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## (54) Plastic bag opening apparatus.

(57) An apparatus for opening plastic bags to remove their contents has a pair of wheels (11,12) mounted in approximate coplanar relationship such that there is a point of approximate cotangency. The two wheels rotate in opposite directions, and a series of tines 13 are mounted in spaced relation on the periphery of each wheel to extend normal to the direction of travel of the loop. Once a filled plastic bag is placed onto the apparatus at the point of approximate cotangency of the wheels, a biased flexing structure presses the bag against the tines. A hole is created in that surface riding on the tines as the tines move away from the point of approximate cotangency. To remove any articles remaining in an opened bag, a pair of oppositely-rotating rollers (63,68) are positioned so as to draw the bag between them. An oscillating member forward of the rollers acts to prevent any articles remaining in an opened bag from entering between the rollers. A vacuum collection means 73 draws off the emptied bags. The apparatus has particular application to the opening of bags containing recyclable articles.

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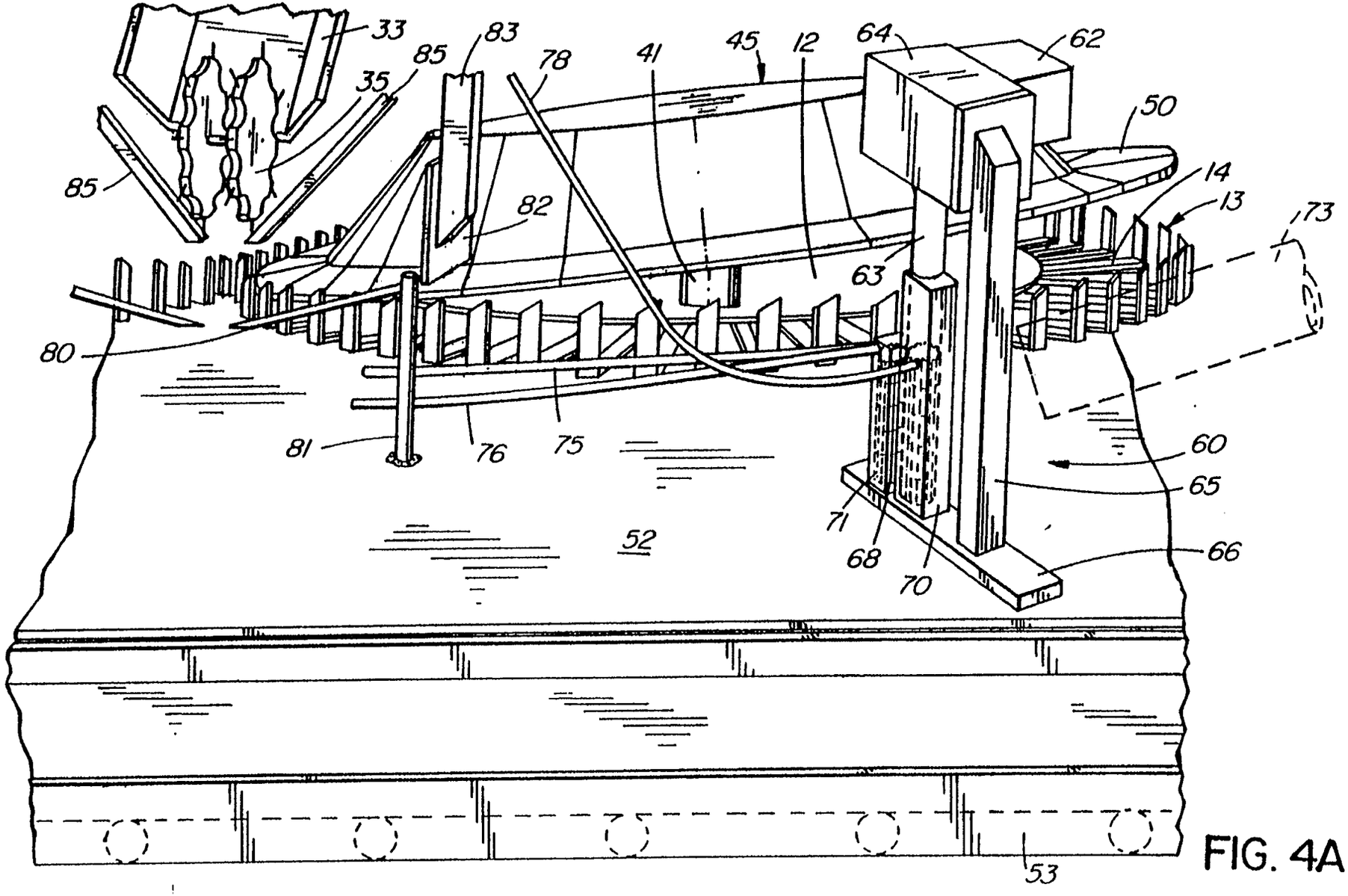
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FIG. 4A

# MODIFIED PLASTIC BAG OPENING APPARATUS

The invention relates to a plastic bag opening apparatus, and more particularly, to an apparatus for the controlled opening of plastic garbage bags filled with items to be recycled.

Concern for the environment has led to the collection for recycling of used glass bottles, tin cans, paper, and other items. For convenience, such materials are often collected and stored in plastic garbage bags. It then becomes necessary to have a means for rapidly opening a large number of such bags, since opening them by hand is a slow and labour-intensive process.

