

[54] **FEED MECHANISM**

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[51] Int. Cl. **G03b 1/30**

[58] Field of Search **226/74, 75**

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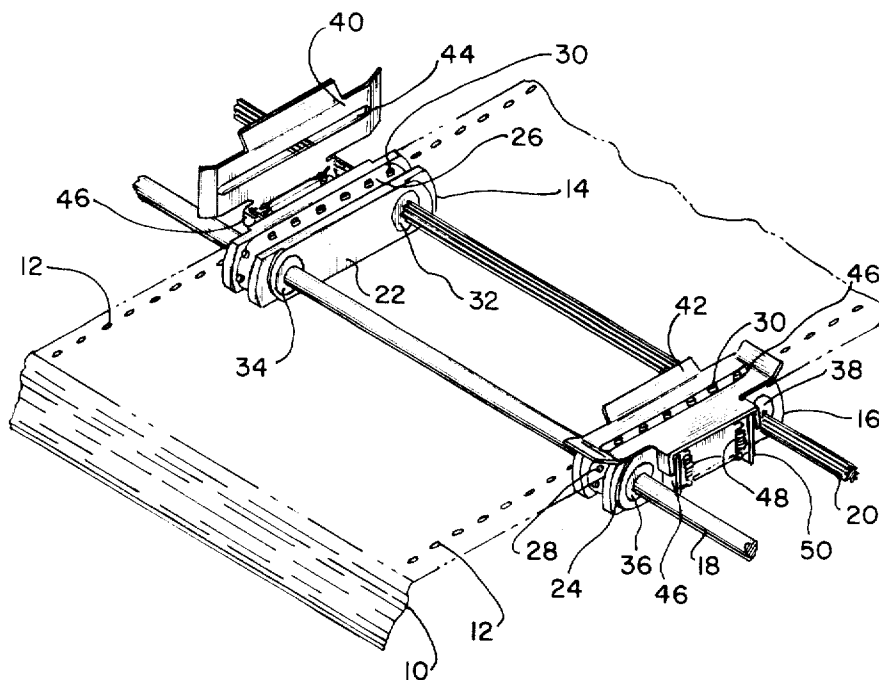
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Primary Examiner—Allen N. Knowles
Attorney, Agent, or Firm—Martin Lukacher

[57] **ABSTRACT**

Mechanisms for feeding documents having perforations along their marginal edges are described. These mechanisms have frames which define linear paths for endless belts made of spring material along the drive path of the document perforations. The frames support the belts for curvilinear motion around and away from the ends of the linear paths. The belts have unitary pin and roller drive elements which extend through perforations in the belt at equidistant intervals therealong. Sprockets supported by the frame and journaled therein carry the belt around the curvilinear paths. The drive elements and the belts can be molded together into a unitary structure.

