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(54) **Apparatus and method for thickening pulp and paper stock.**

(57) Apparatus for thickening a suspension of paper making pulp in water employs a pair of endless perforate belts (30, 31), referred to as wires since they are like paper machine forming wires - one inside the other - which at the inlet end of the apparatus are trained around two spaced rolls (23, 25) from which they converge to wrap a third rill (20) and thereby define a generally V-shaped horizontally extending space into which the stock to be thickened is delivered by a headbox (50) positioned between the two wires. The resulting sandwich of wire-pulp-wire is then caused to wrap the major portion of the third roll (20) so that it reverses its direction and then travels around additional rolls (33, 23) until it completes the major part of a loop, during which travel, drainage through the outside wire (31) takes place. When the sandwich reaches this position, the wires separate, pass in diverging relation above and below a trough (60) in which the thickened pulp is collected, above and below the headbox (50), and then reconverge to continue the operation.

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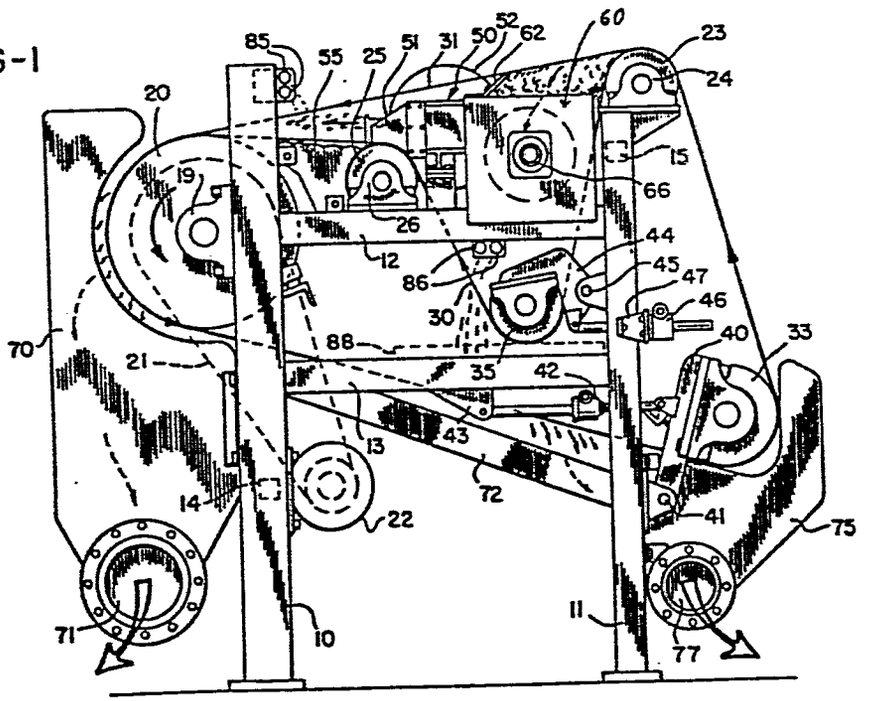
FIG-1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APPARATUS AND METHOD FOR THICKENING PULP AND PAPER STOCK

The pulp and paper making industry has for many years made regular use of apparatus for thickening pulp and paper stock, usually for storage or other temporary treatment purposes. The apparatus most commonly used is known as a decker, and is relatively closely comparable in structure and mode of operation with a cylinder type paper machine, in that its main components are a wire-covered cylinder mold and a vat in which the cylinder mold rotates. In operation, the thickened pulp collects on the outer surface of the mold and is then dumped or couched therefrom for transport to a storage tank or other next station.

Deckers occupy a substantial amount of floor space, and are also relatively expensive, since the cylinder mold is a fairly complex piece of machinery, including as it does a structural framework for the filter wire. In addition, a decker is necessarily slow in operation, partly because the rotational speed of the cylinder mold must be kept below values at which centrifugal force would tend to cause the thickened pulp to be thrown off its surface, and the surface speed of cylinder molds is commonly in the range of only 200-250 ft./min.