Various mechanical arrangements have been suggested for opening filled bags and emptying their contents. One such arrangement is described in U. S. Patent No. 4,798,508, granted to The Dow Chemical Company on January 17, 1989 and entitled 'Machine and Method for Opening a Filled Bag, Emptying the Bag, and Disposing of the Empty Bag'. In that case, a bag is guided into a space between a pair of rotating drums. A series of spikes extend radially from each drum through a belt extending around the drum. As it enters the space between the drums, the bag becomes impaled on the spikes and is drawn into a cutter means. The cutter means slits the bag in half to empty the contents, and each half of the emptied bag is carried away on the spikes of a respective drum to a point where the spikes move away from the belt to release the respective half bag.

Because it is desirable to maintain the integrity of glass bottles and similar brittle objects during the opening of garbage bags in the recycling process, employing an arrangement such as that described in U. S. Patent No. 4,798,508 for opening of the bags is not practical. What is instead required is a means for opening a side of a filled plastic bag and for orienting the bag such that its contents fall through the opened side. The apparatus of the subject invention is a plastic bag opening means capable of rapidly opening and emptying a plastic bag while maintaining the integrity of the individual items within the bag.

The apparatus of the invention has a pair of wheels, one moving in a first plane of rotation and the other moving in a second plane of rotation. The one wheel is adapted to rotate in a clockwise direction and the other wheel is adapted to rotate in a counterclockwise direction. Both wheels rotate at approximately the same angular speed, and are oriented such that the first and second planes are approximately coplanar and such that there is at least one close location where the two wheels extend in tangential spaced relationship to each other. The apparatus also has a series of tines mounted in spaced relation on the periphery of each wheel so as to extend on the same side of the plane of rotation of the respective wheel and in a direction primarily normal to that plane of rotation. The apparatus further has a means for pressing a bag onto those tines moving past the close location such that those tines penetrate a first surface of the bag. The subsequent divergence of the tines on the two wheels as they move away from the close location acts to create tear lines in the first surface of the bag. The apparatus also has oscillatory strainer means and vacuum collection means positioned adjacent to the periphery of each wheel. The tangential spaced relationship of the wheels and the spacing between adjacent tines on the same wheel are such that as the tines on the two wheels move away from the close location the tear lines created in the first surface of the bag are sufficiently close that those lines connect to form a single continuous hole in that surface. All or a substantial portion of the contents of the bag is adapted to fall through that hole. Through a combined straining and oscillating action, the oscillatory strainer means is adapted to empty the bag of any remaining contents. The vacuum collection means is adapted to collect the emptied bag. At least one part of the vacuum collection means may be positioned so as to be immediately adjacent the oscillating strainer means and downstream of that strainer means relative to the rotation of the respective wheel.

The oscillatory strainer means may be a pair of rollers each mounted such that the axis of rotation of each roller is parallel to the other roller and extends generally horizontally. The two rollers are adapted to rotate in opposite directions and are so spaced from each other that their cylindrical surfaces engage along a pull line. The pull line is positioned such that a bag caught on a tine moving past one end of the rollers is drawn into the pull line. The oscillatory strainer means also has an oscillating member extending in front of the the pair of rollers, and having first and second portions. The first portion defines one lip of an oscillating slot in a barrier sitting in front of the pull line ; bags entering the pull line are pulled through that slot. The second portion defines an oscillating guide member for moving against a bag entering the slot to assist in preventing any articles in the bag from entering the slot.

A stationary ring may sit adjacent the circumference of each wheel. Each ring has a slightly larger diameter than the diameter of the circle formed by tines on each wheel. The tines on each wheel move inside of and proximate the respective ring. Each ring is mounted to the apparatus such that the top edge of that portion of the ring extending adjacent the strainer means extends proximate the upper end of tines moving past the strainer means.

The bag pressing means may comprise a biased flexing structure of multiple links, one of the links having a plate means for pressing on the bag. The flexing

structure may be comprised of four links hinged together serially in a generally boxlike configuration. The outer end of each outer link is hinged to the frame of the apparatus. The flexing structure is normally supported on the frame of the apparatus in a rest position, and is biased by a bias means to return to that rest position after movement. With this arrangement, the initial contact of a bag with the plate means moves the flexing structure from the rest position. The bias means subsequently acts to press the bag against the tines on the wheels at the close location and then returns the flexing structure to the rest position.

The vacuum collection means may have another part which is positioned downstream of the one part relative to the rotation of the respective wheel. The other part of the vacuum collection means comprises a pair of stationary vertical pipe sections one extending above and one extending below the path of the tines at a fixed position. Air is driven out of the bottom pipe section and pulled into the upper pipe section at the same flow rate so as to create an upward column of air across tines moving past the fixed position.

The invention will next be more fully described by means of two preferred embodiments utilizing the accompanying drawings, in which :

Figure 1 is a partially-sectioned plan view of the first preferred embodiment of the plastic bag opening apparatus.

Figure 2 is a partially-sectioned front view of the first preferred embodiment.

Figure 3 is a partially-sectioned side view of the first preferred embodiment.

Figure 4A is a perspective view of the first preferred embodiment.

Figure 4B is the perspective view of Figure 4A, but additionally illustrating a sequence of possible positions of a plastic bag caught on a tine of one of the wheels of the apparatus.

Figure 5 is a side view of one type of tine that may be used in the first preferred embodiment.