9 Claims, 12 Drawing Figures



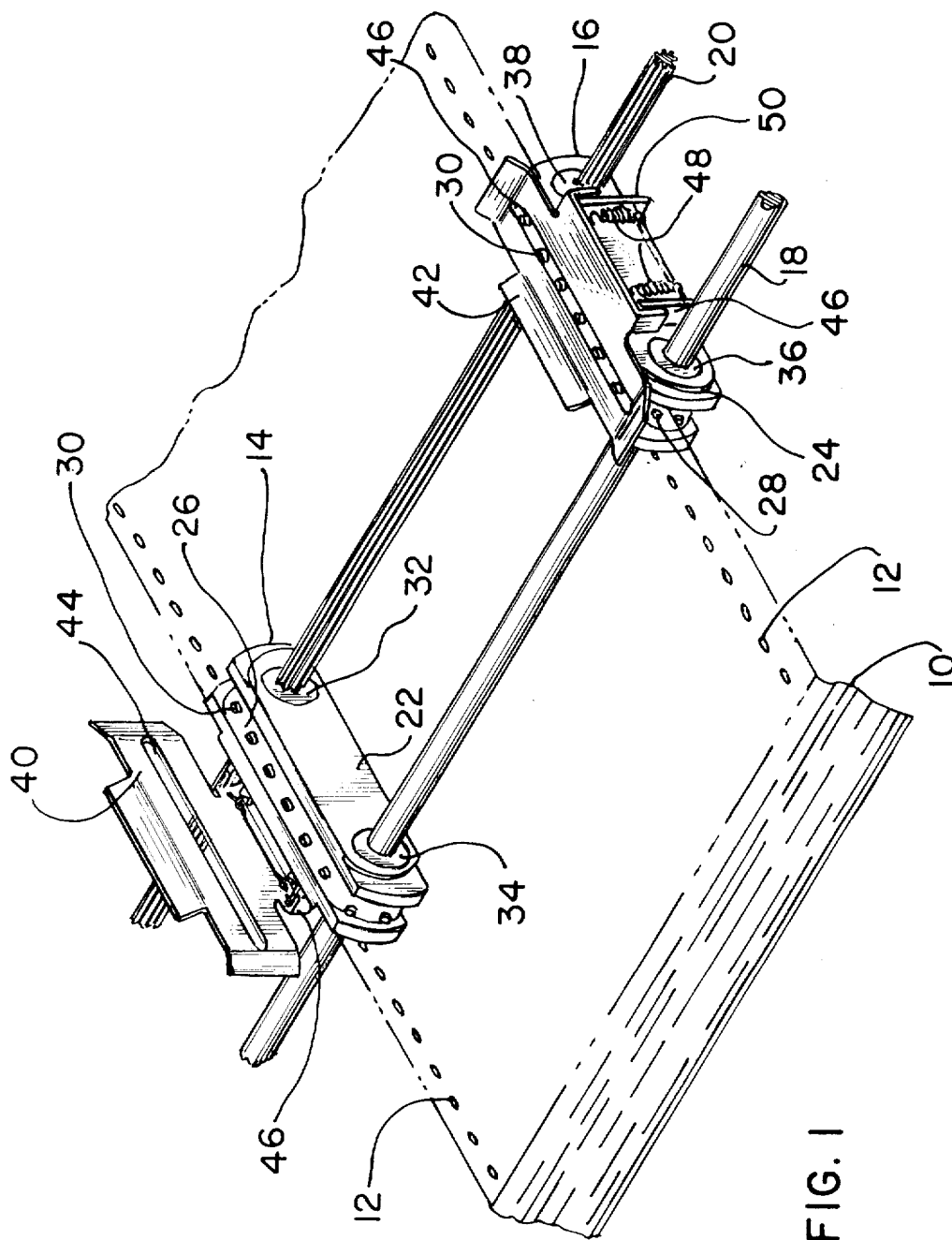


FIG. 1

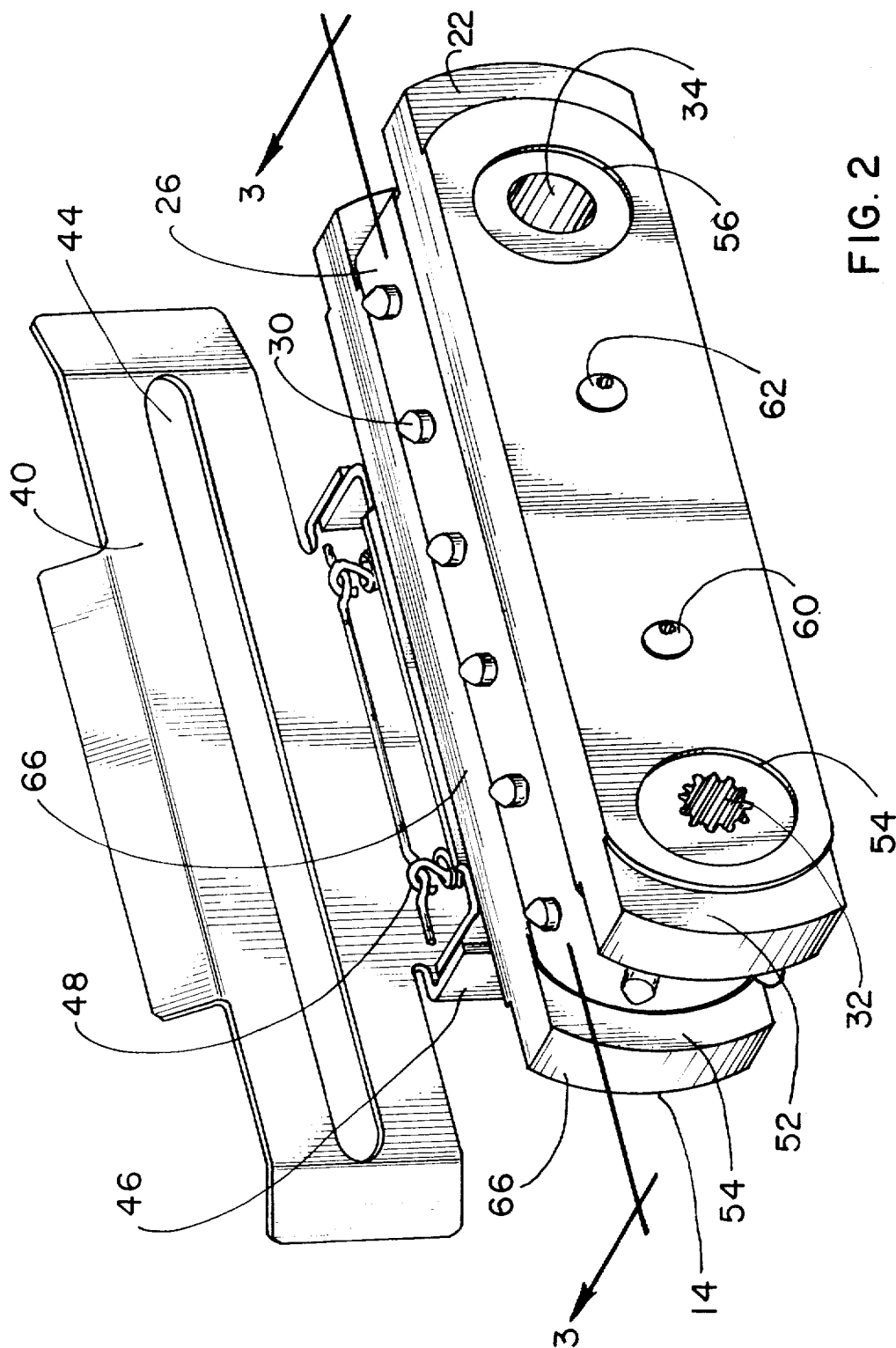


FIG. 2

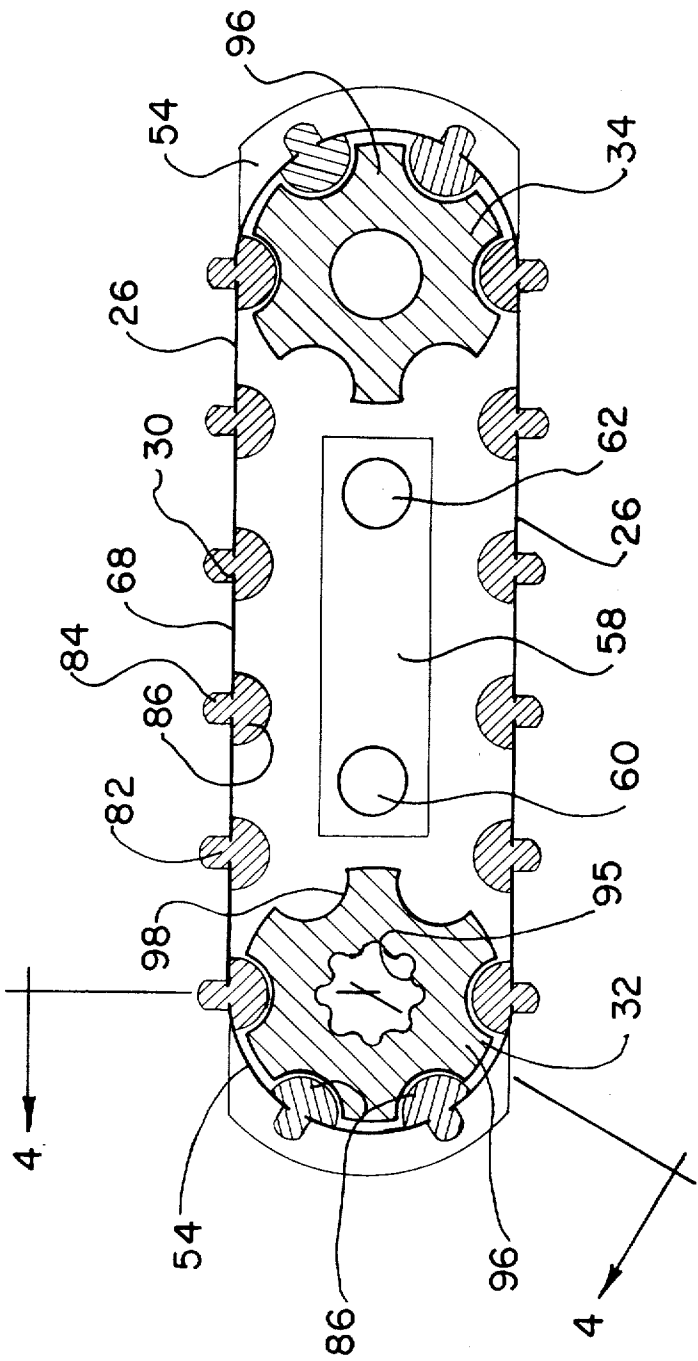


FIG. 3

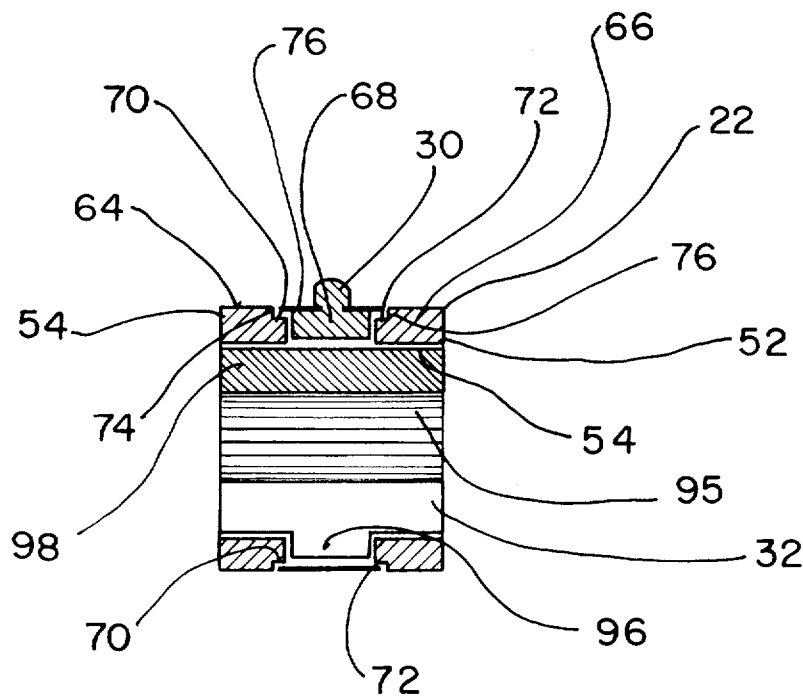


FIG. 4

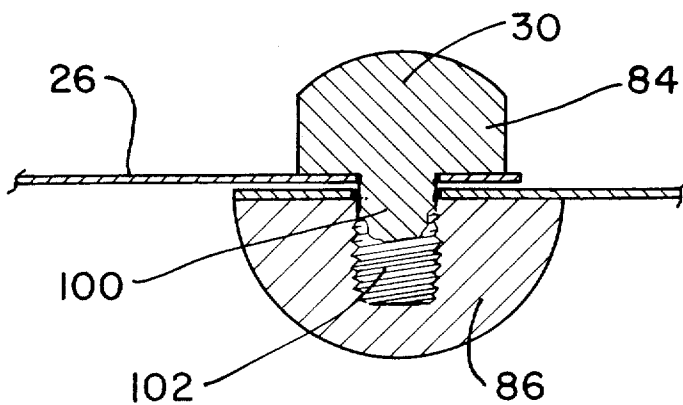


FIG. 7

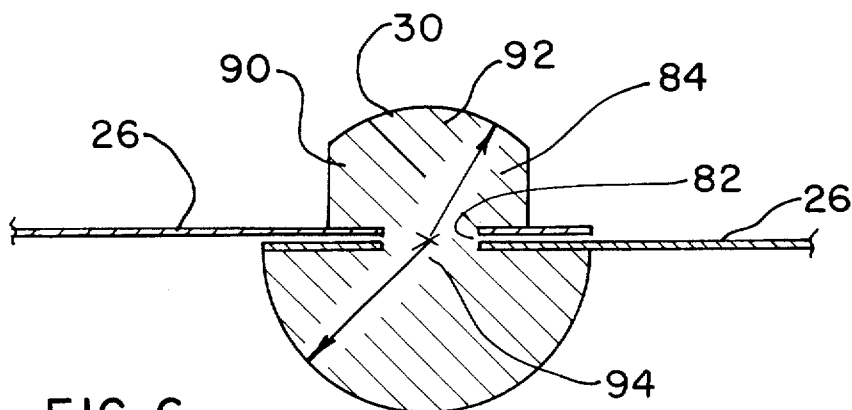


FIG. 6

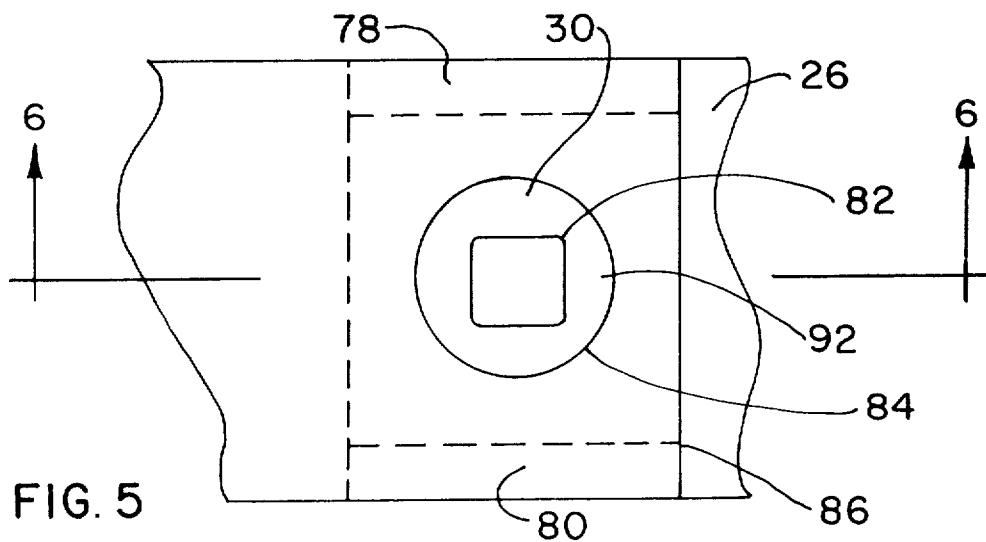


FIG. 5

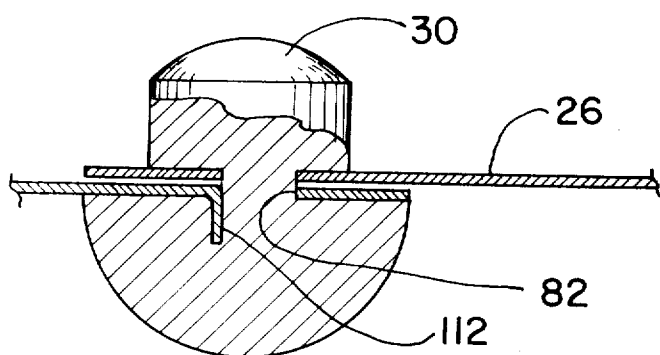


FIG. 10

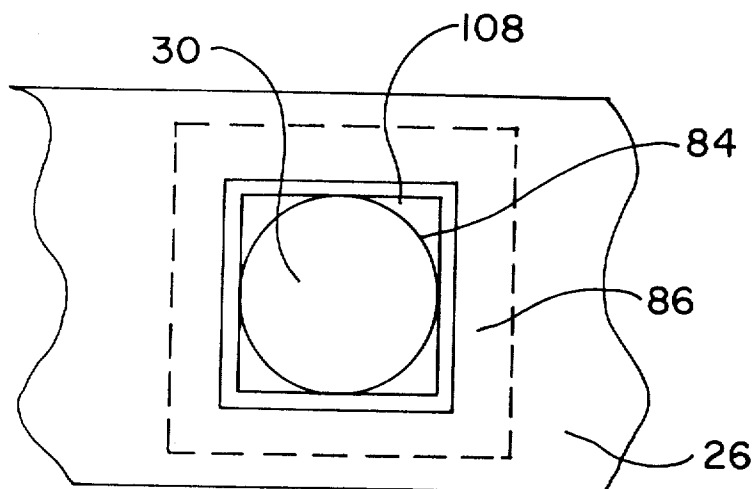


FIG. 9

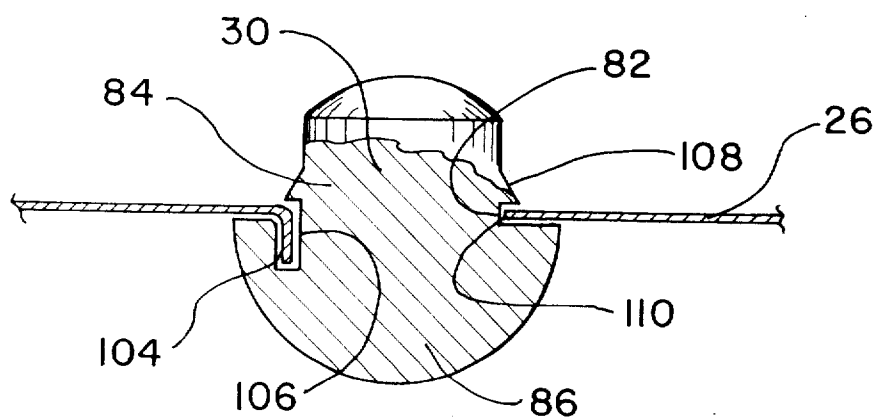


FIG. 8

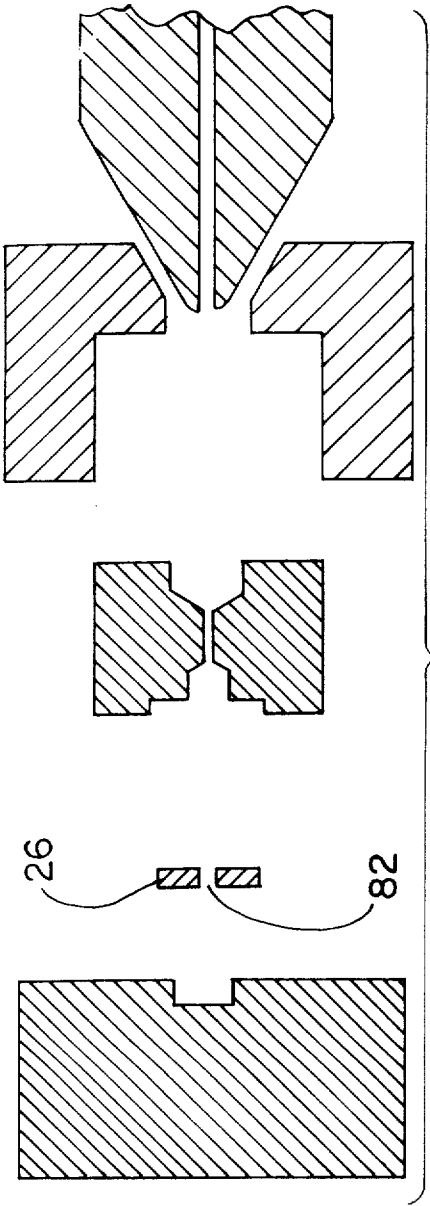


FIG. 12

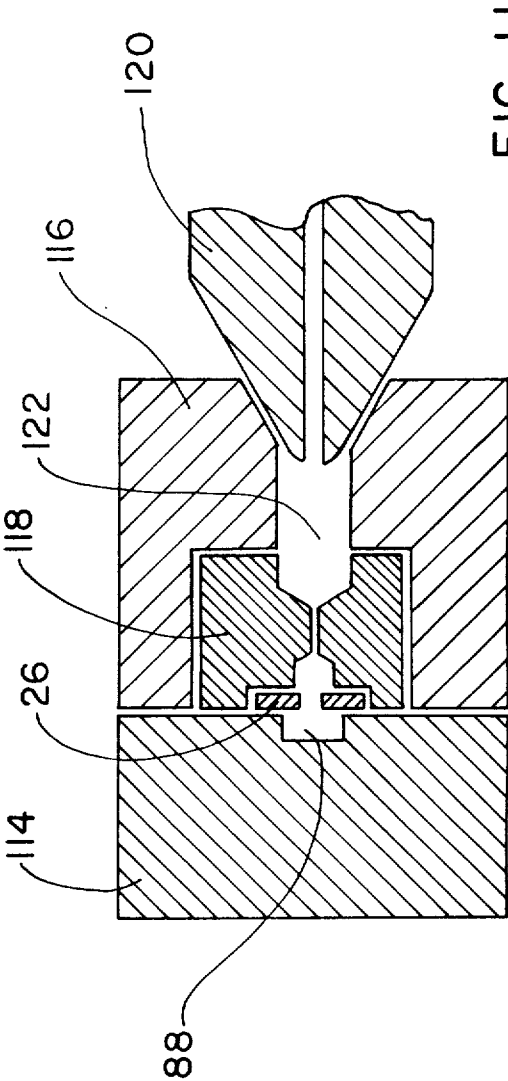


FIG. 11

FEED MECHANISM

The present invention relates to mechanisms for feeding, advancing or positioning movable members and particularly to mechanisms for feeding perforated webs.

The invention is especially suitable for use in feeding of edge-perforated documents as are generally used in computer peripheral equipment, such as printers, typewriters and optical character readers. Features of the invention are however generally applicable for feeding any movable members, such as work tables used on machine tools, particularly numerically controlled machine tools, tapes and other record media.

Feeding of certain driven members, particularly computer forms requires a feed mechanism capable of moving at extremely high speeds and of undergoing rapid acceleration and deceleration. Any skew or meandering of the drive causes misalignment of the forms or members with operating devices, such as printer heads. If the feed mechanism is not fast acting, misregistration can readily occur. In the case of perforated documents which are fed through pin drive elements, skewing and improper entrance and stripping of the pin tends to tear the document, jam the document in the mechanism and cause costly down time of the entire computer system. These requirements for high speed rapid acceleration and