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(54) Ribbon blender having a plurality of sections jointly forming ribbons.

(57) A ribbon blender (32) has a shaft (34), and a plurality of blender sections (40, 42, 44) are positioned on the shaft and rotate with it. Three types of modular ribbon blender sections are used in forming the blender, including a center section (44) and first and second end sections (40, 42) assembled on opposite sides of the center section. The end sections are substantially the mirror image of each other. Each of the sections have a hub portion (46, 60, 72) and first ribbon segments (54, 68, 80) and second ribbon segments (56, 70, 82) located in generally helical paths that are spaced from the hub portion. The sections are assembled on the shaft so that the ribbon segments of one section form a continuation of segments of an adjacent section, thus forming substantially continuous helical ribbons around the shaft. The ribbon segments (80, 82) of the center section join an outer ribbon segment of one of the end sections with an inner ribbon segment of the other ribbon section to provide for cross mixing of material in the area of the center section of the ribbon blender. Such a ribbon blender is especially useful for mixing developer material in the sump of an electrographic apparatus, such as a copier/duplicator.

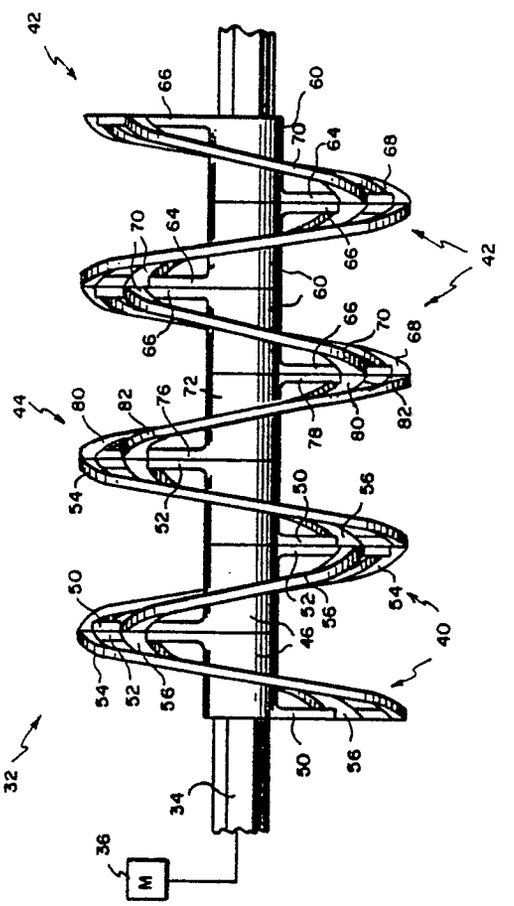

FIG. 2

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RIBBON BLENDER HAVING A PLURALITY OF SECTIONS JOINTLY FORMING RIBBONS

This invention relates to an improved ribbon blender construction especially useful for mixing developer material in the sump of an electrographic copier/duplicator or the like.

European Patent Application Number 86 111 950.1 entitled "Electrographic Development Apparatus and Method: discloses a copier/duplicator having a continuous coil ribbon blender located in the sump of a development station for mixing developer material. The ribbon blender includes a rotatable shaft having a plurality of radially extending holes spaced longitudinally and circumferentially about the axis of the shaft. Rods project radially from the holes. Continuous ribbons are threaded around the shaft accurately located with respect to the shaft and rods, and then secured to the rods by spot welding, for example.

While such a ribbon blender has worked well, there are some disadvantages to that construction. More specifically the ribbon blender is somewhat difficult to make because it requires accurate drilling of holes in the shaft, securing the rods in place and then threading and spot welding the ribbons to the rods. Care must be taken to assure proper positioning of the ribbons with respect to the shaft as well as the rods. In addition, a ribbon blender as disclosed in such application is somewhat expensive due, in part, to the manner in which it is constructed. Also, it is not a modular construction and thus is normally fabricated for a sump of a specific length.

An object of the present invention is to provide an improved ribbon blender for mixing material in a sump which is relatively inexpensive and simple to manufacture. Another object of the invention is to provide a ribbon blender for mixing a supply of developer material in a sump of a development station of electrographic apparatus which is modular in construction and can be made of substantially any desired length by adding or subtracting modular sections of the blender.

