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(54) 180 Degree cleaning blade holder.

(57) A cleaning blade holder that has a top portion (90), and bottom portion (95) which contains a groove (40) into which a protruding rib (65) on the back side surface of the blade (60) fit. An alternative bottom portion (94) has a plurality of nodules (100) that interconnect with apertures in corresponding positions along the length of the blade body. The blade holder holds the blade body in a horizontal position allowing the edges on either side of the blade body to extend from the holder. Each side of the blade body provides two edges (60a,60b,60c,60d). Rotation of the blade holder produces a new cleaning edge. Two other cleaning edges are produced by reversing the blade body in the holder and rotating the blade holder again between positions one and two.

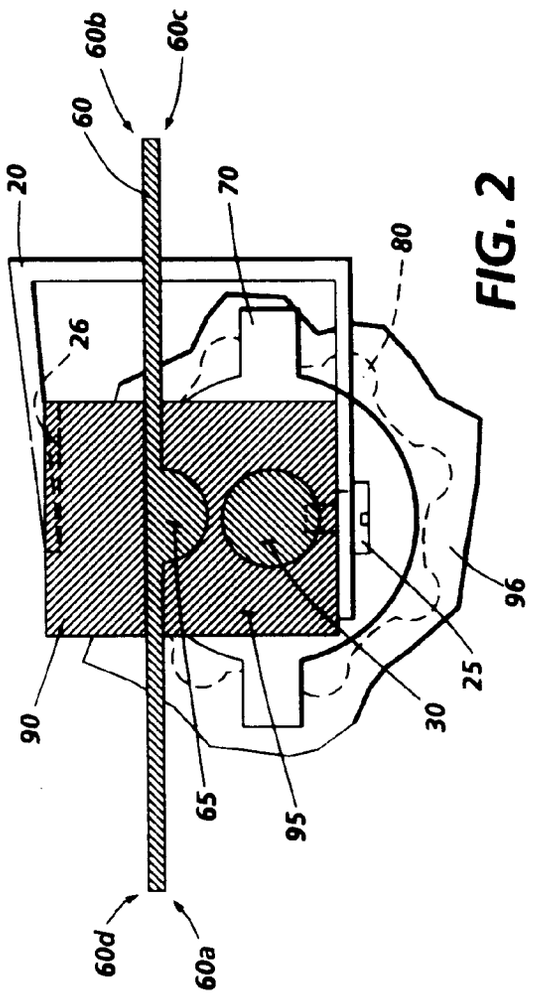

FIG. 2

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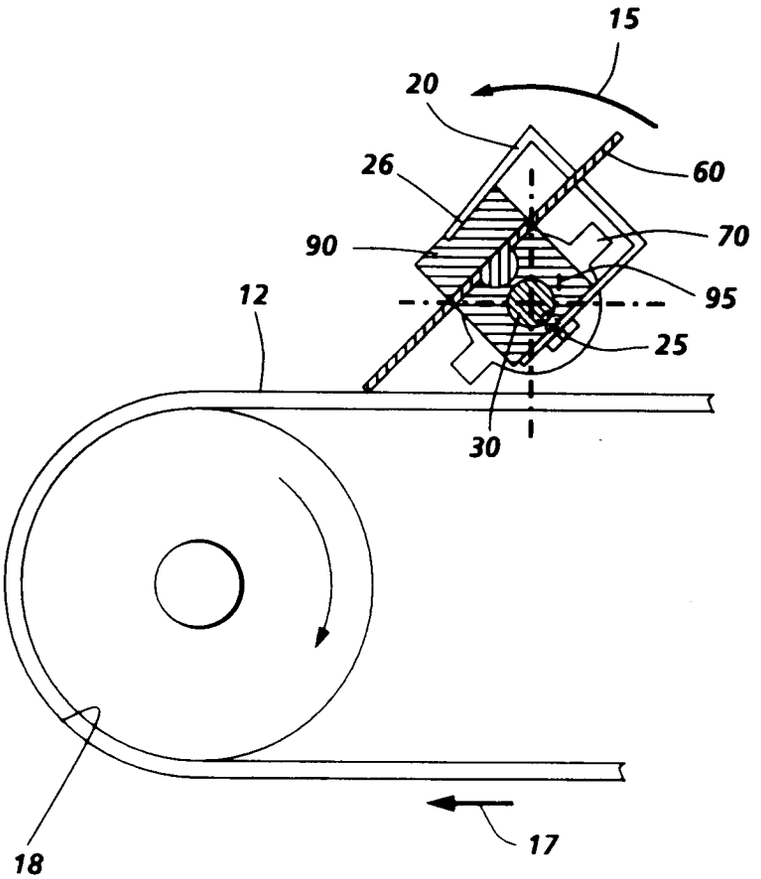

FIG. 4

This invention relates generally to electrophotographic printing and, more particularly, to apparatus used in electrophotographic printing to remove particles adhering to the imaging surface.