Figure 6 is an end view of the tine of Figure 5.

Figure 7 is a plan view of the second preferred embodiment of the plastic bag opening apparatus.

Figure 8 is a side view of the second preferred embodiment.

Figure 9 is a cross-sectional view of a chain and an attached tine of the second preferred embodiment, the view being taken along the line IX-IX in Figure 7.

Figure 10 is a perspective view of an alternate strainer apparatus for the first preferred embodiment of the bag opening apparatus.

Figure 11 is a perspective view of an alternate suction mechanism for removal of bag remnants for the first preferred embodiment.

Figure 12 is a perspective view of an alternate bag feeding arrangement for the first preferred embodiment.

Figure 13 is a side view of a device for pressing filled bags against the tines in the alternate bag feeding arrangement of Figure 12.

Figure 14 is a cross-sectional end view of the device of Figure 13, the view being along the line XIV-XIV in Figure 13.

Figure 15 is a perspective view of the first preferred embodiment with the alternate structural arrangements of Figures 10 to 14.

With reference to the first embodiment of Figures 1 to 4B, a pair of identical wheels 11 and 12 are positioned in the same horizontal plane. Each of the wheels 11 and 12 has a series of tines 13 supported at equally-spaced intervals around its periphery. Each tine 13 is secured to an outer end of a respective horizontal arm 14, the inner end of each arm 14 being attached to the periphery of the wheel. The separation between the rotational axes of wheels 11 and 12 is such that at one position, generally designated 15 in Figure 1, the path of the tines on wheel 11 passes close to the path of the tines on wheel 12. An electric motor (not shown) is connected to an input shaft 16 of a first gear box 17 and, through a belt 18, to a second gear box 19. A pulley 20 is mounted on the output shaft of gear box 17 for driving a belt 21, which also extends around a pulley 22 that is secured to wheel 11 to rotate with that wheel. The wheel 12 has been removed from Figure 1 to better illustrate the corresponding drive arrangement for that wheel, as well as to illustrate the underframe 23 of the apparatus above which wheels 11 and 12 rotate. The illustrated arrangement causes wheel 11 to rotate clockwise and wheel 12 to rotate counterclockwise at corresponding angular speeds, the series of tines 13 on the two wheels moving apart after passing position 15.

Each of the tines 13 is attached to the periphery of either wheel 11 or wheel 12 so as to extend vertically. They may, however, have a slant toward the direction in which the periphery is travelling. In the side view of Figure 5, tine 13 is shown attached to the periphery 28 of one of the wheels 11 and 12 so as to extend at an angle of approximately 75 degrees to the plane of rotation of the particular wheel ; although the magnitude of that angle is not critical, all of the tines 13 should be mounted at the same angle. The point 29 at the end of tine 13 is actually a line edge 30, as better shown in the end view of Figure 6. As also shown in Figure 6, each tine may also be slanted in a radial direction such that its outer end extends toward the centre of the particular wheel.

A chute 33 is secured to the frame of the bag opening apparatus at an angle such that its lower end terminates close to position 15. The upper end of chute 33 is may be positioned under the end of a conveyor belt (not shown). The angle on the chute 33 is sufficiently steep that a plastic bag filled with material freely slides down chute 33 onto the double series of tines moving past position 15. A pair of cogged wheels 35 are mounted to freely rotate in spaced relation on

an axle 36, each end of that axle being connected to a respective one end of a pair of identical beams 37. The pair of wheels 35 are typically eight inches apart. The other end of each beam 37 is pivotally connected to an axle 38, which is fixed to the frame of the bag opening apparatus.

As shown in Figures 2 and 3, the wheel 12 is supported on a first bearing 40 to rotate on a fixed axle 41 extending from the top of underframe 23 of the apparatus ; wheel 11 is similarly supported. Above the bearing 40, the axle 41 has a slight bend toward position 15. Above that bend, a second bearing 43 on axle 41 supports a frustoconical saucer 45. A peg 46 mounted on the upper surface of wheel 12 extends into an aperture in a bottom surface 48 of saucer 45. The peg 46 allows wheel 12 and saucer 45 to rotate together in angularly-offset planes of rotation. A similar saucer 49 rotates with wheel 11. The purpose of the pair of saucers 45 and 49 is to position a garbage bag on the two series of tines 13 moving past position 15 ; the bag rests on the frustoconical edges of the two saucers and on an annular lip 50 on each saucer.

A portion of underframe 23 defines a sloping ramp 52, the ramp having an angle of approximately 25 degrees to the horizontal. The upper end of ramp 52 extends under a portion of wheels 11 and 12, as shown in Figures 1 to 4B, and the bottom end of ramp 52 abuts a conveyor belt assembly 53.

As best illustrated in Figures 4A and 4B, a strainer apparatus generally designated 60 is positioned adjacent the periphery of wheel 12 ; an identical apparatus is positioned adjacent the periphery of wheel 11. Apparatus 60 is formed by a motor 62 driving a first vertical shaft 63 through a gear box 64. Gear box 64 is supported on a vertical strut 65 secured to ramp 52 through a connected bottom support 66. The lower portion of first shaft 63 has a series of gear teeth extending vertically in-line with the symmetrical axis of that shaft. A second shaft 68, supported for rotation on bottom support 66, extends parallel to shaft 63 and has a series of complementary gear teeth meshing with the gear teeth of shaft 63. Because of the meshing gear teeth of shafts 63 and 68, the clockwise rotation of shaft 63 causes a counterclockwise rotation of shaft 68. The gear teeth on shafts 63 and 68 each sit in a respective one of a pair of housings, 70 and 71, the separation between those two housings defining a pair of narrow vertical slits. Associated with strainer assembly 60 is a suction pipe 73, as shown in Figures 1 and 2 and in outline in Figures 3, 4A and 4B. Suction pipe 73 extends at an angle, its one end being positioned proximate the outer one of the vertical slits extending between housing 70 and housing 71.

