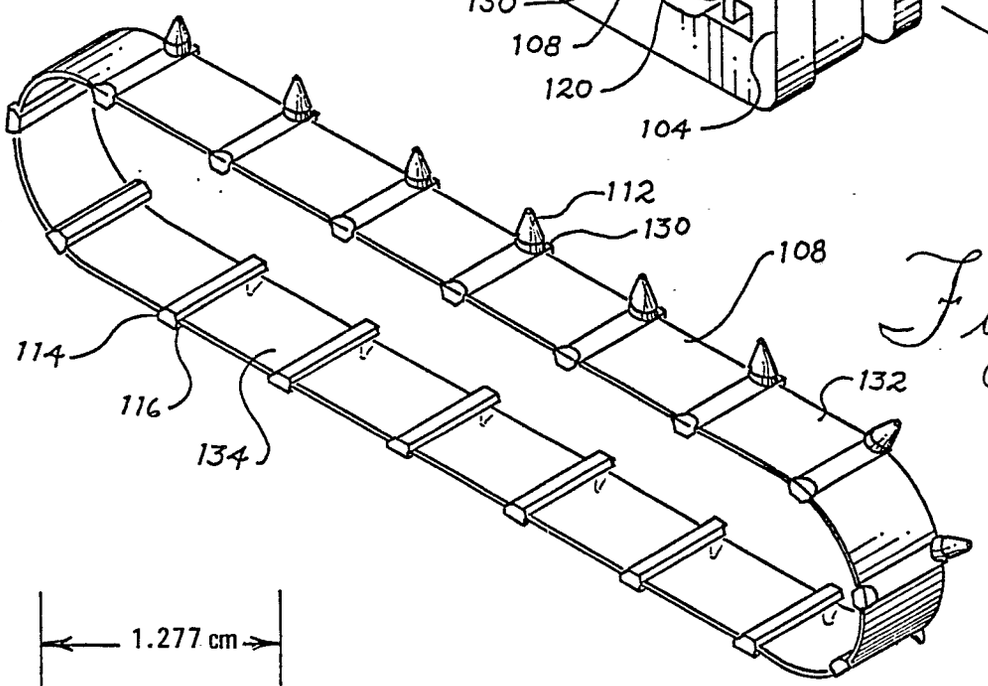


Fig. 6

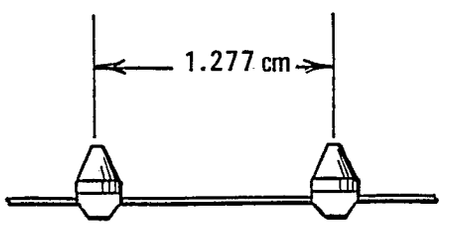


Fig. 10

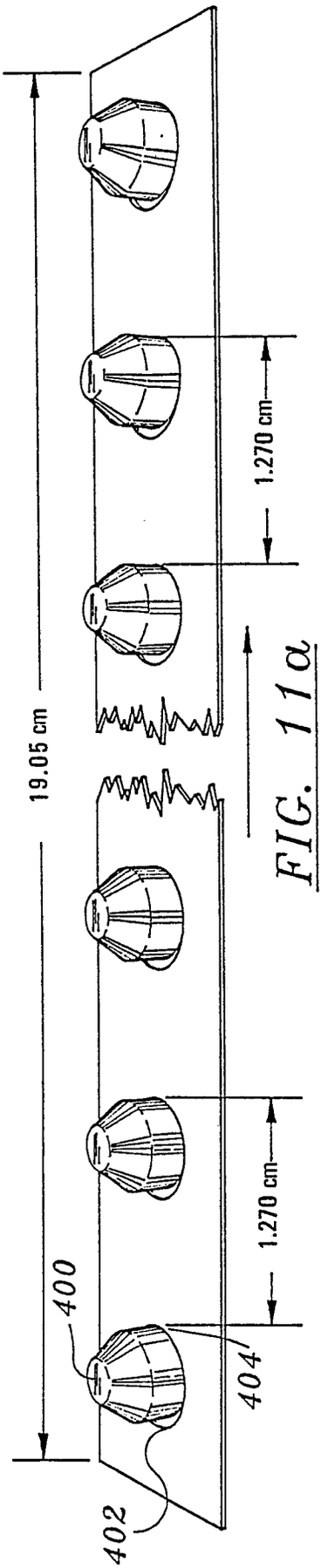


FIG. 11a

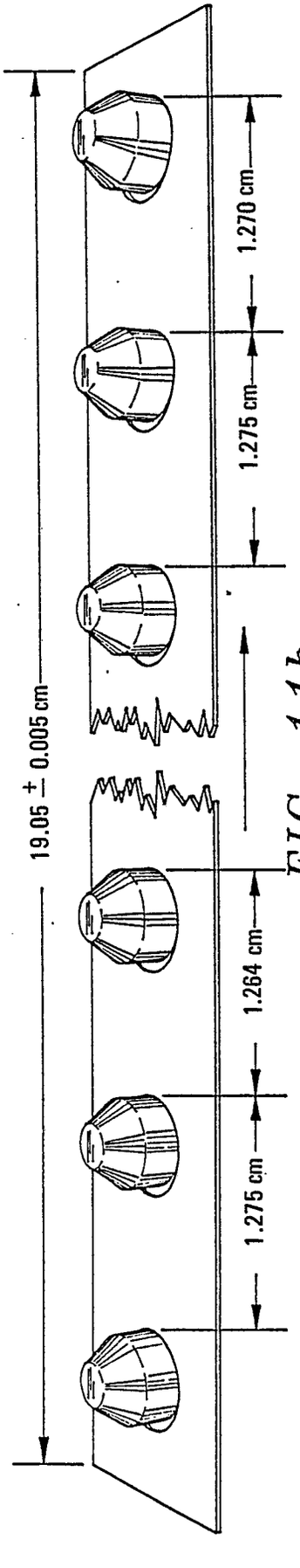


FIG. 11b

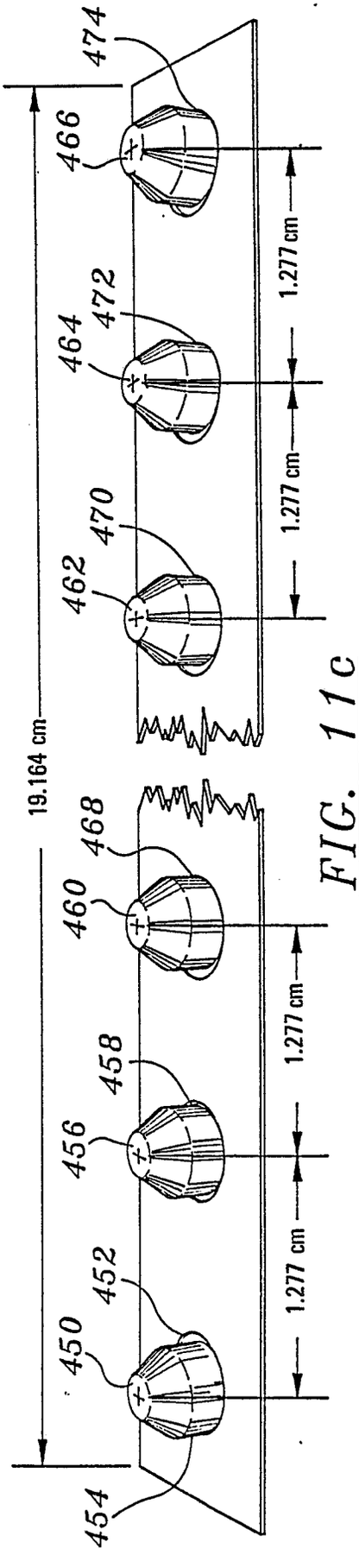


FIG. 11c

European Patent Office

EUROPEAN SEARCH REPORT

Application number

DOCUMENTS CONSIDERED TO BE RELEVANT

EP 89114424.8

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.*) 5
Y	DE - B2 - 2 158 969 (VOCKENHUBER) * Fig. 2; column 2, lines 15-29 * --	1,4,7	B 41 J 11/32 B 65 H 20/20 G 03 B 1/30
D,Y	US - A - 4 453 660 (CORNELL et al.) * Fig. 2; abstract * --	1,4,7	
A	GB - A - 1 496 869 (HONEYWELL) * Fig. 2; page 1, lines 78-80 * ----	10	

TECHNICAL FIELDS SEARCHED (Int. Cl.* 5

B 41 J
B 65 H
G 03 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	14-12-1989	MEISTERLE

CATEGORY OF CITED DOCUMENTS

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