The objects are accomplished with a ribbon blender having an elongate rotatable shaft, which is characterized by a plurality of ribbon blender sections coupled to the shaft for rotation with the shaft. Each blender section has a hub portion with an opening for receiving the shaft, and each section has first and second ribbon segments located in generally helical paths and are spaced from the shaft. Each of the ribbon segments of one section is a continuation of a segment of an adjacent section so that the segments jointly form substantially continuous helical ribbons around the shaft. The helical path of the ribbons around one portion of the shaft is opposite to the path of the helical ribbons around another portion of the shaft so that rotation of the shaft effects movement of material in the sump in two opposite directions.

In the detailed description of the preferred embodiment of the invention presented below, reference is made to the accompanying drawings is which:

Fig. 1 is a fragmentary cross-section view of a development station for an electrographic copier/duplicator or the like incorporating a ribbon blender of the present invention;

Fig. 2 is a fragmentary elevation view of the ribbon blender itself; and

Figs. 3, 4 and 5 are views of three modular blender sections used in fabricating the ribbon blender of Fig. 2.

Referring initially to Fig. 1 of the drawings, development apparatus generally designated 10 is adapted to provide a supply of marking particles, such as toner, to an electrostatic image formed on a photoconductor 12 of electrographic copier/duplicator apparatus to develop the image. The photoconductor can be in the form of an endless web, or drum, or discrete sheets. The photoconductor is moved in the direction shown by the arrow in Fig. 1 along a path leading past the development apparatus 10 during operation of the electrographic apparatus. The image developed on the photoconductor can be fused to the photoconductor or can be transferred to a receiver sheet and fused on such sheet, as is well known in the electrographic arts.

The development apparatus 10 has an elongate housing 14. A magnetic brush 16 located in the upper portion of housing 14 extends substantially the entire length of the housing and is closely adjacent to the path of the photoconductor 12. The magnetic brush can be of any suitable construction. The brush shown by way of example comprises a core 18 having a series of permanent magnets 20 concentrically arranged around the core 18. The core and magnets are rotatable in a clockwise direction as viewed in Fig. 1 by a motor (not shown). Magnets 20 are arranged so that the poles at the outer portions thereof are alternately north and south poles. Concentric with the core 18 and magnets 20 is a cylindrical, non-magnetic shell 22. The shell can be stationary or it can be driven in a clockwise direction, for example. The magnets 20 attract magnetic developer material against the shell and rotation of the core brings such material into contact with the lower or insulating surface of the photoconductor 12 in a conventional manner.

A feed skive 23 has an edge adjacent to the surface of shell 22. Skive 23 limits the thickness of developer material carried to photoconductor 12 by the brush 16. A wiper 25 removes developer material from shell 22 after such material has been carried past the area of contact with the photoconductor.

Housing 14 has a first generally cylindrical recess 24 along one longitudinal side edge portion of the housing and a second generally cylindrical recess 26 adjacent to recess 24 and located slightly above the recess 24. Recess 24 and adjacent areas of the housing 14 define a sump 28 for developer material (not shown). Sump 28 extends substantially the full length of the housing 14 and eliminates the need for a separate end sump for mixing developer as required in some prior apparatus. Development apparatus as generally described above is disclosed in more detail in the beforementioned copending European Patent Application Number 86 111 950.1.

In accordance with the present invention, an improved ribbon blender generally designated 32 is provided in sump 28. The lower portion of the blender is generally adjacent but spaced from the cylindrical recess 24 of housing 14. The blender is used to mix developer material in the sump and triboelectrically charge such material before it is delivered to magnetic brush 12. A ribbon blender has been found to be especially desirable for mixing developer material having "hard" permanent magnetic carrier particles. Such a material is disclosed in U.S. Patent No. 4,546,060, issued on October 8, 1985.