deceleration, close tolerances on skewing, entry and exit of the pins, and accuracy of movement with respect to the operating member, such as the printer head, are not compatible with each other and have resulted in the use of complex and costly feed mechanisms. Characteristic of these feed mechanisms is the so called "tractor" which employs a chain, much like a bicycle chain, which is carried by a pair of sprocket gears, each link of the chain carries a sprocket pin which extends from an outboard bracket or beam cantilevered from the chain. The pins enter the perforations in the document as they pass from curved paths around the sprockets into a straight path and are stripped from the documents as they leave the curved path when drawn around a second sprocket. Close tolerances are required between the pin location and the sprockets or else pairs of these tractors along opposite marginal edges of the document will not be in synchronism and will cause the entire document to skew, drag, bind, or actually tear in the mechanism. Thus, complex phasing adjustments at the sprocket shafts are required and must be maintained by regular adjustments during operation. Such adjustments are oftentimes incompatible with clean entry and stripping of the pins which cause driving forces to be applied to the document perforations in other than the linear path, thus tearing and damaging the document. The chain, bracket and sprocket drives also are heavy, have high inertia, and are not compatible with high speed and rapid acceleration and deceleration of the driven member.

Other attempts at feed mechanisms have included timing belts, pulley drives, pressure rollers, and capstan arrangements, all of which are generally very complex and have high cost of manufacture. Also, timing belts suffer from stretch and skew effects and do not maintain necessary intimate contact with the driven member. Also, frequent adjustments, belt replacements, and binding with documents being fed, have militated against the acceptance of such mechanisms in operational equipment.