A pair of lower guide bars 75 and 76 extend adjacent to the path of the tines 13 from ramp 52 to the top of the housing 71, the lower end of guide bar 75 being secured to ramp 52 at a position more proximate wheel 12 than the lower end of guide bar 76. An upper guide bar 78 extends upwardly from an attachment point on housing 70 to a attachment point (not shown) on the frame of the bag opening apparatus.

A cam bar 80 extends adjacent to the path of tines 13 at a location between position 15 and strainer assembly 60. One end of cam bar 80 is secured to ramp 52, and the other end of that cam bar is secured to the top of a vertical strut 81 which is secured by its lower end to ramp 52. As shown in Figures 4A and 4B, a vertical plate 82 is supported by a strut 83 from the frame of the bag opening apparatus. Plate 82 has a generally rectangular profile, and is mounted such that its lower surface sits slightly above the annular lip 50.

A pair of bars 85 extend downwardly at an angle from the frame of the bag opening apparatus such that their lower ends assume a spaced relation from the tines 13. The plan view of Figure 1 illustrates the position that the bars 85 assume relative to the overall apparatus.

The first embodiment of the apparatus operates in the following manner. With the wheels 11 and 12 rotating together at an angular speed of between 3 and 10 revolutions per minute (preferably, at about 8 revolutions per minute), a filled plastic bag is dropped down chute 33. The pair of cogged wheels 35 rotate as the plastic bag slides under them and end up sitting on the bag as the bag moves onto the two series of tines 13 at position 15. The weight of the wheels 35 acts to press the plastic bag more firmly onto the tines 13, and the wheels 35 also help to position the bag over the tines. Although the bag opening apparatus has been shown to function satisfactorily without the wheels 35, their presence does improve performance. As the two series of tines 13 diverge, the line edge 30 on each tine digs into the bag surface riding on that edge. In a working apparatus, each of the wheels 11 and 12 have a diameter of approximately six feet, the successive tines 13 on the periphery of each wheel have a length of approximately four inches and are spaced approximately four inches apart, and the two wheels 11 and 12 have a separation distance such that at position 15 the tines 13 on respective wheels are approximately four inches apart. With this configuration, it has been found that the tear lines created in the bag surface by the divergence of the tines connect to form a single hole in the bag surface. The distance separating the tines 13 on the two wheels at position 15 has been found to be an important parameter for the effective functioning of the apparatus. If that distance is too small, a bag rides on the tines without effectively being penetrated ; if that distance is too large, the tear lines created in the bag surface are not sufficiently close that the webs between those lines can break to form a single hole in that surface.

As the hole is created in the lower surface of the bag, the upper portion of the bag comes into contact with the pair of bars 85. The movement of the upper

portion of the bag is retarded while the lower portion continues to move on the tines, the bag thereby being rotated such that its opened lower surface moves in advance of the upper portion of the bag. The bars 85 are positioned sufficiently above the tines 13 to allow such bag rotation. A majority of the recycled materials 86 within the opened bag falls through the opened lower surface of the bag onto ramp 52, and then slide onto conveyor belt assembly 53 which transports them to a sorting location. Materials coming to rest on the wheel lips 50 come into contact with a respective one of the plates 82 sitting above those lips, each plate 82 acting to push such materials onto ramp 52. Rigid items such as cans sometimes become wedged onto the tines 13. The cam bar 80 pushes such items off of the tines.

Although a majority of the items in each bag are removed by the foregoing process, a few items usually remain in the corners of the bag. The strainer apparatus 60 and the guide bars associated with that apparatus are used to recover those items. The opened plastic bag 87 is dragged by one or more of the tines 13 across the lower guide bars 75 and 76, and subsequently between those lower guide bars and the upper guide bar 78. The bag then enters into the vertical slit between housings 70 and 71, and into the path of the pair of meshing gears on shafts 63 and 68. Once the meshing gears have a hold on the bag, those gears proceed to pull the bag across their meshing surfaces. Any items remaining in the bag are too large to enter the vertical slit between housings 70 and 71, and such items are pushed through the bag and onto ramp 52. As the remnants of the bag 87 move out of the other side of straining apparatus 60, those remnants are collected by suction pipe 73, which feeds them to a waste bin (not shown).