As best illustrated in Figs. 1 and 2, ribbon blender 32 has a shaft 34 which can be driven by a motor shown diagrammatically at 36 in Fig. 2 in order to rotate the ribbon blender in the direction indicated by the arrow in Fig. 1. The shaft preferably is non-circular in shape and, in the preferred embodiment illustrated, is hexagonal to provide a series of flat longitudinally extending surfaces.

Mounted on shaft 34 are a plurality of modular ribbon blender sections of three different configurations. These sections are best illustrated in Figs. 2-5 and are generally designated 40 for the sections shown on the left end portion of the shaft in Fig. 2, 42 for the sections shown on the right end portion of the shaft in Fig. 2, and 44 for the single section located at the center portion of the shaft between sections 40 and 42.

As shown in Figs. 2 and 4, ribbon blender section 40 comprises a generally cylindrical hub portion 46 that has an opening 48 that is the same shape as the shaft 34 and only slightly larger so that the section 40 can be assembled on the shaft by threading the shaft through the opening 48 and sliding the section along the shaft. The section 40 is coupled to the shaft for rotation with the shaft by the close fit between the surfaces of shaft 34 and opening 48. Located at opposite ends of the hub portion 46 are ribbon supports 50, 52 which project in a radial direction and which are located at generally diametrically opposite portions of the hub 46.

Blender section 40 further comprises an outer ribbon segment 54 and an inner ribbon segment 56. Both of the segments have end portions connected to the supports 50, 52 and extend in a generally helical manner around the hub portion 46 and spaced from the hub section. The ends of a segment 54 are connected to the outer end portions of the supports while the ends of a segment 56 are connected to the supports between the hub 46 and the segment 54. Because the ribbon segments 54, 56 extend in different directions around the shaft, rotation of the section by the shaft 34 to effect movement of the ribbon segments causes material in the sump to be moved in one direction by ribbon segments 56 and in the opposite direction by ribbon segments 54. This will be explained in more detail later.

Referring now to Figs. 2 and 5, ribbon blender section 42 is substantially the mirror image of the blender section 40. More specifically, section 42 comprises a hub portion 60 having a hexagonal opening 62 for receiving shaft 34 in order to key the sections 42 to the shaft for conjoint rotation of the shaft and sections. Projecting from opposite ends of the hub portion 60 are supports 64, 66 which extend in radial directions and substantially 180 degrees from each other. Section 42 has an outer ribbon segment 68 and an inner ribbon segment 70, both of which extend substantially 180 degrees around the hub portion 60 and the axis of rotation of shaft 34. The ends of the ribbon segments 68, 70 are attached to the supports 64, 66. The segment 68 has its ends attached to the outer ends of the supports 64, 66 while a segment 70 has its ends connected to the supports between the hub and the ends of segment 68. Outer ribbon segment 68 of section 42 extends around the left side of hub portion 60, as viewed in Fig. 5, whereas the corresponding outer ribbon segment 54 of section 40 extends around the right side of the hub portion 46 thereof. Similarly, the inner ribbon segment 70 of section 42 extends around the right side of the hub portion 60 whereas the inner ribbon segment 56 of section 40 extends around the left side of the hub portion 46. When sections are rotated by the shaft, the outer ribbon segments 68 tend to move developer material in one direction along the axis of the shaft 34 and the hub portion 60 while the inner ribbon segments 70 tend to move material in the opposite direction.

Referring now to Figs. 2 and 3, ribbon blender section 44 also has a hub portion 72 with a hexagonal opening 74 which receives shaft 34 in order to couple the section 44 to the shaft for rotation therewith. Projecting from the ends of hub portion 72 are supports 76, 78 which extend in radial directions relative to the hub portion 72 and are substantially 180 degrees apart. Section 44 also has two ribbon segments 80 and 82 that have end portions secured to the supports 76, 78 and with the segments extending in a helical manner about the hub portion 72 in opposite directions. Segment 80 has one end portion connected to the outer end portion of support 76 whereas its other end portion is connected to the support 78 between the ribbon segment 82 and the hub portion 72. In a similar manner the ribbon segment 82 has its end portions extending between the outer end of support 78 and the portion of support 76 between the ribbon 80 and the hub portion 72.