It is accordingly a primary objective of the present invention to provide apparatus for thickening pulp and paper stock which is less expensive to build and to maintain than conventional thickeners, which occupies less floor space than conventional thickeners, which will operate at substantially higher speeds than can be used

for conventional thickeners, and which therefore can replace a conventional thickener of much greater size and cost.

The thickening apparatus of the invention is of entirely different construction from a decker, and more nearly resembles a paper machine of the twin-wire vertical type. Instead of a cylinder mold, the invention employs a pair of endless perforate belts like paper machine forming wires - one inside the other - which at the inlet end of the apparatus are trained around two spaced rolls from which they converge to wrap a third roll and thereby define a generally V-shaped space into which the stock to be thickened is delivered. The major operating elements of the apparatus in addition to the wires are a relatively large imperforate roll, a minimum number of other rolls, and a screw conveyor for discharging the thickened pulp to one side of the machine.

According to one aspect of the present invention, the large imperforate roll and a second roll are rotatably mounted in spaced relation in a frame, drive means are provided for the large roll, and a plurality of other rolls are rotatably mounted in the frame. A headbox mounted in the frame includes an outlet for the pulp suspension to be thickened facing the large roll, and a pair of endless wires are supported on the first named two rolls and certain of the other rolls which are located to guide the wires into separate runs which travel in diverging relation from the second roll to enclose the headbox and then to converge with each other and into wrapping relation with the large roll, whereby the headbox

outlet delivers pulp suspension into the space between the converging wire runs for compression therebetween and subsequent travel in sandwiched relation with the wires around the large roll. Certain of the other rolls are located to guide this sandwich from the large roll into wrapping relation with the second roll, the wires are maintained under tension to cause liquid to be expressed therethrough as the wire-pulp-wire sandwich wraps the rolls during its travel from the large roll to the second roll and thereby to thicken the pulp between the wires, and trough means are mounted in the frame between the second roll and the headbox and between the separated wire runs in position to collect the thickened pulp therefrom.

In operation, the pulp slurry to be thickened is deposited by a headbox on the upper surface of a short, substantially horizontal run of the inside wire which converges with a run of the outside wire on the surface of the large roll after substantial gravity drainage through the inside wire. The resulting sandwich of wire-pulp-wire is then caused to wrap the major portion of the large roll so that it reverses its direction and then travels around additional rolls until it completes the major part of a loop, during which travel drainage through the outside wire takes place.

When the sandwich reaches this position, the wires separate, pass in diverging relation above and below a trough in which the thickened pulp is collected, and above and below the headbox. They then reconverge to continue the operation by receiving the continuous pulp slurry flow from the headbox while a screw conveyor in the

trough delivers the pulp collected therein to a discharge location at one side of the apparatus. Throughout their travel in converged relation, the two wires are maintained under sufficient tension to exert substantial pressure on the pulp therebetween as they wrap each successive roll, and thereby to force liquid to be extruded through the wire which is outermost with respect to each roll.

Among the important advantages of the apparatus of the invention is that it can be operated at much higher speeds than conventional thickeners, because the pulp being dewatered is enclosed between two wires throughout the dewatering process, and centrifugal force can thus be employed to augment the dewatering action instead of being a limitation as in the case of a decker. Thus where a decker cannot be operated safely at a speed materially in excess of 250 ft./min., the apparatus of the invention has a practical speed range as high as 2500 or more ft./min.

In addition, the apparatus of the invention is considerably simpler and requires substantially less floor space than conventional thickeners. More specifically, with the two wires following the same path throughout most of their lengths, the least number of rolls is needed. This is pointed out below in connection with the description of a preferred embodiment thereof.

An additional advantage is that drainage takes place through both wires from a relatively thin fiber mat, thereby promoting efficient removal of ink, chemicals and fillers when the apparatus of the invention is used in conjunction with a pulp washing operation.

In order that the invention may be more readily understood, reference will now be made to the accompanying drawings, in which:

Fig. 1 is a somewhat diagrammatic side elevational view of thickening apparaus in accordance with the invention, with some of the supporting frame removed;

Fig. 2 is a plan view of the same apparatus with the wires removed;

Fig. 3 is a fragmentary side elevation of the large roll and adjacent portions of the wires; and

Fig. 4 is a fragmentary elevation looking from right to left in Fig. 3.