In the process of electrophotographic printing, a photoconductive surface is charged to a substantially uniform potential. The photoconductive surface is imagewise exposed to record an electrostatic latent image corresponding to the informational areas of an original document being reproduced. This records an electrostatic latent image on the photoconductive surface corresponding to the informational areas contained within the original document. Thereafter, a developer material is transported into contact with the electrostatic latent image. Toner particles are attracted from the carrier granules of the developer material onto the latent image. The resultant toner powder image is then transferred from the photoconductive surface to a sheet of support material and permanently affixed thereto.

This process is well known and useful for light lens copying from an original and printing applications from electronically generated or stored originals, and in ionography.

In a reproduction process of the type as described above, it is inevitable that some residual toner will remain on the imaging (i.e. photoreceptive, photoconductive) surface after the toner image has been transferred to the sheet of support material (e.g. paper). It has been found with such a process that the forces holding some of the toner particles to the imaging surface are stronger than the transfer forces and, therefore, some of the particles remain on the surface after transfer of the toner image. In addition to the residual toner, other particles, such as paper debris (i.e. Kaolin, fibers, clay), additives and plastic, are left behind on the surface after image transfer. (Hereinafter, the term "residual particles" encompasses residual toner and other residual particles remaining after image transfer.) The residual particles adhere firmly to the surface and must be removed prior to the next printing cycle to avoid interfering with recording a new latent image thereon.

Various methods and apparatus may be used for removing residual particles from the photoconductive imaging surface. Hereinbefore, a cleaning brush, a cleaning web, and a cleaning blade have been used. Both cleaning brushes and cleaning webs operate by wiping the surface so as to effect transfer of the residual particles from the imaging surface. After prolonged usage, however, both of these types of cleaning devices become contaminated with toner and must be replaced. This requires discarding the dirty cleaning devices. In high-speed machines this practice has proven not only to be wasteful but also expensive.

The shortcomings of the brush and web made way for another now prevalent,form of cleaning known and disclosed in the art --- blade cleaning. Blade cleaning involves a blade, normally made of a rubberlike material (i.e. polyurethane) which is dragged or wiped across the surface to remove the residual particles from the surface. Blade cleaning is a highly desirable method, compared to other methods, for removing residual particles due to its simple, inexpensive structure. However, there are certain deficiencies in blade cleaning which are primarily a result of the frictional sealing contact that must occur between the blade and the surface. This frictional sealing contact often leads to blade failure and as a result requires blade replacement.

To change a cleaning blade in a conventional xerographic copier a customer service engineer (CSE), technical representative or the like, must, for every blade change, perform sometimes as many as 24 process steps that include completely removing the photoreceptor belt module.

The conventional process for installing the cleaning blade (average size of the cleaning blade is about a 37 cm x 1.8 cm x 0.2 cm urethane slab) in its present holder requires the CSE to push the blade into the holder channel until the blade reaches maximum penetration (about 1.1 cm) along the entire length of the blade. This is not a simple operation. The blade uses a friction fit to hold the blade in position inside its holder. The blade's snug fit causes it to stick to the sides of the holder and resist being pressed into the channel. Since the blade is pliable, the blade bends as the CSE tries to push it into its proper position, making the job difficult.

It requires a lot of practice to be able to accomplish the task of installing a new blade in this manner. Even after the blade is finally inserted into the holder channel, it is not obvious whether or not the blade is properly aligned for an even cleaning edge. Although cleaning blades have been able to clean when installed slightly skewed, a skewed blade can also cause photoreceptor tracking problems. These tracking problems can cause premature failure of the photoreceptor and other failures. A skewed cleaning blade also wears unevenly and causes premature failure of the blade. It is an object of the present invention to enable easier insertion of the blade so that skewing of the blade does not occur.

The following disclosures may be of interest:

US-A-4,202,437 to Gordon discloses a conveyor belt scraper assembly to remove foreign matter from a conveyor belt. This design allows rapid and efficient replacement of worn out blades. The scraper assembly is mounted on a pair of slide housings which allows adjustment of the angular orientation of the blade to compensate for substantial wear on the scraper edge. A scraper core holds three blades, all 120 degrees apart which may be used substitutively when one blade wears out. The blades consist of two working edge surfaces so that when one surface is dimin-

ished and unusable, the mounting can be reversed to provide a new working surface.

US-A-4,311,094 to Ellison discloses a method and apparatus for removing foreign matter from a printing plate mounted on a cylinder. A pair of parallel, spaced flexible blades contact the surface of the plate whereby one blade spreads and thins ink on a surface while the other blade dislodges and removes them from the surface. The blades are supported by a mounting member which extends across the entire width of the printing plate and is parallel to the axis of the plate cylinder.