In the specific embodiment of the ribbon blender illustrated in the drawings, the blender is formed by using a single blender section 44 along a central portion of the shaft 34, a plurality of sections 40 on the left end portion of the shaft (as viewed in Fig. 2), and a plurality of the sections 42 on the right end portion of the shaft. The various sections are assembled on the shaft so that each of the ribbon segments of one section comprise a continuation of a segment of an adjacent section. In this manner the segments jointly form substantially continuous helical ribbons around the shaft 34. More specifically, the blender section 40 located immediately adjacent the center section 44 is positioned so that the support 52 at one end of the hub portion 46 is adjacent to the support 76 of blender section 44. Thus ribbon segment 80 of the center section abuts and forms substantially a continuation of the ribbon segment 54 of the adjacent section 40. As the sections 40 are assembled on shaft 34, adjacent sections are rotated 180 degrees with respect to the previously assembled section so that the support 50 of one section is adjacent the support 52 of the adjacent section. In this manner the outer ribbon segments 54 of any two adjacent sections 40 will abut each other and form continuations thereof. In a similar manner, the inner segments 56 are in engagement and jointly form continuous ribbon segments.

The blender section 42 adjacent to the center section 44 is assembled on the shaft so that the support 66 of section 42 is adjacent and abutting the support 78 of the center section 44. This brings the end of ribbon segment 68 into engagement with the outer end of the ribbon segment 82 of the center section 44 so that they form continuations of each other. In a similar manner ribbon segment 80 of section 44 engages and forms a continuation of the inner ribbon segment 70 of the section 42 that abuts section 44.

Additional blender sections 42 can be assembled on shaft 34 with each adjacent section 42 being offset 180 degrees with respect to the adjacent sections so that the outer ribbon segments and inner ribbon segments of the sections 42 form continuations of each other to produce substantially continuous inner and outer helical ribbons. Thus the support 66 of section 42 adjacent section 44 is aligned with support 64 of the next adjacent setion 42.

In practice a plurality of the sections 40, 42 and 44 are assembled on shaft 34 until a ribbon blender of the desired length is obtained. The sections at the end of the ribbon blender can be held in place by suitable retainers, such as by "E" rings, set screws, etc. The blender is then placed in the sump 28 and coupled to motor 36. When driven in the direction shown in Fig. 1, the outer ribbons 54, 68 of sections 40, 42 drive developer material toward the center portion of the sump and the ribbons 56, 70 drive developer material toward the ends of the sump. This developer material flows in outer and inner generally cylindrical paths surrounding the shaft 34. When the developer material reaches the center section 44, segments 80, 82 transfer developer material flowing toward the center section from the outer ribbon segments 68 of sections 42 to the inner ribbon segments 56 of sections 40. Similarly, the cylindrical flow of developer material produced by segments 54 of sections 40 and moving toward the center section 44 are transferred by segment 80 to the inner segments 70 of sections 42. Thus desirable cross-mixing occurs in the area of the center section 44 to provide good circulation of developer material from one end portion of the sump to the other end portion thereof. Such cross mixing is disclosed in the before-mentioned European Patent Application Number 86 111 950.1.

As the material is mixed in sump 28, some of the material is transferred by the ribbon blender to a feeding means generally designated 90 in Fig. 1. Feeding means 90 comprises a shaft 92 and end plates secured to the shaft, one of which is shown at 94. The plates carry a plurality of vanes 96 which carry developer material in a counterclockwise direction around the portion 26 of the housing and delivers it to the magnetic brush 16. Rotation of the magnetic core 18 of the brush moves developer material counterclockwise around the shell 22. The thickness of material on the shell is determined by the skive 23. As the material moves around the shell some of it is transferred to the

latent electrostatic image on the lower surface of photoconductor 12, as well known in the art. Material remaining on the shell is scraped off by the wiper 25.