The thickening apparatus of the invention as shown in the drawing includes a relatively simple frame comprising two columns 10 and 11 on each side connected by upper and lower side beams 12 and 13, and by any suitable cross braces 14 and 15. The large plain roll 20 which is a major operating element of this apparatus is mounted by pillow block bearings 19 on the pair of columns 10, and it is driven as shown through a belt drive 21 by a motor 22 mounted on one of the cross braces 14. A smaller couch roll 23 is mounted by bearings 24 on top of the pair of columns 11, and another plain roll 25 is mounted by bearings 26 on the upper pair of side beams 12 at a location between rolls 20 and 23 and at a level below that of roll 23.

The rolls 20, 23 and 25, along with tensioning rolls as described hereinafter, support inner and outer endless wires 30 and 31, the term "wires" being used to include woven or otherwise perforate belts of any suitable

metal, plastic or textile material. Both wires wrap a major portion of the large roll 20, from which they travel downwardly at an angle to the vertical until they wrap a guiding and tensioning roll 33 from which they travel upwardly at a small angle to the vertical to the roll 23. The two wires diverge as they leave the roll 23, the outer wire 31 traveling directly to the large roll 20, but the inner wire 30 travels downwardly into wrapping relation with a tensioning guide roll 35 from which it travels upwardly and around the fixed roll 25 to the large roll 20.

The tensioning guide roll 33 is mounted in bearings on arms 40 pivotally mounted at 41 on columns 11. Jacks 42 mounted at 43 on each of the side beams 13 controls the pivotal movement of the arms 40 to tension the wires by corresponding movement of roll 33. The roll 35 is similarly mounted on arms 44 pivotally mounted at 45 on the columns 11 with its pivoting movement controlled by jacks 46 mounted by brackets 47 on the columns 11.

The arrangement of rolls 20, 23, 25 and 35 effects guiding of the two wires in the upper portion of the apparatus so that a run of the inner wire 30 travels substantially horizontally from roll 25 to roll 20, while a complementary run of the outer wire 31 travels from roll 23 directly to roll 20 in converging relation with the horizontal run of wire 30. A headbox 50 is mounted on side beams 12 in the space between the separated runs of the two wires, with its slice outlet 51 projecting toward the converging wire runs and the roll 20, the headbox 50 having an inlet 52 at one side of the apparatus for

receiving the pulp slurry to be thickened. A drainage pan 55 is also mounted on the side beams 12, between the rolls 20 and 25, to receive liquid draining through the horizontal run of wire 30 as it travels from roll 25 to roll 20.

Also mounted on side beams 12, between the headbox 50 and columns 11, is a trough 60 for receiving thickened pulp from the wires 30 and 31 as they diverge on leaving the roll 23. A doctor blade 61 is mounted along the upstream edge of trough 60 to remove pulp from the upper surface of wire 30 as it leaves roll 23 and direct that pulp into the trough 60. A second doctor blade 62 is mounted above the downstream side of trough 60 to remove any pulp which may cling to the underside of wire 31. A conveyor screw 65 is mounted in the bottom of trough 60 and provided with a drive 66 so that it will convey the pulp accumulating in the trough 60 to the outlet 67 at the front end of the trough.

In operation, the headbox 50 delivers the pulp slurry to be thickened onto the upper surface of the run of wire 30 traveling from slice 51 to roll 20, in essentially the same manner as on a Fourdrinier paper machine. Gravity drainage through this run of wire 30 is collected in the pan 55 for removal to one side of the machine, and since this is free drainage through an initially bare wire, a substantial volume of white water will be removed through wire 30 between rolls 25 and 20.

As the two wire runs converge on the surface of roll 20, they form a sandwich with the pulp as the filling which wraps the roll 20, and with the wire 31 under

substantial tension in accordance with the invention, it squeezes the pulp against roll 20 and thereby effects substantial dewatering as the sandwich wraps the roll, this drainage being through the outer wire 31. A drain pan 70 of appropriate profile surrounds the wrapped surface of roll 20 to receive the water which is expressed through wire 31 as the sandwich wraps roll 20, and which is thrown into the pan by centrifugal force at the relatively high surface speed of roll 20. The drain pan 70 is provided at its bottom end with a white water outlet 71.