US-A-4,328,888 to Luke discloses a conveyor belt scraper blade in which one longitudinal axis makes contact with a conveyor belt surface to be scraped. The blade extends in opposite lateral directions beyond the periphery of a metallic reinforcing strip to provide two scraper edges. The hard rubber blade, bonded to a metallic reinforcing strip, makes contact with the conveyor belt and scrapes foreign matter therefrom. After wearing of one edge of the blade, the worn blade may be released from the supporting arrangement and reversed to present its other edge to the belt surface.

The present invention provides an apparatus for cleaning particles from an imaging surface, comprising means for cleaning particles from the imaging surface where the cleaning means has at least two surfaces; and means for holding the cleaning means where the holding means is movable to position one of the surfaces in contact with imaging surface, with the other of the surfaces being remote therefrom.

By way of example only, embodiments of the invention will be described with reference to the drawings, in which:

Figure 1 is a schematic elevational view of a rotatable blade holder;

Figure 2 is a sectional view of the blade holder containing a ribbed blade body;

Figure 3 is a schematic view illustrating the separate components of the blade holder;

Figure 4 is a schematic elevational view illustrating the orientation of the blade holder and the blade angle in operation;

Figure 5 is a schematic of the blade holder with an alternative blade body configuration; and

Figure 6 is a sectional view of the alternative blade body configuration of Figure 5.

Figure 1 shows a rotatable blade holder having a top component 90 and a bottom component 95 held together on each end by a spring clip or clamp 20. The bottom component 95 has a channel through which a shaft 30 is inserted. The shaft 30 extends through the channel in the base of the bottom component 95 into bearings 97, one on each end of the shaft 30, that anchor the blade holder in the machine frame 96. A spring 10 is helically wound about one end of the shaft 30 between the bearing 97 and the side edge of the bottom component 95 of the blade holder. The spring 10 expands and contracts in the directions indicated by the arrow 14. The other end of the shaft 30, opposite the shaft 30 end with the helically wound spring 10, terminates in a knob 80. The knob 80 is used to rotate the entire blade holder to the desired position to place a cleaning edge of the blade body 60 in line contact with an imaging surface (not shown in Figure 1) in order to clean the surface of residual debris. The knob 80 is pressed forward, in the direction indicated by arrow 13, after which the blade holder is rotated 180 degrees to bring another cleaning edge in contact with the imaging surface. As the knob 80 is pressed forward, the spring 10 contracts and the key 70 also moves forward in the direction of arrow 13. Figure 1 depicts, via phantom lines, the forward movement of the key 70 and the knob 80 when pressed in for rotation. When the knob 80 rotates the blade holder to the desired blade cleaning position, the knob 80 is released allowing the spring 10 to expand to its initial position, thus moving the key 70 and the knob 80 back to their original positions. There are slots in the key block 73 that allow the key 70 to lock into position upon each rotation of 180 degrees or whatever is the desired locking position.

The upper portion of the bottom component 95 of the blade holder, located above the shaft 30 channel, has a trough or indentation 40 in which a blade rib 65 fits. The rib 65 is inserted into the trough 40 to guide the blade body 60 into proper alignment within the blade holder. The blade holder top component 90, in the figure, lies along the longitudinal center line of the top surface of the blade body 60. The top component 90 and the bottom component 95 of the blade holder are fastened together by a spring clamp or clip 20 on either end of the blade holder assembly to hold the blade body 60 in place.

Figure 2 shows a sectional view of the blade holder in Figure 1. The spring clamp 20 has a pressure fit to hold the blade holder components 90, 95 together firmly. The top component 90 of the blade holder has a grove 26 into which the top end of the spring clamp 20 is slidably inserted. The bottom end of the spring clamp 20 has a pronged shape that forms a pressure fit around the neck of a screw 25 that extends from the base of the bottom component 95 of the blade holder. The screw 25 extends far enough from the base of the bottom component 95 of the blade holder, to allow the pronged end of the spring clamp 20 to fit between the head of the screw 25 and the base of the blade holder bottom 95. The end of the screw 25 terminates in the shaft 30 enabling a secure hold between the shaft 30 and the bottom component 95 of the blade holder.

To rotate a cleaning blade installed in the blade holder to a new edge is a simple task, as described below. When copy quality is a problem and the cleaning blade is the suspected culprit, the customer can

be directed to rotate the blade.

With continued reference to Figure 2, the blade body 60 has a total of four cleaning edges 60a, 60b, 60c, 60d that extend laterally outside of the blade holder assembly. When the blade holder assembly is in its initial cleaning position (1), the cleaning edge 60a is in line contact with the photoreceptive surface (shown in Figure 4). When the blade edge 60a requires replacing, the blade holder assembly is rotated 180 degrees to second position (2). The second cleaning edge 60b is then placed in line contact with the imaging surface.