Figures 7, 8 and 9 illustrate a second embodiment of the bag opening apparatus of the invention. In this embodiment, a pair of chains 90 and 91 each extends through a path defined in part by a guide track, those guide tracks being designated as 92 and 93 respectively. Each guide track 92 and 93 is comprised of an upper track section and a lower track section, as shown in Figure 9. A chute 95 has a function corresponding with the chute 33 of the first embodiment, and a pair of cogged wheels 96 have a function corresponding with the pair of wheels 35 in the first embodiment. The chain 90 extends around a sprocket 97 and a sprocket 98, and the chain 91 extends around a sprocket 99 and a sprocket 100. The chains 90 and 91 have a series of tines 102 mounted on them. Unlike with the first embodiment, each of the tines 102 extends vertically and has a pointed upper end. To steady the movement of the tines 102 through the guide tracks 92 and 93, each tine has a pair of carrier wheels 103 mounted on it, the axis of rotation of each wheel 103 extending in-line with the longitudinal axis of the tine. One wheel 103 of each pair of carrier wheels rides in the upper track section of either guide track 92 or 93, and the other wheel 103 rides in the lower track section. A suction pipe 104 extends vertically at a position midway between the centre of sprockets 98 and 100, the lower end of that pipe terminating slightly above the plane extending through the upper end of the tines 102. A conveyor system generally designated 105 extends under the region between guide tracks 92 and 93 for collecting material that falls from bags held by the tines moving in those tracks.

The second embodiment of the apparatus operates in a manner analogous to the apparatus of the first embodiment. A filled garbage bag is deposited onto chute 95 and slides onto the tines 102 moving past position 107. The two series of tines 102 then diverge in straight lines and create a hole in the adjacent bag surface. Then, for a short distance, the two series of tines 102 travel in parallel paths holding the emptied bag tautly between them. The two series of tines 102 then converge as each passes around a respective one of the sprockets 98 and 100, and the hold of tines 102 on the emptied bag is thereby relaxed. The bag then passes under suction pipe 104, which pulls the empty bag off of the tines and deposits it into a waste bin (not shown).

Figures 10 to 14 illustrate some alternate structural arrangements that may be used with the first embodiment of the apparatus, and Figure 15 is an illustration of the first embodiment with those alternate arrangements.

Illustrated in Figure 10 is an alternate strainer apparatus for the first preferred embodiment. That apparatus comprises a motor 120 driving the worm within a worm gear 121. The worm wheel within gear box 121 is mounted on a bearing in a frame member 122 of the bag opening apparatus and is connected to the horizontal shaft 123 of a first roller generally designated 124. First roller 124 is a steel cylinder and a surrounding cylindrical tire 125 of soft urethane approximately one-inch thick. A horizontal shaft 127 of a second roller generally designated 128 is mounted on a bearing in the frame member 122. Similar to first roller 124, second roller 128 is a steel cylinder and a surrounding cylindrical tire 129 of soft urethane approximately one-inch thick. Horizontal shafts 123 and 127 are mounted in frame member 122 with a separation such that tire 125 continually presses against tire 129 ; that contact causes second roller 128 to rotate with the same angular speed as roller 124, but in the opposite direction.

The alternate strainer apparatus further comprises a cam plate 132 mounted on shaft 127 such that the working surface of plate 132 is proximate tire 125. Plate 132 has an eccentricity such that the maximum radius is approximately 0.125 inches greater than the minimum radius, the maximum radius being offset 180 degrees from the minimum radius on

plate 132. Mounted on bearings on frame member 134 of the bag opening apparatus is a pivot shaft 135 to which is fixed a pair of bars 136. The bars 136, which extend above second roller 128, are integrally connected to an arcuately-shaped plate 137 which forms the upper lip of a horizontal slot 138 having the same height as the line of contact between tires 125 and 129. A metal plate 140, which is fixed to the frame of the bag opening apparatus, forms the lower lip of slot 138. A cam wheel 142 is mounted on one of the bars 136, wheel 142 being freely rotatable. Cam wheel 142 is positioned so as to ride on cam plate 132. As shaft 127 and cam plate 132 rotate, cam wheel 142 and plate 137 move through a reciprocating vertical motion. The rotation of cam plate 132 causes the distance between the upper and lower lips of slot 138 to vary between a minimum value of approximately one-quarter of an inch and a maximum value of approximately three-eighths of an inch. The alternate strainer apparatus is mounted on the frame of the bag opening apparatus such that the horizontal slot 138 extends at approximately the same height as the locus traced by the upper end of the tines 13, and such that one end of slot 138 and one end of rollers 124 and 128 are proximate that same locus. Fixed to plate 137 is a wedge-shaped plate 144 that maintains a small distance from the upper end of the tines 13 for all vertical positions of plate 137. Two support members 145 extend between plates 137 and 144 to maintain their relative position.

A plastic bag caught on one of the tines 13 is pulled through the slot 138 and is almost immediately captured by the pair of tires 125 and 129. The proximity of the plate 144 to the top of tines 13 prevents any articles remaining in the bag from moving over those tines. Plate 144 also acts as a barrier to stop articles in bags from being thrown up against plate 137, thus preventing breakage of items such as glass bottles. The bottom surface of plate 144 extends in a plane only slightly above slot 138, and the contact of plate 144 on articles remaining in a bag orients those articles such that their path is not directly into slot 138. The small size of slot 138 acts as a barrier to recycled articles in a bag, allowing the tires 125 and 129 to strip the bag away from those articles. Occasionally, a flattened can or similar thin item becomes momentarily wedged in slot 138 ; it has been found that the reciprocating motion of slot 138 results in the release of such wedged items.