A pan 72 is mounted between the columns 10 and 11 to underlie the run of the sandwich of wire-pulp-wire from the roll 20 to the roll 33, and it leads to another drain pan 75 of appropriate profile to surround the wrapped portion of roll 33, the pan 75 having a white water outlet 77. Gravity and tension drainage will continue through the wire 31 into the pan 72, and it is augmented by centrifugal force around the roll 33. The final run of the sandwich has already been described, which culminates in separation of the wire around roll 23 and deposit of the thickened pulp in the trough 60.

It is believed that the advantages of this apparatus, including especially its extreme simplicity, will be apparent from the foregoing description. Not only are the wires the only parts subject to wear, but the usual requirement of lateral guiding means for the wires is eliminated by providing the rolls, as shown in Figs. 3-4, with circumferential grooves 80 and 81 which mate with tongue-like strips 82 and 83 on the inside surfaces

of the two wires, the outer wire 31 being sufficiently wider than the inner wire 30 so that the marginal strips thereof which have tongue strips 83 thereon overlap the edges of the wire 30.

Provision is made for continuously showering the wires 30 and 31 clean at locations where they are separated from each other. Shower pipes 85 mounted on the columns 10 spray shower water on the run of wire 31 from roll 23 to roll 20. The shower water falls on the pulp on the converging run of wire 30, but this volume of water is so small that it has no material effect. Similarly shower pipes 86 are mounted on side beams 12 to shower the run of wire 30 from rolls 35 to roll 25, with the shower water draining into a pan 88 mounted on the beams 13 connected with the white water recovery system.

The efficiency and effectiveness of the apparatus has already been demonstrated by tests wherein with the wires only 36 inches wide, the roll 20 of a diameter of 25 inches, and the overall horizontal dimensions of the apparatus 104 inches long by 72 inches wide, a pulp slurry at a supply consistency of 0.5% can be thickened up to 10-15% in a single pass at belt speeds in the range of 2000 to 2500 ft. per minute. The dramatic comparison with conventional thickeners is emphasized by the fact that similar production would require two conventional deckers each having a 36-inch diameter cylinder mold with a 120-inch face. Further, while it is necessary with a decker to keep the cylinder mold speed low in order to prevent pulp from being thrown off its surface, centrifugal force aids the effectiveness of the apparatus

of the invention by causing liquid to be thrown through the wire 31 as the wire-pulp-wire sandwich wraps the rolls 20 and 33.

Another outstanding advantage of the invention is the simplicity of construction of its apparatus and the maintenance thereof. In general, the only parts subject to serious wear are the two wires, and they are recognized as being expendable elements which require replacement from time to time just like paper machine wires. Again in contrast with conventional practice, wear in the filter wire of the cylinder mold of a decker requires a much more complex and expensive repair procedure, including either drainage of the vat, removal therefrom of the cylinder mold, or both. The resulting down time is therefore of substantial duration on a conventional thickener whereas it is minimal on the apparatus of the invention.

While the form of apparatus herein described constitutes a preferred embodiment of this invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention as defined in the appended claims.

CLAIMS

1. Apparatus for thickening a suspension of paper making pulp in water, characterized by

(a) means (10-15) defining a frame,

(b) first (20) and second (23) rolls rotatably mounted in spaced relation in said frame,

(c) drive means (22) for said first roll,

(d) a plurality of other rolls (25, 33, 35) rotatably mounted in said frame,

(e) headbox means (50) mounted in said frame and including an outlet (51) for the pulp suspension to be thickened facing said first roll,

(f) a pair of endless wires (30, 31) supported on certain of said rolls including said first (20) and second (23) rolls,

(g) certain of said other rolls (25, 35) being located to guide said wires into separate runs which travel in diverging relation from said second roll (23) to enclose said headbox means (50) therebetween and then in converging relation with each other and into wrapping relation with said first roll,