The stationary blade holder makes removal of the blade body 60 (when it is no longer usable on the first two cleaning edges 60a, 60b) much easier. Although blade removal requires removal of the photoreceptor, the removal task is simplified because the top component 90 of the blade holder can be totally separated from its bottom component 95 allowing a new blade edge 60d to be easily brought into position. When another new cleaning blade edge is required, the spring clamps 20 are unfastened to allow separation of the top component 90. The blade body 60 is removed, reversed and then reinserted in the blade holder using the rib 65 for proper alignment of the blade edges. After reassembling the blade holder assembly, the blade holder assembly is rotated 180 degrees back to position (1), and a third new cleaning edge 60d is in line contact with the photoreceptive surface to clean the photoreceptive surface. Rotating the blade assembly 180 degrees to position (2), prepares the fourth cleaning edge 60c for cleaning of the photoreceptive surface. The design of the blade body 60 and the blade holder, with the mating rib 65 and groove 40 (see Figure 1), aid proper blade alignment. The order of use of the cleaning edges 60a, 60b, 60c, 60d and rotation between the two positions of the blade holder for cleaning can be varied.

Figure 3 shows the blade holder and its separate components. As already described, the top component 90 of the blade holder is detachable from the remainder of the blade holder assembly when the spring clips 20 are removed. The grooves 26 exist on each end of the top surface of the top component 90 for the top part of a spring clip 20 to be slidably inserted. The screw 25 extends from the base of the blade holder, to secure the bottom part of the spring clip 20. The blade body 60 lies horizontally between the top component 90 and the bottom component 95 of the blade holder. The blade body 60 is aligned in the blade holder by insertion of the rib 65, that extends lengthwise down the centerline of the blade body 60, into the trough 40 in the bottom component 95 of the blade holder. (The rib 65 can be molded or bonded to the bottom surface of the blade body.) The trough 40 extends the length of the blade body 60 down the center line of the bottom component 95 of the blade holder. The shaft 30 runs through a channel under the trough 40 in the blade holder's bottom component 95. Also shown in Figure 3 is the key 70 that locks the blade holder in place after rotation, the knob 80 in phantom lines, for rotating the blade holder, and the machine frame 96.

Figure 4 shows the orientation of the blade holder and the blade angle when the copier is in operation. The cleaning blade edge has an angle of 15 to 25 degrees when the copier is in operation. Figure 4 shows one of the four cleaning edges in line contact with the photoreceptive surface 12. The arrow 15 indicates the direction of rotation of the blade holder. The blade body 60 has two cleaning edges (60a, 60d, and 60b,60c respectively on each side of the blade body 60, protruding from the blade holder. The photoreceptor belt 18, as shown, moves in the direction of arrow 17. The figure shows the cleaning blade edge operating in the doctoring mode. However, the cleaning blade edge can operate in either the wiping or doctoring mode.

Figure 5 shows a blade holder with an alternative blade body configuration. This figure shows a blade body 61 that has a series of apertures or holes through which nodules or nubbins 100 are inserted. The nodules 100 are located on the top surface of the bottom component 94 of the blade holder and extend upward through the coinciding holes in the blade body 61. The ends of these nodules 100 terminate in mating indentations on the bottom surface of the top component 90 of the blade holder. The blade holder assembly and operation of Figure 1 is also applicable to this figure providing some adjustments are made for the alternate blade body 61. This figure's blade body 61 utilizes nodules 100 and apertures instead of a rib 65 (shown in Figure 1) to align the blade edge and secure the blade body 61 into the blade holder assembly. However, the blade body 61 of Figure 5 still provides four cleaning edges 61a, 61b, 61c, 61d as shown in Figure 6. These four cleaning edges achieve line contact with the photoreceptive surface in the same manner as the cleaning edges 60a, 60b, 60c 60d of the ribbed blade body 60 described Figure 4.

Figure 6 shows a sectional view of the blade holder assembly in Figure 5. The top component 90 of the blade holder has a groove 26 into which the top end of the spring clamp 20 is slidably inserted. The ends of the nodules 100 are received by the mating indentations of the top component 90 of the blade holder. The blade body 61 is held in place by a series of nodules 100 inserted through apertures or holes in the blade body 61. The blade body 61 has four cleaning edges 61a, 61b, 61c and 61d. The bottom end of the spring clamp 20 has a pronged shape that forms a pressure fit around the neck of the screw 25 that extends from the base of the bottom component 95 of the blade holder. The screw 25 extends far enough from the base of the bottom component 94 of the blade holder, to allow the pronged end of the spring

clamp 20 to fit between the head of the screw 25 and the base of the blade holder bottom component 94. The end of the screw 25 terminates in the shaft 30, to securely hold the shaft 30 in the bottom component 94 of the blade holder.