It is an object of the present invention to provide improved feed mechanisms wherein the foregoing difficulties and disadvantages are substantially eliminated.

It is a further object of the present invention to provide feed mechanisms having moving elements with extremely low mass which are adapted to rapidly accelerate and decelerate a driven member, such as an edge-perforated document, and which is also adaptable to drive such a driven member at high speed.

It is a still further object of the present invention to provide a feed mechanism which is easily positioned with great accuracy with respect to a driven member and maintain such position without requiring continual adjustment.

It is a still further object of the present invention to provide a feed mechanism especially adapted for feeding webs such as computer forms, which is easy to clean and maintain.

It is a still further object of the present invention to provide a feed mechanism having low noise and vibration characteristics.

It is a still further object of the present invention to provide feed mechanisms which are especially adapted for feeding computer forms which are uncomplicated and which may be readily manufactured at low cost.

Briefly described, a feed mechanism embodying the invention utilizes a strip of flexible material, such as stainless spring steel and the materials to be mentioned hereinafter which are extremely stable dimensionally and yet are extremely light in weight and have low inertia. The strip material is characterized as having flexibility without being subject to fatigue failure. The following properties of the material contribute to this characteristic: low modulus of elasticity; high tensile strength; high folding endurance; and high impact strength. Strips of the following materials have, in accordance with the invention been found to possess these characteristics: Stainless steel; titanium, polyester film (sold under the Trademark Mylar by E. I. Dupont & Co., Wilmington, Del.) and polyimide film (sold under the Trademark Kapton, also by Dupont).

The strip is formed into an endless belt and presents a feeding surface facing outwardly and a surface opposite to the feeding surface which faces the area enclosed by the belt. Drive elements project from the feeding surface of the belt and may be in the form of pins which are spaced equidistant from each other; the increments between the pins being equal to the increments between the perforations of the document which is adapted to be driven by the mechanism. The drive elements may also have portions which project from the opposite or inner surface of the belt and which may be integral with the portions of the element which project from the feeding surface thereof. A frame supports the belt along the opposite or inner surface thereof and provides a bed along a linear path which may be disposed adjacent to the document to be fed. Driving means which may be disposed in the frame are provided for driving the belt. These driving means may be sprockets, at least one of which is a drive sprocket, while the other is an idler sprocket. The sprockets may be formed with hemi-cylindrical slots which engage the portions of the drive elements projecting from the opposite surface of the belt. These portions may be hemi-cylindrical and function as rollers in that as the sprockets turn, the drive elements roll with respect to the

hemi-cylindrical slots in the sprockets thus providing accurate, low friction drive for the belt. The entire assembly thus provides accurate guidance of the belt, extremely low mass with respect to its moving elements, and accurate entry and removal of the driving elements from the driven member, such as the computer form, at the perforations therein.