An important advantage of the present invention is that the various modular sections 40, 42 and 44 can be cast or molded relatively inexpensively and then quickly and easily assembled on the shaft 34. This not only is a simple manufacturing technique but substantially reduces the cost of a ribbon blender as compared to a typical prior construction wherein rods are secured to a shaft and individual ribbons are then welded to the rods, as explained hereinbefore. Another advantage of the present invention is that the number of sections 40 and 42 used in the ribbon blender can be varied, as desired, for manufacturing relatively long or relatively short ribbon blenders. Moreover, the use of hexagonal openings 48, 62 and 74 in the various sections, together with a shaft of hexagonal shape not only simpifies assembly but also permits accurate alignment of adjacent segments even though they are offset from each other by 180 degrees on the shaft. Moreover, the hexagonal shaft and openings in the sections simplifies keying or securing of the sections to the shaft for conjoint rotation.

In the description of the operation of the apparatus, shaft 34 was described as rotating in a counterclockwise direction as viewed in Fig. 1. By reversing the direction of the shaft the flow of material can also be reversed. Thus a clockwise rotation of the shaft will drive the inner cylindrical flow of developer material toward the center section 44 whereas the outer ribbons will drive the material in the opposite direction or toward the ends of the shaft.

In some cases the ribbon blender can be formed solely from ribbon blender sections 40 or from sections 42. Such would be desirable when the material in the sump is to be driven by the outer ribbons from one end of the sump and to the other end of the sump and then returned to its original position by the inner ribbons. In this case center section 44 could be completely eliminated. Thus the formation of a ribbon blender using a plurality of identical sections or sections which are the mirror image of each other further increases the versatility of a ribbon blender manufactured in accordance with the present invention.

Claims

1. A ribbon blender (32) for mixing material in a sump, the blender including an elongate rotatable shaft (34),

characterized in that a plurality of ribbon blender sections (40, 42, 44) are coupled to the shaft for rotation with the shaft, each section having a hub portion (46, 60, 72) with an opening for receiving the shaft, each section having first ribbon segments (54, 68, 80) and second ribbon segments (56, 70, 82) located in generally helical paths that are spaced from the shaft, each of the ribbon segments of one section comprising a continuation of a segment of an adjacent section so that the segments jointly form substantially continuous helical ribbons around the shaft, and the helical path of the helical ribbons around one portion of the shaft being opposite to the path of the helical ribbons around another portion of the shaft so that rotation of the shaft effects movement of material in the sump in two opposite directions.

2. A ribbon blender as set forth in claim 1 characterized in that the sections (40) along a first portion of the shaft are substantially identical to each other, and the sections (42) along a second portion of the shaft are substantially identical to each other and are substantially the mirror image of the sections along the first portion of the shaft.

3. A ribbon blender as set forth in claim 1 characterized in that a plurality of adjacent sections (40, 42) are substantially identical to each other, and the identical blender sections are offset about the axis of the shaft with respect to adjacent sections.

A ribbon blender as set forth in claim 1 characterized in that the blender sections are modular in construction with some of the sections (40) being substantially the mirror image of other sections (42).

5. A ribbon blender (32) for mixing a supply of developer material in a sump of a development station of electrographic apparatus, the ribbon blender including an elongate shaft (34) rotatable about an axis and having first and second end portions,

characterized in that the blender has a plurality of ribbon blender sections (40, 42, 44), each section having an elongate hub portion (46, 60, 72) with an opening for receiving the shaft, each section being coupled to the shaft for rotation with the shaft, each blender section having first ribbon segments (54, 68, 80) and second ribbon segments (56, 70, 82) located in generally helical paths that are spaced from the shaft, each section having means (50, 64, 76) for supporting one end portion of each ribbon segment from one end portion of the hub and means (52, 66, 78) for supporting the other end portion of each ribbon segment from the other end portion of the hub, each of the ribbon segments of one section comprising a continuation of a segment of an adjacent section so that the segments jointly form substantially continuous helical ribbons around the shaft, and the segments (40) at the first end portion of the shaft being the

mirror image of the segments (42) at the second end portion of the shaft so that rotation of the shaft effects movement of material in the sump in two opposite directions.