(h) whereby said headbox means outlet (51) is operable to deliver pulp suspension into the space between said converging runs for compression therebetween and subsequent travel in sandwiched relation with said wires around said first roll (20),

(i) certain (23) of said other rolls being located to guide said wire-pulp-wire sandwich from said first roll into wrapping relation with said second roll,

(j) means (42) for maintaining said wires under tension to cause liquid to be expressed therethrough as

said wire-pulp-wire sandwich wraps said rolls during travel from said first roll(20) to said second roll (23) and thereby to thicken the pulp between said wires, and

(k) trough means (60) mounted in said frame between said headbox means (50) and said second roll (23) and between said separated wire runs in position to collect the thickened pulp therefrom.

2. Apparatus as defined in claim 1 wherein said rolls (20, 23, 25) guiding said wire runs into converging relation are positioned to guide said converging runs along a generally horizontal path, and wherein said headbox means outlet (51) is positioned to deliver the pulp suspension to be thickened onto the lower of said converging wire runs.

3. Apparatus as defined in claim 1 wherein one (30) of said endless wires is enclosed within the other (31) thereof.

4. Apparatus as defined in claim 1 wherein said first roll (20) is provided with a first circumferential groove (81) adjacent one end thereof and a second circumferential groove (80) intermediate the ends thereof, wherein the inner (30) of said wires is provided on the inner surface thereof with a guide strip (82) engaged in said second groove, and wherein a marginal strip of the outer (31) of said wires extends laterally beyond said inner wire and is provided on the inner surface thereof with a guide strip (83) engaged in said first groove (81) in said first roll.

5. Apparatus for thickening a suspension of paper making pulp in water characterized by

(a) means (10-15) defining a frame,

(b) a relatively large plain roll (20) rotatably mounted at one end of said frame and provided with drive means,

(c) a first wire-supporting roll (23) rotatably mounted at the other end of said frame at a level above said large roll (20),

(d) a second wire-supporting roll (25) rotatably mounted in said frame at a location between said first named two rolls with the top thereof in approximately the same horizontal plane as that of said large roll (20),

(e) a third wire-supporting roll (35) rotatably mounted in said frame at a location below that of said second wire supporting roll (25),

(f) an outer endless wire (31) trained to wrap said large roll (20) and said first supporting roll (23) whereby the top run of said wire travels from said first supporting roll (23) directly to said large roll (20),

(g) an inner endless wire (30) trained to wrap said large roll (20) and said first (23) and second (25) supporting rolls and under said third supporting roll (35) whereby said inner wire diverges from said outer wire at the surface of said first supporting roll (23) and travels downwardly to and under said third supporting roll (35) to said second supporting roll (25) and then substantially horizontally from said second supporting roll (25) to said large roll (20) in converging relation with said top run of said outer wire (30),

(h) headbox means (50) for delivering the pulp suspension to be thickened onto said horizontal run of said inner wire for compression between said converging wire runs and subsequent travel in sandwiched relation with said wires around said large roll (20) to said first supporting roll (23),

(i) means (42) for maintaining said wires under tension to cause liquid to be expressed through said outer wire as said wire-pulp-wire sandwich wraps said large roll and thereby to effect thickening of said sandwiched pulp, and

(j) means (60) on said frame between said diverging wires at a location intermediate said first supporting roll and said headbox means (50) for collecting the thickened pulp from said wires.

6. Apparatus as defined in claim 5 further comprising a fifth roll (33) mounted at the opposite end of said frame from said large roll (20) and at a level below that of said first supporting roll (23) whereby said wire-pulp-wire sandwich wraps a substantial portion of the surface thereof under tension to cause additional liquid to be expressed through said outer wire.

7. Apparatus as defined in claim 6 wherein said tension maintaining means include means (44, 46) mounting said third supporting roll (35) and said fifth roll (33) in said frame for swinging movement, and means (47, 42) for controlling said swinging movement of said rolls to regulate the tension in said wires.