The belt and pins can be molded together to provide an integral structure. The capability for such a structure is provided by the aforementioned materials which have a high melting point or combustion temperature.

The foregoing and other objects and advantages of the present invention will become more readily apparent from a reading of the following description in connection with the accompanying drawings in which:

FIG. 1 is a perspective view of a sleeve mechanism for continuous computer forms which embodies the present invention;

FIG. 2 is an enlarged perspective view of a feed mechanism provided in accordance with the invention which is typical of the mechanism shown in FIG. 1;

FIG. 3 is a front sectional view of the mechanism shown in FIG. 2, the section being taken generally along the line 3—3 in FIG. 2;

FIG. 4 is a sectional view of the mechanism shown in FIG. 2, the section being taken along the line 4—4 in FIG. 3;

FIG. 5 is a fragmentary plan view showing a portion of the endless belt used in the mechanism shown in FIGS. 2 to 4;

FIG. 6 is a sectional view showing one of the belt drive elements in greater detail; the section being taken along line 6—6 in FIG. 5;

FIG. 7 is a sectional view similar to FIG. 6 showing another embodiment of the drive element;

FIG. 8 is a sectional view similar to FIG. 7 showing still another embodiment of the drive element-belt arrangement;

FIG. 9 is a plan view of the drive element shown in FIG. 8;

FIG. 10 is a sectional view similar to FIG. 8 of a drive element in accordance with still another embodiment of the invention;

FIG. 11 is a sectional view schematically illustrating the manufacture of the belt and drive elements of the type shown in FIGS. 6 or 10, with the mold closed; and

FIG. 12 is a sectional view schematically illustrating the manufacture of the belt and drive elements, as in FIG. 11, but with the mold open.

Referring first to FIG. 1, a continuous web 10 is shown in position for feeding by the feed mechanism provided in accordance with the embodiment of the invention illustrated herein. This web is typical of the continuous forms used in computer printers. The form has rows of perforations 12 along its marginal edges which are adapted to be engaged during feeding.

Feeding is accomplished by two feed mechanisms 14 and 16, each disposed under the document along the paths of the perforations 12. The mechanisms are mounted on a pair of parallel shafts 18 and 20. The shaft 20 is a drive shaft which is adapted to be driven through suitable gearing or chain drives from a power source, such as an electric motor. The other shaft 18 is a guide shaft. The feed mechanisms 14 and 16 are laterally positioned with respect to each other along the

shafts. Accordingly, by moving the mechanisms 14 and 16 closer or further away from each other, various width documents may be accommodated.

The mechanisms themselves are identical. It is a feature of this invention that separate right-hand and left-hand mechanisms are not required. The mechanisms may be used universally either as right-hand or left-hand mechanisms. Note that the drive shaft 20 is fluted, while the guide shaft 18 is not. Inasmuch as the feed mechanisms accommodated both fluted and unfluted shafts, they may have their positions reversed. Drive will be provided due to the fluting of the drive shaft 20.

The mechanisms each have frames 22 and 24 which support and define paths for endless belts 26 and 28, driving elements 30 project from the feeding surface of the belt. These are the pin portions of the driving elements 30 which enter the perforations 12 along linear paths defined by the frames 22 and 24. Drive for the belts is provided by sprockets 32, 34, 36 and 38; the journaled portions of which are visible in FIG. 1.

Pivotable guide plates 40 and 42, which have slots 44 and 46 through which the pin portion of the drive elements 30 project, are to hold the document 10 down against the feeding surface of the belts. It will be noted that alignment and edge guidance of the belts 26 and 28 is provided exclusively by the frames 22 and 24. The guide plates 40 and 42 merely prevent the documents from blowing off the feeding surfaces. The guide plates 40 and 42 are mounted on brackets 46 extending from the frames 22 and 24. Springs 48 bias the guide plates 40 and 42 downwardly upon the documents with minimal hold-down pressure. The brackets 46 and springs 48 together with ears of a U-shaped portion 50 of the guide plates 42 provide a detent mechanism for maintaining the plates 40 and 42 in the open position (as shown in the case of the plate 40). Accordingly the plates, when maintained in open position, as for document loading, will not fall by their own weight on to the document. The guide plates 40 and 42 must therefore be manually pivoted downwardly towards the documents to the position shown in the case of the plate 42.

By virtue of the materials used in the mechanism and the shapes of the parts thereof, they can readily be cleaned and also can be used in severe environments where resistance to corrosion, and cleanliness are problems (viz., in food or drug handling and processing).

Referring to FIGS. 2, 3 and 4, there is shown the feed mechanism 14. The frame 22 has two side plates 52 and 54. These plates have holes 54 and 56 for receiving the sprockets 32 and 34 (which may be installed at either end of the plates — i.e., in either of the holes 54 or 56). The plates are secured together in side-by-side relationship by a spacer bar 58 through which bolts 60 and 62 project.

The upper surfaces 64 and 66 of the plates are accurately machined to be flat and co-planar with each other. It is in the plane of these surfaces 64 and 66 that the feeding surface 68 of the belt lies. Spaced below the surfaces 66 and 68 are shoulders 70 and 72, which provide support surfaces for the surface of the belt 26 opposite to the feeding surface 68 thereof. The vertical walls 74 and 76 between the shoulders 70 and 72 and the surfaces 64 and 66, provide for edge guidance of the belt 26 and prevent any lateral meandering thereof

which could cause misalignment with the perforations in the documents 10 (FIG. 1).