6. A ribbon blender as set forth in claim 5 characterized in that the first ribbon segments (54, 68) and second ribbon segments (56, 70) of the sections at the end portions of the shaft are spaced different distances from the hub portions and comprise radially outer and inner ribbon segments, respectively, so that the helical ribbons formed by the outer segments (54, 68) of such sections extend around the helical ribbons formed by the inner ribbon segments (56, 70), and wherein a central ribbon blender section (44) is located between the sections (40, 42) at the first and second end portions of the shaft, the first ribbon segment (80) of the central section extending between the inner ribbon segment of the adjacent section on the first end portion of the shaft and the outer ribbon segment of the adjacent segment on the second end portion of the shaft, and the second ribbon segment (82) of the central section extending between the outer ribbon segment of the adjacent section on the first end portion of the shaft and the inner ribbon segment of the adjacent segment on the second end portion of the shaft.

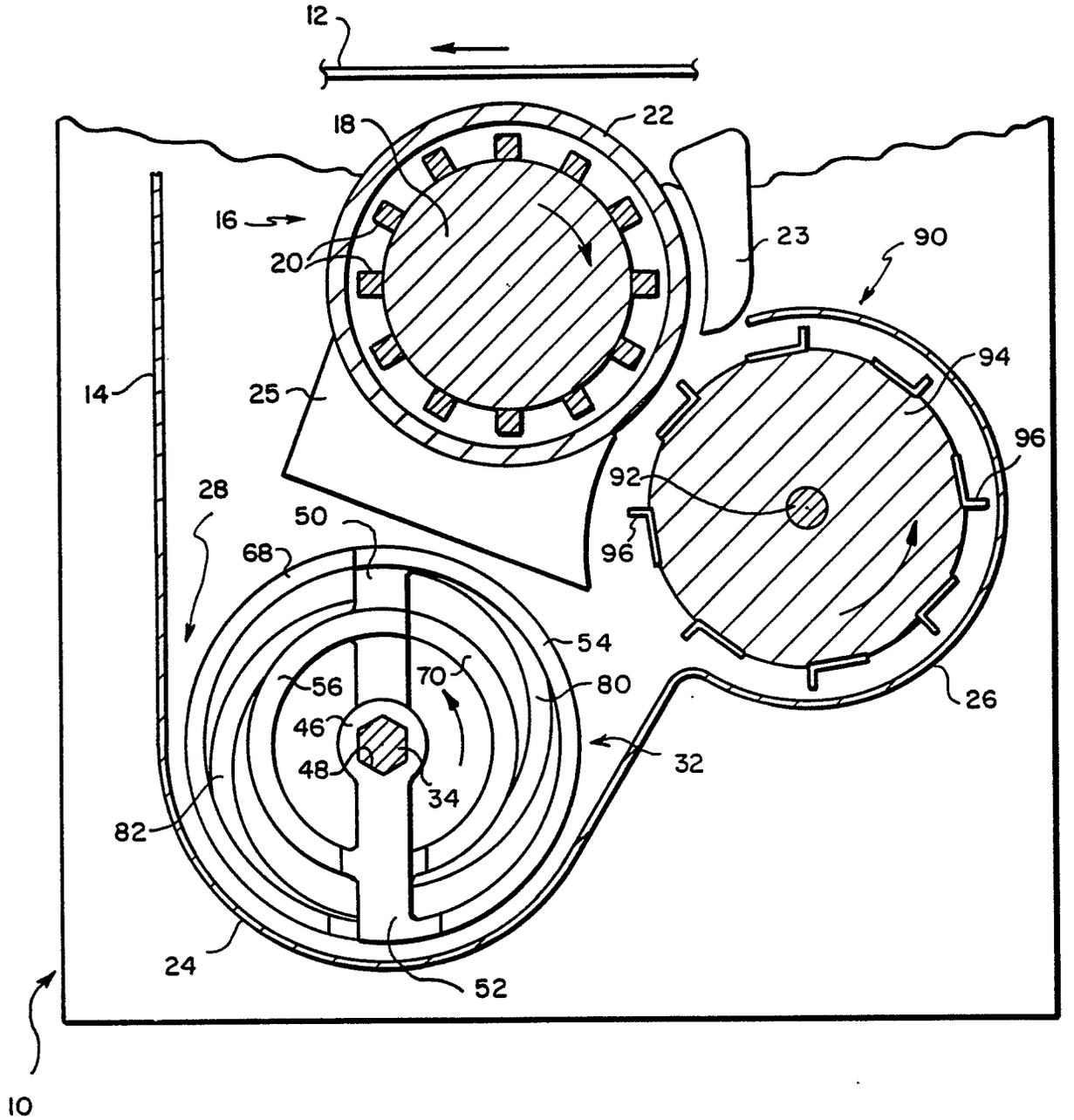
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FIG. 1