In conventional blade cleaning apparatus, misaligned blade is not an uncommon problem. Out of a small population of randomly chosen used blades, 14% had a magnetite stain that indicated skewed wear. This wear pattern can be caused by the photoreceptor not tracking properly or the cleaning blade not being installed properly Since it is much easier to misalign the blade than the photoreceptor it can safely be assumed that most of these blades were not correctly installed. After the CSE has loaded the blade into its holder, the holder must be clipped (at two locations) onto cleaning assembly brackets inside the machine. Another easy error for the CSE to make is to clip only one side of the holder into position. At a quick glance the holder will appear to be properly installed. This error has also been observed in operating copiers, but it should be noted that this error causes the same problems cited earlier pertaining to skewed blades.

To decrease the service time needed to change the cleaning blade to less than one minute and to reduce the steps required to accomplish this task, a 180 degree rotating cleaning blade holder as described above can be installed. This blade holder, as already described, includes a stationary holder and an improved blade design that has four cleaning edges (see Figures 1 through 6). By using this holder, the cleaning blade potentially has double the life of a conventional blade before the blade actually needs to be replaced.

One known form of blade failure is entrapment of a particle, causing a streak on the photoreceptor. It has been noted that a particle trapped on the surface of a photoreceptor can sometimes be released by moving the cleaning blade away from the photoreceptor then returning it to its working position. When a streak failure is observed using a blade holder as shown in the drawings, the customer or CSE could easily cam back the cleaning blade, rotate the holder, then test to see if the failure persists.

For the cleaning blade to seal against the photoreceptor surface and insure proper cleaning, the blade holder must be sufficiently rigid to prevent bowing. It is recommended that rigidity calculations be performed and an appropriate material be selected for the new holder so that it will provide a uniform blade load across the photoreceptor.

The typical blade material for cleaning blades is polyurethane. The common fabrication of polyurethane cleaning blades is through the use of a centrifuge. For blade holders as shown in the drawings, it is preferred that the cleaning blade be made without the use of mold release because mold release reduces the reliability of the "mold side" of the cleaning blade. However, if the blade is fabricated using mold release in the centrifuge, it is recommended that the cleaning blade edge be on the air side and not the mold side. Although it is possible to use the "mold side" for cleaning, it is not recommended that the cleaning blade be used on the "mold side" because of its reduced reliability (CSE's do occasionally use the mold side). One method of attaining four cleaning edges that are all from the air sides is to bond two separate blade bodies together on their mold sides, leaving only their air sides exposed on the top and bottom surface of the composite blade body. The overall thickness of the two laminated blades would be equivalent to the thickness of a conventional cleaning blade.

Cleaning blades made from various silicone materials are also being considered. Silicone blades are made without mold release which is believed to be a chief cause of the "mold side" unreliability problem.

In recapitulation, it is evident that the cleaning blade holders shown in the drawings are rotatable 180 degrees, between two positions, to allow four different cleaning edges from the same blade body to be used to clean the imaging surface before the cleaning blade must be replaced. In addition, the cleaner blade body reduces the time required to install a new blade and prevents uneven wear on the blade due to improper alignment upon installation. Two blade configurations are discussed above, the preferred configuration comprising a rib molded or laminated perpendicular to the lateral plane of the back surface of the blade body. The rib is used as a guide to easily align the blade body into a corresponding groove in the bottom component of the blade holder for an even cleaning edge. The rib also secures the blade body in place as the top component of the blade holder is clamped in place, allowing the cleaning blade edges to laterally extend from opposite sides of the blade holder. The alternative blade configuration comprises a series of apertures in the blade body through which nodules on the top surface of the blade holder's bottom component are inserted. The top component of the blade holder contains the mating indentions to the nodules, on the bottom component, to secure the blade body in place when the top and bottom components are clamped together. The four cleaning blade edges are similarly exposed as in the ribbed blade configuration discussed above.

Claims

1. An apparatus for cleaning particles from an imaging surface (12), comprising:

   a cleaning blade (60) having at least two cleaning edges (60a, 60b, 60c, 60d) spaced from one another; and

means (90,95) for holding said cleaning blade, said holding means being rotatable to position one of the cleaning edges in contact with the imaging surface.

2. An apparatus as claimed in claim 1, wherein said cleaning blade has at least one further cleaning edge and is reversible to position the further cleaning edge in contact with the imaging surface.

3. An apparatus as claimed in claim 1 or claim 2, wherein said holding means is rotatable about an axis parallel to the imaging surface.