The nature and characteristics of the belt 26 is an important feature of the invention. The belt is a strip of flexible material. The material is dimensionally stable and does not have more than negligible stretch. Other characteristics of the material are low modulus of elasticity, high tensile strength, high folding endurance and high melting or combustion point (for moldability as will be explained hereinafter). In addition to stainless steel, titanium, Mylar or Kapton may be used. Kapton for example, has a tensile modulus of 430,000 psi and its modulus of elasticity is so low that 13,000 psi of stress produces only 5 percent elongation of the belt 26, when made of this material. The selection of flexible belt materials can be made with regard to the above mentioned characteristics and examples. Metal of course is especially suitable such as stainless spring steel.

The strip is joined into an endless belt, preferably by overlapping at the location of one of the drive elements as shown in FIG. 6, the overlap portion being spot welded at at least two spots 78 and 80 (FIG. 6). Whereas timing belts which are generally available are made of fibrous material, rubber, nylon, or the like, the belt 26 is of the flexible material having the foregoing characteristics. It maintains its shape along curvilinear and linear paths defined by the frame 22, it also presents edges to the walls 74 and 76, which are stiff and straight and readily guided along the desired path. The materials are also heat resistant so as to be adaptable to molding of the drive elements 40 directly thereon as will be explained more fully hereinafter. Thus, the belt and its associated drive elements can be provided as an integral structure which can not change its shape or size over indefinite periods of use and have chemical and solvent resistance. It and the rest of the mechanism can even be sterilized.

The belt has perforations (holes) 82 therein at equidistant intervals along the belt. These perforations are located along the transverse of central longitudinal axis of the belt, and the increments are even-circular pitch increments; the circle being a circle having the diameter of the sprockets 32 and 34. Inasmuch as the spacing of the perforations 12 in the documents 10 are standard, the increments will correspond to such standard spacing.

The drive elements 30 are disposed in the perforations. These drive elements project transversely both from the feeding surface 68 of the belt and from the surface thereof opposite to that feeding surface 68. The portion of the feeding element 30 which projects through the feeding surface 68 is the pin portion 84 of the element. The portion of the element 30 which projects through the surface opposite to the feeding surface of the belt 26 is the driving means engaging portion thereof; the driving means being the sprockets 32 and 34, in this illustrative embodiment of the invention. These latter driving element portions are in the form of hemi-cylinders 86, where the diametral surface of the cylinders 86 is in juxtaposition with the surface of the belt 26 opposite the feeding surface 68 thereof. The hemi-cylinders 86 function as low-friction rollers in cooperation with the sprockets 32 and 34 and will be referred to hereinafter as the rollers 86.

The driving elements are shown in greater detail in FIGS. 5 and 6. The pin portion 84 of the element has

a cylindrical section 90 over which a cap 92 portion is located. The cap 92 is a segment of a sphere which has the same point of generation 94 as the hemi-cylindrical roller 86.

As shown in FIGS. 5 and 6, the ends of the belt 26 are disposed in overlapping relationship with their respective perforations 82 in alignment with each other. The drive element is then formed, as by molding, in the perforations 82. The overlapping ends of the belt 26 may be secured by spot welding at 78 and 80 prior to or after molding, preferably prior to molding. As shown in FIG. 5 the perforations 82 are square or some other non-symmetric shape and serve to key the drive elements, especially the rollers 86; thus preventing any interference at the sprockets 32 and 34.

The sprockets 32 and 34 are also interchangeable. The sprockets 32 have fluted holes 95 for receiving either the drive or guide shaft (FIG. 1). The sprockets have a central portion 96 and cylindrical side portions 98 which are journaled in the side plates 52 and 54 of the frame 22. As shown in FIG. 3, the central portion 96 of the sprocket has hemi-cylindrical slots 98 into which the rollers 86 of the drive elements fit and ride. The slots are at equi-distant increments along the pitch circle of the sprocket fluted portion 96. The rollers 86 thus roll while driven and have minimum frictional contact with the sprockets.

The drive elements are preferably made of low-friction material such as nylon. It has been found that the plastic material sold by General Electric Company of Schenectady, New York, under their Trade Name VALOX is especially suitable.

FIG. 7 illustrates a drive element 30 having a pin portion 84 including a screw tip 100 which screws into a threaded hole 102 in the roller portion 86, such screw fitting being a feature of the embodiment of the drive element illustrated in FIG. 7.

In FIG. 8 the belt 26 is formed with a downwardly projecting path 104 which fits into a slot 106 in the roller portion 86 of the drive element 30. The drive element 30 illustrated in FIGS. 8 and 9 has a pin portion 84 and roller portion 86. The pin portion has a lip 108 of square configuration which slopes downwardly from the pin portion 84 towards the roller portion 86 and defines a slot 110 into which the perforations 82 in the belt 26 may fit. The element 30 illustrated in FIGS. 8 and 9 is snap-fitted into the belt 26, by pressing the pin portion 84 upwardly through the perforations 82 until the belt lies over the lip 108 and snaps into the slot 110.

FIG. 10 illustrates a drive element 30 similar to the drive element illustrated in FIGS. 5 and 6. The belt 26 however is formed with tabs 112 at each perforation 82 to firmly anchor the drive element in the belt and prevent rotation or other movement of the element during operation of the feed mechanism. The element 30 and belt 26 as shown in FIG. 10, may be formed by molding, as was the case of the element shown in FIGS. 5 and 6.

The method of manufacturing the belt 26 and drive elements 30 by molding is illustrated in FIGS. 11 and 12. FIGS. 11 and 12 illustrate the manufacture of the belts by injection molding. The mold shown in FIGS. 11 and 12 shows the belt 26 with the mold in closed and open positions. The mold itself is a three-part mold having a base 114, a top 116, and a center portion 118. An injection nozzle 120 is provided for feeding hot

plastic material into the mold through a channel 122 formed when the mold is closed. It will be apparent that the molding process illustrated in FIGS. 11 and 12 may be accomplished very rapidly to mold each of the drive elements into the perforations in the belt 26 in very rapid sequence, and yields a molded-through belt assembly, which resists contact with abrasive material, such as the paper of many computer forms.

From the foregoing description it will be apparent that there has been provided improved feed mechanisms which have the advantage of highly accurate and high speed feeding of movable members, especially computer forms which are perforated. An important advantage of the invention is that feed mechanisms in accordance therewith may be readily manufactured at low cost. While an illustrative embodiment of the invention has been disclosed herein, it will be appreciated that variations and modifications thereof within the scope of the invention will undoubtedly suggest themselves to those skilled in the art. Accordingly, the foregoing description should be taken merely as illustrative and not in any limiting sense.