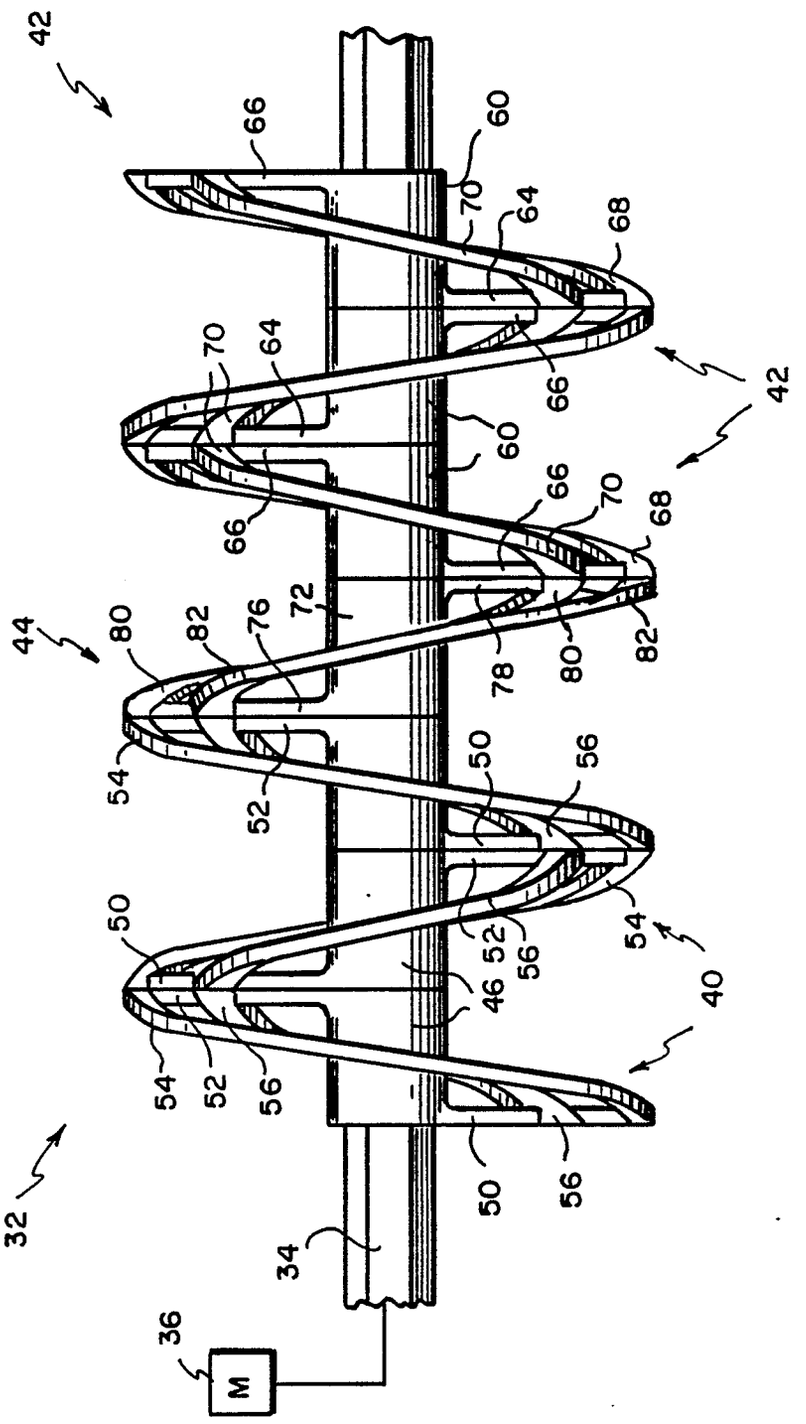
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FIG. 2