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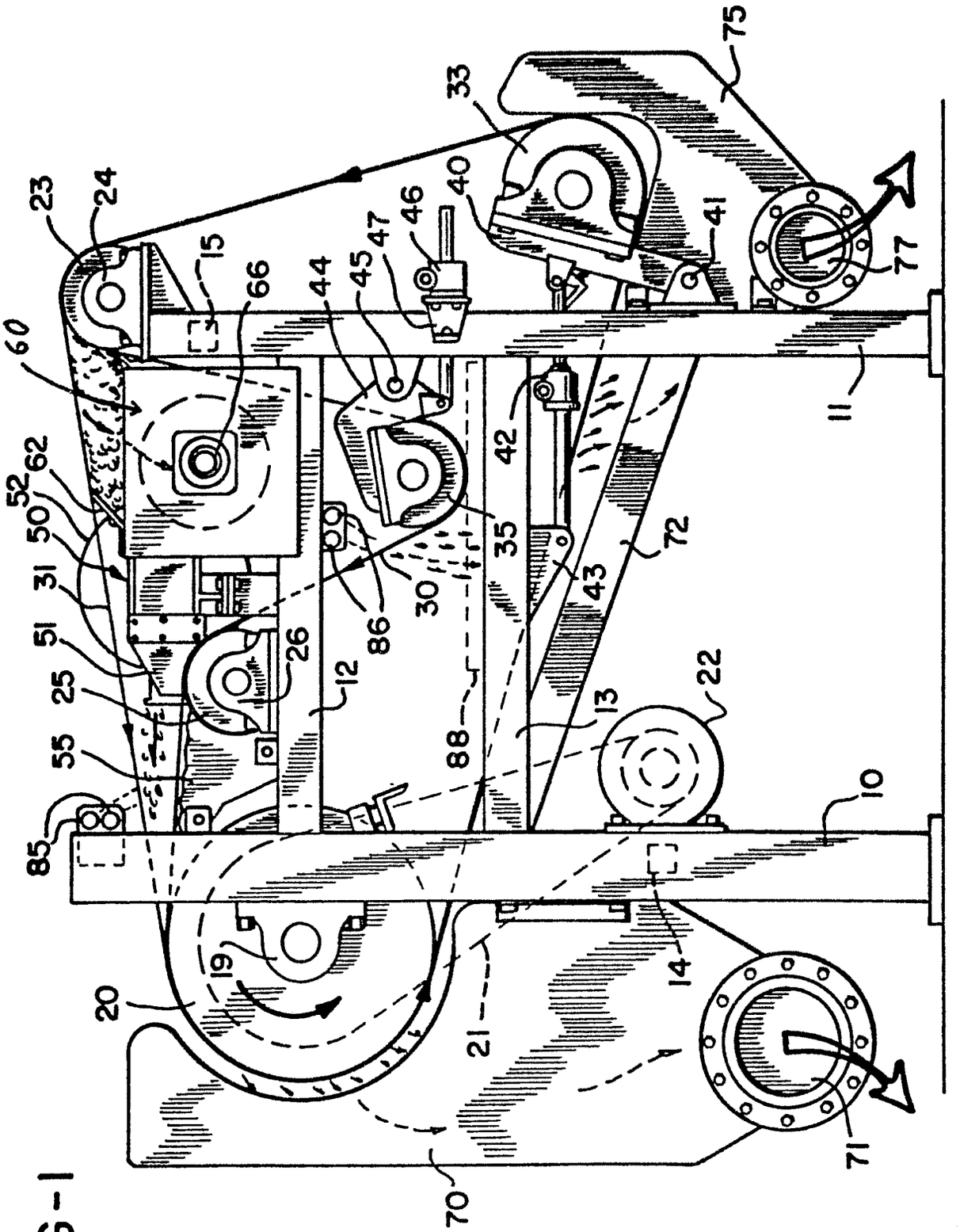