Illustrated in Figure 11 is an alternate suction mechanism for removal of remnants of bags from the bag opening apparatus. The alternate suction mechanism has a primary suction pipe means generally designated 150 and a secondary suction pipe means generally designated 151. The primary means 150 comprises a rectangular pipe 153 having an area of approximately twenty square inches and positioned just downstream on the bag opening apparatus from the strainer apparatus. Pipe 153 has a rectangular slot cut in one side, and is oriented such that the path of tines 13 passes through that slot. Positioned approximately four feet downstream in the path of tines 13 from pipe 153 is the secondary suction pipe means 151. That secondary means comprises a pair of circular pipes 155 and 156 each with an area of approximately twenty square inches. Pipe 155 is positioned so as to extend vertically such that its lower open end sits just above the upper end of tines 13, and pipe 156 is positioned so as to extend vertically such that its upper open end sits just below the lower end of tines 13. As shown in Figure 11, pipes 153 and 155 feed into a common suction pipe 157 which enters a bag remnant collection bin 158. On top of bin 158 is a fan 159, which produces both a suction in pipe 157 and a corresponding outward air flow through pipe 156. The resultant powerful air stream between pipes 156 and 155 is sufficient to pull any remaining plastic remnants off of the tines 13 .

Figures 12, 13 and 14 illustrate an alternate bag feeding arrangement. Filled bags are deposited into a trough generally designated 160 having a horizontal floor 161 connected to a pair of sloping side members 162. Through a longitudinal slot 164 in floor 161 extend a series of pushdogs 165 connected to a continuous driven chain. A first end of trough 160 terminates adjacent the position 15 discussed earlier, at which the two sets of tines 13 are most proximate. Above position 15, a bag pressing device generally designated 170 is mounted to the frame of the bag opening apparatus. Device 170, which is shown in side view in Figure 13, comprises a series of four linked bars 171, 172, 173 and 174, as well as two ramped members 175 and 176 to be discussed. One end of bar 171 is hinged at position 180 to the frame of the bag opening apparatus. At rest, bar 171 extends downwardly from its one end at an angle of approximately 60 degrees to the horizontal. The other end of bar 171 is pivotally connected to one end of bar 172. At rest, bar 172 has a first portion extending from its one end at an angle of approximately 20 degrees to the horizontal and has an integral second portion extending upwardly from the first portion at approximately 40 degrees to the horizontal. The other end of bar 172 is pivotally connected to one end of a short bar 173 which extends upwardly at approximately 50 degrees to the horizontal. The other end of bar 173 is pivotally connected to one end of bar 174 which, at rest, extends generally horizontally. The other end of bar 174 is hinged at position 181 to the frame of the bag opening apparatus ; that frame also has a spar 183 which maintains bar 174 in its horizontal rest position by providing support from below. The dimensions 'a', 'b', 'c', 'd' and 'e' shown in Figure 13 are 13 inches, 18 inches, 22 inches, 9 inches and 26 inches, respectively. As also shown in Figure 13, a pair of heavy springs 184 extend in tandem from frame spar

183 to bar 171 ; those springs carry only a slight load when bag pressing device 170 is in the rest position illustrated in Figure 13.

The inner ramped member 175, which is fixed to the second portion of bar 172, is a plate 185 having a pair of edge flanges 186. Each edge flange 186 ends along one of the pair of edges of plate 185 that are parallel to bar 172. The outer ramped member 176, which is pivotally connected by a pair of ears 187 to bar 172, is formed from a pair of plates 188 which each support an edge flange 189 and which are connected by a U-shaped member 190. A ridged element 191 also extends from each of the plates 188 parallel to the edge flanges 189. In the rest position of outer ramped member 176, the plates 188 rest on the plate 185 of inner ramped member 175. Inner ramped member 175 is sized to press on bags of smaller size than those on which outer ramped member 176 is intended to press.

The alternate bag feeding arrangement of Figures 12, 13 and 14 operates in the following way. Once a series of filled bags are deposited into trough 160, the pushdogs 165 push the bags toward the first end of trough 160. The bag first in line is grabbed by the tines 13 on wheels 11 and 12, and forced against the bag pressing device 170. Large bags contact the edge flanges 189 and ridged elements 191 of outer ramped member 176, causing that member to rotate upwardly while maintaining a guiding contact. Small bags initially contact edge flanges 186 of inner ramped member 175. As the bag starts to press against the edge flanges 186, the bars 171, 172 and 173 move to the left in Figure 13, extending springs 184. Bars 172, 173 and 174 then start to move upwardly as the bag is caught by tines 13 at position 15 and pulled further under bag pressing device 170. As the inner ramped member 175 (and also the outer ramped member 176 in the case of a large bag) press downwardly on the bag, the two series of tines 13 rip the bag open. The bag pressing device 170 then returns to its rest position, just in time to begin its action on the following filled bag.

Figure 15 illustrates the relative position in the first embodiment of each of the alternate structural arrangements of Figures 10 to 14. Some additional small modifications to the first embodiment are also shown. The guide bars 75, 76 and 78 in Figure 4A have been removed, as have the cam bar 80 and the vertical strut 81. Figure 15 illustrates the addition of a pair of stationary steel rings 195, each ring sitting outside of and proximate the tines 13 on a respective one of the wheels 11 and 12. Each ring 195 is maintained in position by having its lower edge welded to the top edge of a rigid arcuate steel curtain 196 which is itself welded to ramp 52. Ring 195 is oriented such that its top edge extends proximate the path of the upper end of tines 13 moving past plate 144 of the strainer apparatus. A heavy rubber mat 197 extends from below position 15 to ramp 52, each side of mat 197 extending partially up an end of a respective one of the curtains 196. This arrangement effectively prevents material falling from opened bags from being trapped under wheels 11 and 12. Another change from the first embodiment of Figure 4A is the replacement of plate 82 with a heavy rubber flap 198.