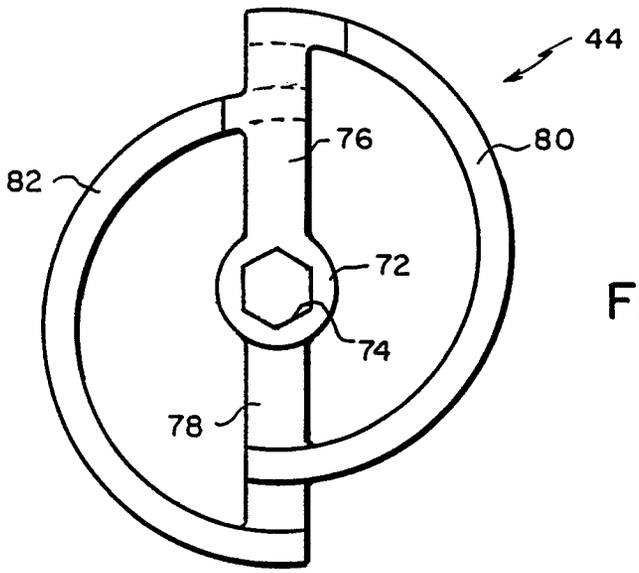

FIG. 3

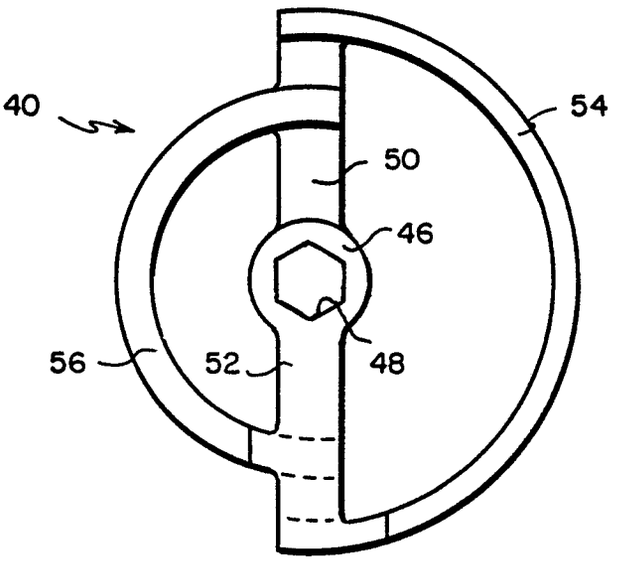

FIG. 4

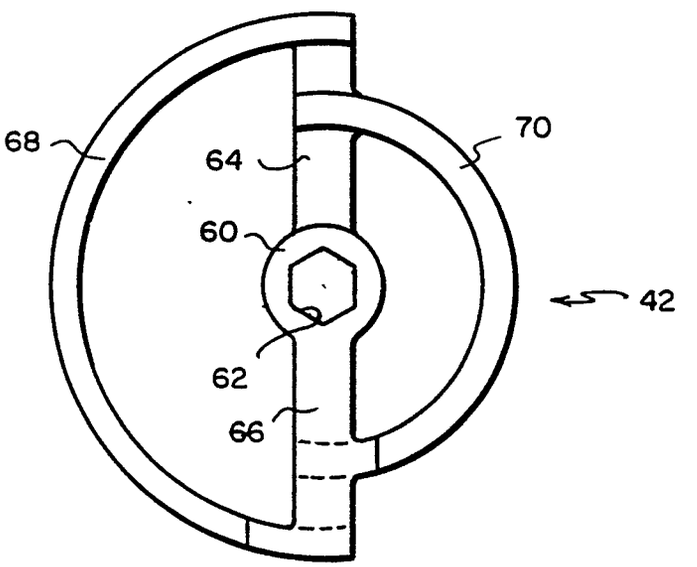

FIG. 5