FIG-1

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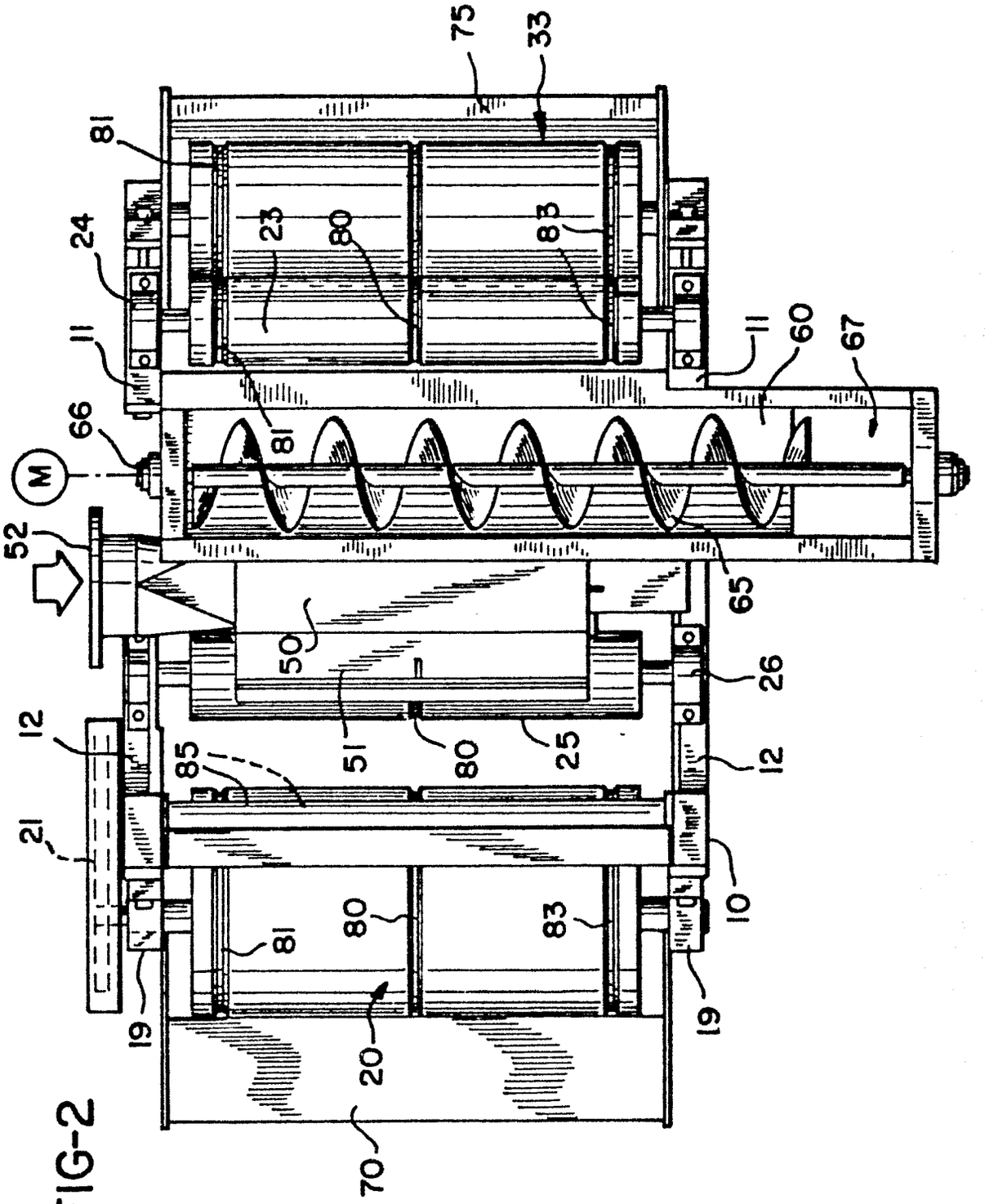