4. An apparatus as claimed in any one of the preceding claims, wherein said cleaning blade has four cleaning edges spaced from one another, said holding means being rotatable to position one of the cleaning edges in contact with the imaging surface.

5. An apparatus as claimed in any one of the preceding claims, wherein said holding means rotates about 180 degrees to position another cleaning edge in contact with the imaging surface.

6. An apparatus as claimed in any one of the preceding claims, wherein said holding means holds said blade so that the cleaning edge contacting the imaging surface forms a frictional line contact.

7. An apparatus as claimed in claim 6, wherein the cleaning edge contacting the imaging surface forms a cleaning angle with the imaging surface.

8. An apparatus as claimed in claim 7, wherein the cleaning angle formed by the cleaning edge contacting the imaging surface ranges from about 15° to about 25°.

9. An apparatus as claimed in any one of the preceding claims, wherein the holding means comprises two components between which the cleaning blade is held, the components being separable to permit removal of the blade.

10. An apparatus as claimed in claim 9, wherein one of the said components includes means (40, 100) for locating the cleaning blade.

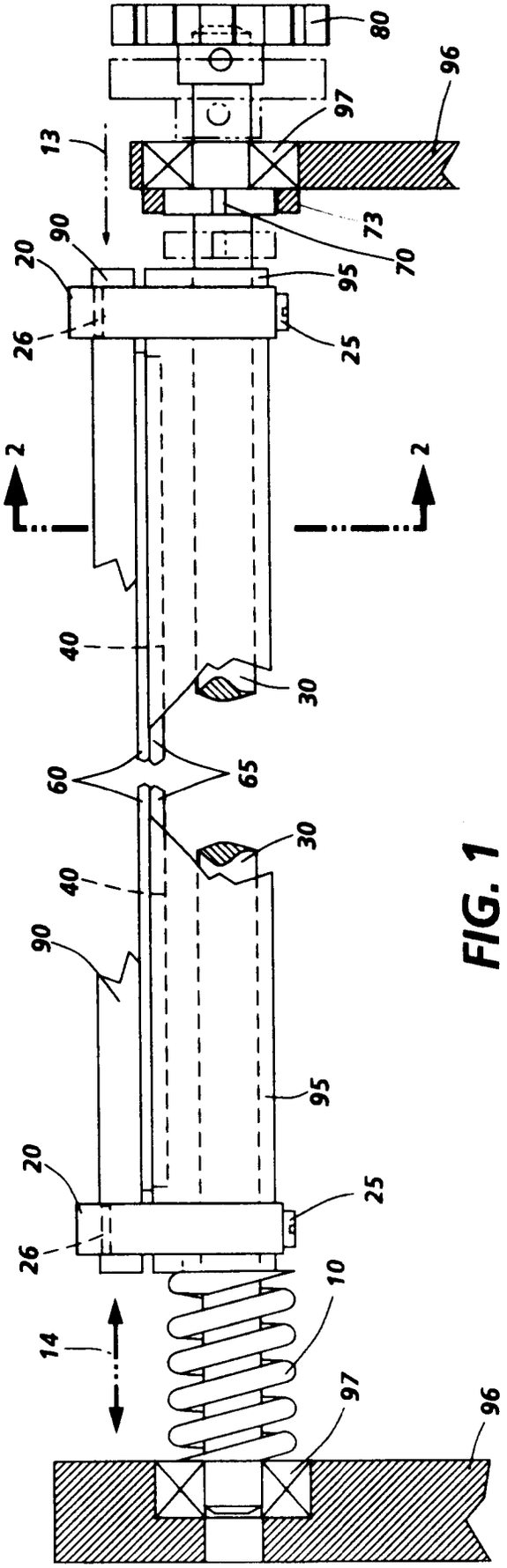
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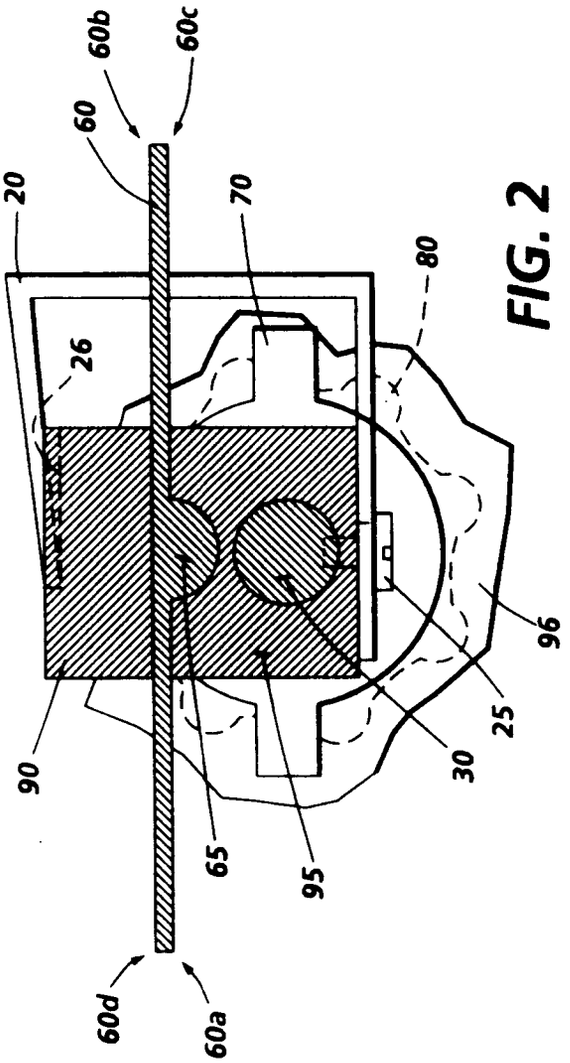
FIG. 1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60d
60a