Through use of the alternate structural arrangements shown in Figures 10 to 15, improved operational speed of the bag opening apparatus has been achieved.

## Claims

1. An apparatus for removing the contents of a filled plastic bag, the apparatus comprising :
   (a) a pair of wheels, one of the wheels moving in a first plane of rotation and the other wheel moving in a second plane of rotation, the one wheel being adapted to rotate in a clockwise direction and the other wheel being adapted to rotate in a counterclockwise direction, both wheels rotating at approximately the same angular speed and being oriented such that the first and second planes are approximately coplanar and such that there is one close location where the two wheels extend in tangential spaced relationship to each other ;
   (b) a series of tines mounted in spaced relation on the periphery of each wheel so as to extend on the same side of the plane of rotation of the respective wheel and in a direction primarily normal to that plane of rotation ;
   (c) means for pressing a bag onto those tines moving past the close location such that those tines penetrate a first surface of the bag, the subsequent divergence of the tines on the two wheels as they move away from the close location acting to create tear lines in the first surface of the bag ;
   (d) oscillatory strainer means positioned adjacent to the periphery of each wheel ; and,
   (e) vacuum collection means positioned adjacent to the periphery of each wheel ;
   whereby the tangential spaced relationship of the wheels and the spacing between adjacent tines on the same wheel are such that as the tines on the two wheels move away from the close location the tear lines created in the first surface of the bag are sufficiently close that those lines connect to form a single continuous hole in that surface, all or a substantial portion of the contents of the bag being adapted to fall through that hole, and whereby the oscillatory strainer means is adapted through a combined straining and oscillating action to empty the bag of any remaining contents, and

whereby the vacuum collection means is adapted to collect the emptied bag.

2. An apparatus as in claim 1, wherein the oscillatory strainer means comprises a pair of rollers each mounted such that the axis of rotation of each roller is parallel to the other roller and extends generally horizontally, the two rollers being adapted to rotate in opposite directions and being so spaced from ench other that their cylindrical surfaces engage along a pull line, the pull line being positioned such that a bag caught on a tine moving past one end of the rollers is drawn into the pull line, the oscillatory strainer means also comprising an oscillating member extending in front of the pair of rollers and having first and second portions, the first portion defining one lip of an oscillating slot in a barrier sitting in front of the pull line, bags entering the pull line being pulled through the slot, the second portion defining an oscillating guide member for moving against a bag entering the slot to assist in preventing any articles in the bag from entering the slot.

3. An apparatus as in claim 2, wherein the oscillating member and the pair of rollers are driven by the same driving means.

4. An apparatus as in claim 1, wherein at least one part of the vacuum collection means is positioned so as to be immediately adjacent the oscillating strainer means and downstream of that strainer means relative to the rotation of the respective wheel.

5. An apparatus as in claim 2, wherein at least one part of the vacuum collection means is positioned so as to be immediately adjacent the pair of rollers and downstream of those rollers relative to the rotation of the respective wheel.

6. An apparatus as in claim 1, wherein a stationary ring sits adjacent the circumference of each wheel, each ring having a slightly larger diameter than the diameter of the circle formed by the tines on each wheel, the tines on each wheel moving inside of and proximate the respective ring, the ring being mounted to the apparatus such that the top edge of that portion of the ring extending adjacent the strainer means extends proximate the upper end of tines moving past the strainer means.

7. An apparatus as in claim 1, wherein the bag pressing means comprises a biased flexing structure of multiple links, one of the links having a plate means for pressing on the bag.

8. An apparatus as in claim 7, wherein the flexing structure is comprised of four links hinged together serially in a generally boxlike configuration, the outer end of each outer link being hinged to the frame of the apparatus, the flexing structure being normally supported on the frame of the apparatus in a rest position and being biased by a bias means to return to that rest position after movement, whereby a bag initially contacts the plate means and moves the flexing structure from the rest position, and whereby the bias means subsequently acts to press the bag against the tines on the wheels at the close location and then returns the flexing structure to the rest position.

9. An apparatus as in claim 4 or 5, wherein the vacuum collection means has another part which is positioned downstream of the one part relative to the rotation of the respective wheel, the other part of the vacuum collection means comprising a pair of stationary vertical pipe sections one extending above and one extending below the path of the tines at a fixed position, and wherein air is driven out of the bottom pipe section and pulled into the upper pipe section at the same flow rate so as to create an upward column of air across tines moving past the fixed position,

10. An apparatus for opening a filled plastic bag, the apparatus comprising :

(a) a pair of endless loops, one of the loops moving in a first plane of rotation and the other loop moving in a second plane of rotation, the one loop being adapted to rotate in a clockwise direction and the other loop being adapted to rotate in a counterclockwise direction, both loops rotating with the same angular speed, the two loops being oriented such that the first and second planes are approximately coplanar and such that there is at least one close location where the two loops extend in tangential spaced relationship to each other ;

(b) a series of tines mounted in spaced relation on each loop so as to extend on the same side of the plane of rotation of the respective loop and in a direction primarily normal to that plane of rotation ; and

(c) means for positioning a bag on those tines moving past one of the close locations, the subsequent divergence of the tines on the two loops as they move away from the particular close location acting to create tear lines in that bag surface riding on the tines ;

whereby the tangential spaced relationship of the loops and the spacing between adjacent tines on the same loop are such that as the tines on the two loops move away from the

particular close location the tear lines created in that bag surface riding on the tines are sufficiently close that those lines connect to form a single continuous hole in that surface, the contents of the bag falling through that hole.