FIG-2

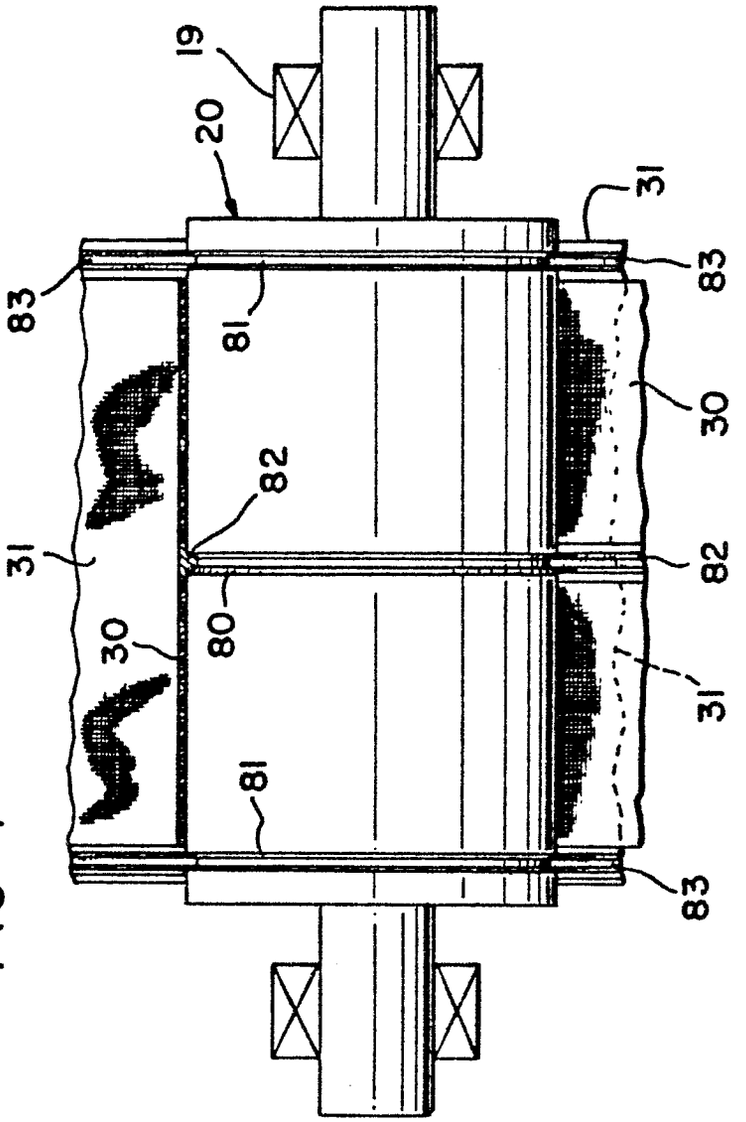
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FIG-4

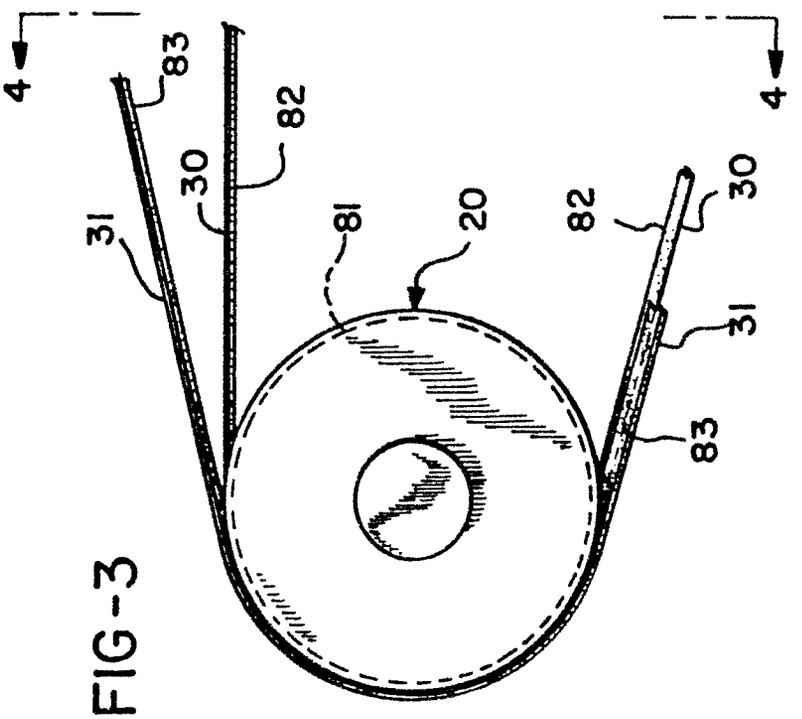
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FIG-3