FIG. 2

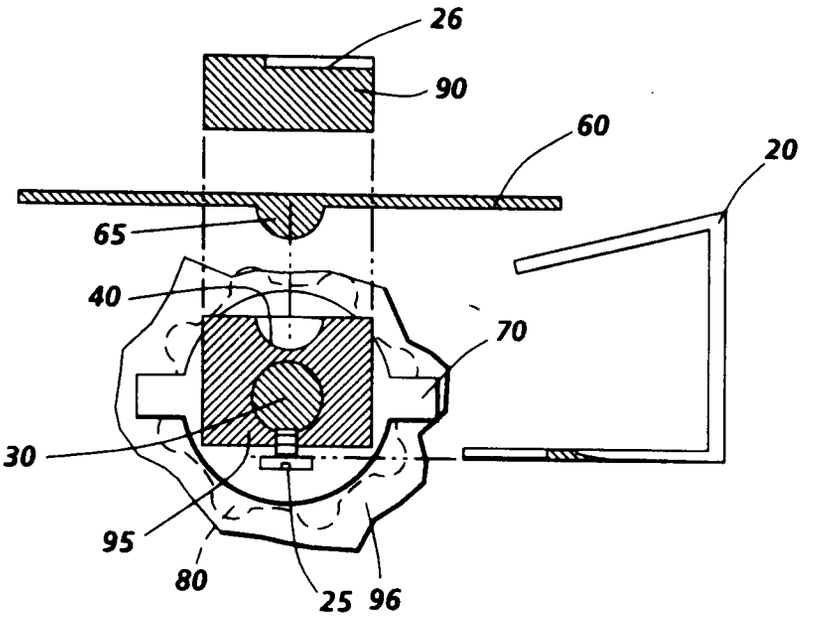

FIG. 3

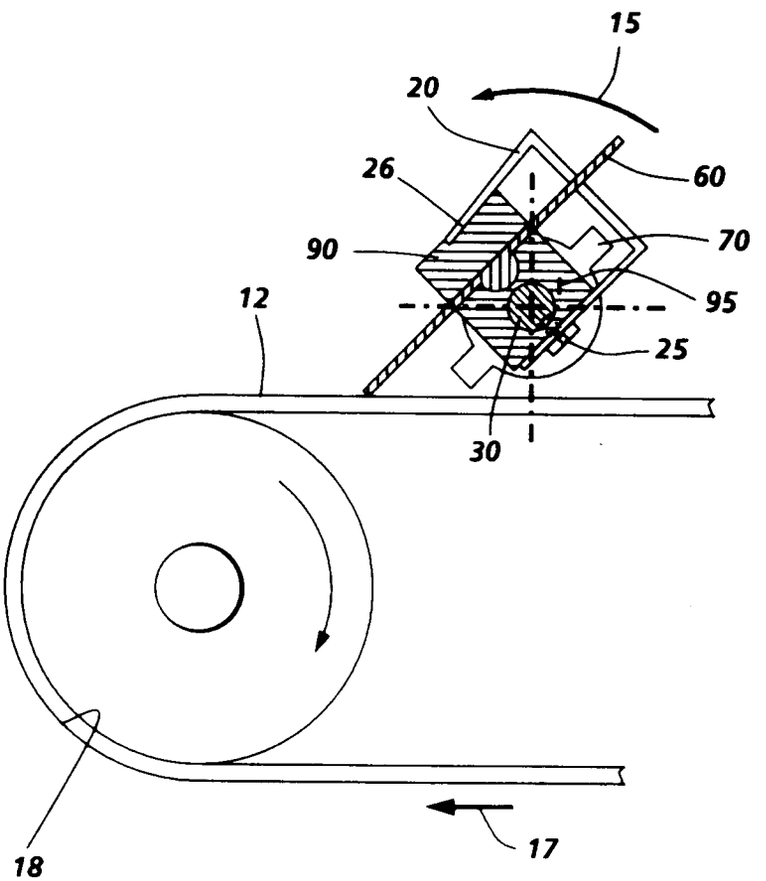

FIG. 4

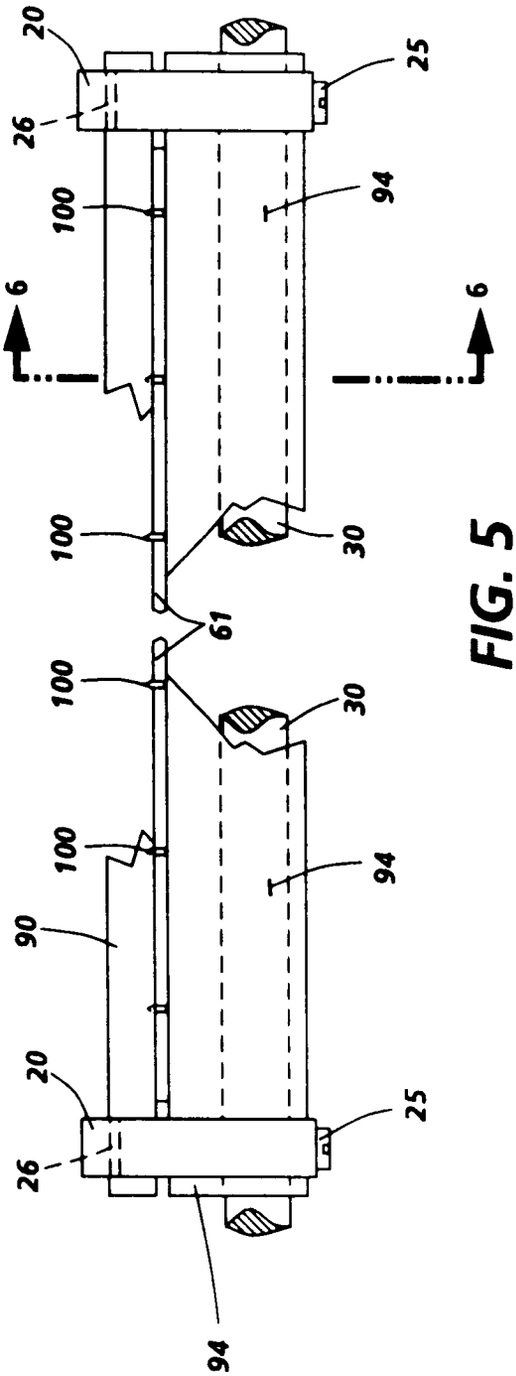
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