What is claimed is:

1. A feed mechanism which comprises:

a strip of flexible material having its thinnest dimension between a feeding surface and a surface closely adjacent thereto,

said strip being formed into an endless belt,

drive elements projecting transversely from the feeding surface of said belt,

a frame supporting said belt along the surface thereof opposite to said feeding surface,

driving means engaged with said belt,

said drive elements having a pin portion which projects through said feeding surface, said pin portion having a cylindrical base and a hemispherical cap on said base and a drive means engagement portion which projects through said opposite surface of said strip, said drive means engagement portion being a hemicylinder having its axis perpendicular to said pin portion, and its base in juxtaposition with said opposite surface, said pin having a hemispherical cap, the surface of said cap and said hemi-cylinder lying along a common circle, said strip being perforated at positions longitudinally spaced from each other, and said drive elements being disposed in said perforations.

2. A feed mechanism which comprises:

a strip of flexible material having its thinnest dimension between a feeding surface and a surface closely adjacent thereto,

said strip being formed into an endless belt,

a frame supporting said belt along the surface thereof opposite to said feeding surface, driving means engaged with said belt,

drive elements projecting transversely from the feeding surface of said belt, said drive elements having a pin portion which projects through said feeding surface, said pin portion having a cylindrical base and a hemispherical cap on said base, and a drive means engagement portion which projects through said opposite surface of said strip, said strip being formed into an endless belt, said strip being perforated at positions longitudinally spaced from each other, said drive elements are disposed in said perforations, and

said perforations each having a tab projecting therefrom into interlocking relationship with said drive elements therein.

3. A feed mechanism which comprises:

a strip of flexible material having its thinnest dimension between a feeding surface and a surface closely adjacent thereto,

said strip being formed into an endless belt,

a frame supporting said belt along the surface thereof opposite to said feeding surface,

driving means engaged with said belt,

drive elements projecting transversely from the feeding surface of said belt, said drive elements having a pin portion which projects through said feeding surface, said pin portion having a cylindrical base and a hemispherical cap on said base, and a drive means engagement portion which projects through said opposite surface of said strip, said drive means engaging element having a larger diameter than said pin portion as measured respectively at the opposite and feeding surfaces of said strip,

said strip being perforated at positions longitudinally spaced from each other, said drive elements being disposed in said perforations, and

said pin portion having a circumferential lip which tapers outwardly in the direction opposite from the cap thereof to define a slot between the bottom of said lip and the top of said drive means engaging portion for receiving one of said perforations in said strip when said drive element is snap fitted therein.

4. A feed mechanism which comprises:

a strip of flexible material having its thinnest dimension between a feeding surface and a surface closely adjacent thereto,

said strip being formed into an endless belt,

drive elements projecting transversely from the feeding surface of said belt, said drive elements having a pin portion which projects through said feeding surface, said pin portion having a cylindrical base and a hemispherical cap on said base;

a frame supporting said belt along the surface thereof opposite to said feeding surface, and

driving means engaged with said belt,

a drive means engagement portion which projects through said opposite surface of said strip; said perforations being selected from square and non-symmetric shapes,

said strip being perforated at positions longitudinally spaced from each other and said drive elements are disposed in said perforations.

5. A feed mechanism which comprises:

a strip of flexible material having its thinnest dimension between a feeding surface and a surface closely adjacent thereto,

said strip being formed into an endless belt,

drive elements projecting transversely from the feeding surface of said belt,

a frame supporting said belt along the surface thereof opposite to said feeding surface,

said frame includes a pair of side plates disposed along opposite edges of said belt, each of said plates having a shoulder extending along the path of said belt, each shoulder extending under said surface of said belt opposite to said feeding surface thereof;

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said plates each have guide surfaces above said shoulders, said guide surfaces extending linearly between the ends of said plates, said guide surfaces being coplanar with said feeding surface of said belt, said shoulders and said guide surfaces having a wall therebetween, said wall and said shoulders providing a guide for said belt along a linear path coplanar with said guide surfaces and, driving means engaged with said belt.

6. The invention as set forth in claim 5 wherein said drive elements include pin portions and hemi-cylindrical lugs, which are spaced in equi-distance from each other along a predetermined circular path, said drive means comprising a pair of sprockets journaled in said frame between the plates thereof, said sprockets having peripheries which define said circular path, said sprockets also having hemi-cylindrical slots therein spaced along said path by distances equal to the spacing of said lugs.

7. The invention as set forth in claim 6 wherein said feed mechanism includes a pair of the mechanisms as defined in claim 5, a drive shaft and a guide shaft, disposed in parallel relationship, said drive shaft extending into and in driving relationship with a first sprocket on each of said mechanisms, and said guide shaft extending into the second of said sprockets of each of said mechanisms, said mechanisms being spaced laterally from each other along said shafts.

8. The invention as set forth in claim 7 wherein a perforated web is disposed on said guide surfaces of said mechanisms with the perforations therein in engagement with the pins projecting from the belts of said mechanisms, each of said mechanisms having a slotted

guide plate pivotally mounted on the frames thereof, said guide plates being pivotable onto guide surfaces thereof to hold down said web on said guide surfaces with said pin portions projecting through said slots in said guide plates.

9. A feed mechanism which comprises:

a strip of flexible material having its thinnest dimension between a feeding surface and a surface closely adjacent thereto,

said strip being formed into an endless belt, drive elements projecting transversely from the feeding surface of said belt,

said strip being perforated at positions longitudinally spaced from each other and said drive elements are disposed in said perforations;

said drive elements having a pin portion which projects through said feeding surface, said pin portion having a cylindrical base and a hemispherical cap on said base; and

a drive means engagement portion which projects through said opposite surface of said strip;

a frame supporting said belt along the surface thereof opposite to said feeding surface, and

driving means engaged with said belt, and said pin and drive means engaging portion being integral with each other and formed by molding on to said strip,

said belt and said drive elements being of dissimilar materials made into an integral assembly by placing said belt in a mold and injecting said drive element materials into said mold and through said belt perforations.

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