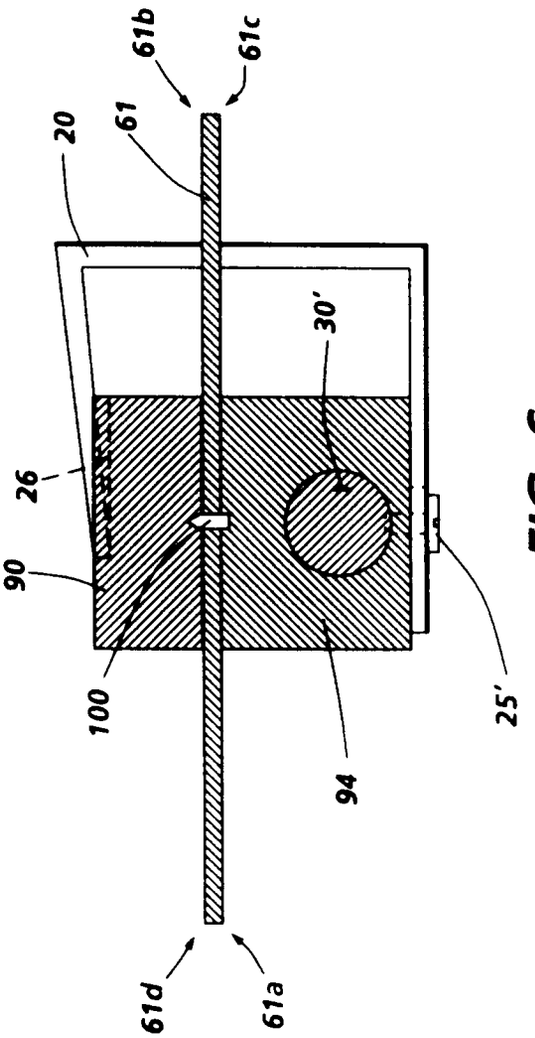
FIG. 5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100
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FIG. 6