**11.** An apparatus as in claim 10, further comprising :
(d) means for transporting a loaded bag to the particular close location.

**12.** An apparatus as in claim 10, further comprising :
(d) means for collecting the contents of the bag after those contents have fallen from the bag.

**13.** An apparatus as in claim 10, further comprising :
(d) means for removing a bag from one or more of the tines after the contents of the bag have fallen from the bag.

**14.** An apparatus as in claim 10, further comprising :
(d) means for transporting a loaded bag to the particular close location ; and
(e) means for collecting the contents of the bag after those contents have fallen from the bag.

**15.** An apparatus as in claim 11 or claim 14, wherein the transporting means is a chute oriented at an angle such that bags slide freely thereon, the lower end of the chute terminating above the particular close location.

**16.** An apparatus as in claim 12 or claim 14, wherein the bag contents collection means is a ramp and a conveyor belt, the ramp being positioned below the endless loops for collecting the bag contents falling from the bag, and the conveyor belt being positioned to extend across the base of the ramp for collecting material coming off of the ramp.

**17.** An apparatus as in claim 13, wherein the bag removal means is a vacuum suction mechanism.

**18.** An apparatus as in claim 10, further comprising :
(d) means for transporting the bag to the particular close location ; and
(e) means for pressing the bag against those tines moving past the particular close location.

**19.** An apparatus as in claim 18, wherein the transporting means is a chute oriented at an angle such that bags slide freely thereon, the lower end of the chute terminating above the particular close location, and wherein the pressing means is a wheel supported on the outer end of a pivoting arm, the inner end of the arm being mounted for rotation on a frame of the apparatus.

**20.** An apparatus as in claim 10, wherein each endless loop is the rim of a wheel, and wherein there exists only one close location at which the rim of each wheel extends in tangential spaced relationship to the rim of the other wheel.

**21.** An apparatus as in claim 13, wherein each endless loop is a chain, and wherein there exist two close locations at which the pair of chains extend in tangential spaced relationship to each other, one of the close locations being the particular close location, the other close location being the location of the bag removal means.

**22.** An apparatus as in claim 10, wherein each tine is attached to each loop such that the tine has a slant toward the direction in which the loop is traveling at the point of attachment.

**23.** An apparatus as in claim 22, wherein each tine is attached to each loop so as to also have a slant toward the inside of the particular loop.

**24.** An apparatus as in claim 10, or claim 22 or claim 23, wherein each tine has a generally rectangular cross-section.

**25.** An apparatus as in claim 10, or claim 22 or claim 23, wherein each tine has a generally circular cross-section.

**26.** An apparatus as in claim 10, wherein each tine has a line edge for contacting the bag surface, the line edge on each tine being oriented so as to extend normal to the direction of movement of the tine.

**27.** An apparatus as in claim 20, wherein the bag positioning means is a pair of elements each having a generally frustoconical shape, each element rotating with a respective wheel, each element being oriented for rotation relative to the respective wheel such that the rotational axis of the element intersects the rotational axis of the respective wheel at a first angle, a flat annular ring extending around the larger end of each element, each ring being oriented such that its surface extends generally normal to the rotational axis of the respective element, the outer periphery of each ring and the rim of the respective wheel moving adjacent to each other at the close location, the conical slope on the two elements acting to position a bag at the close location.

**28.** An apparatus as in claim 27, further comprising at least one rigid member extending from the frame of the apparatus across the path of the upper por-

tion of bags moving away from the close location, the rigid member causing each bag to rotate such that the hole created in the bag surface by the tines extends forward of the upper portion of the bag.

**29.** An apparatus as in claim 27, further comprising a pair of plates, each plate being positioned to extend slightly above and normal to the surface of a respective ring for pushing from the ring any material being carried on the ring.

**30.** An apparatus as in claim 27, further comprising a pair of bag strainer means each strainer means comprising a strainer assembly and a series of guide rails, each strainer assembly being positioned adjacent the periphery of a respective wheel and being comprised of a pair of abutting cylindrical members rotating in opposite directions to define a line of pull adjacent the rim of the wheel, a bag caught on the tines of one of the wheels being guided by the respective series of guide rails into the line of pull of the respective strainer assembly, the cylindrical members of each of the strainer assemblies being adapted to strain from the bag any material remaining in the bag.

**31.** An apparatus as in claim 30, wherein the pair of abutting cylindrical members is a pair of cylindrical gears, and wherein the line of pull is a mesh line defined by meshing of teeth on the pair of gears.

**32.** An apparatus as in claim 30, further comprising a vacuum suction mechanism positioned to collect each bag after straining of the bag by one of the bag strainer means.

**33.** An apparatus as in claim 30, wherein each chain extends around a respective first wheel and a respective second wheel, the particular close location being between the pair of second wheels, each chain moving through a respective fixed track when moving from the respective first wheel to the respective second wheel, the tracks being positioned such that the chains have a greater separation distance when moving through the tracks than when moving around either the first wheels or the second wheels.

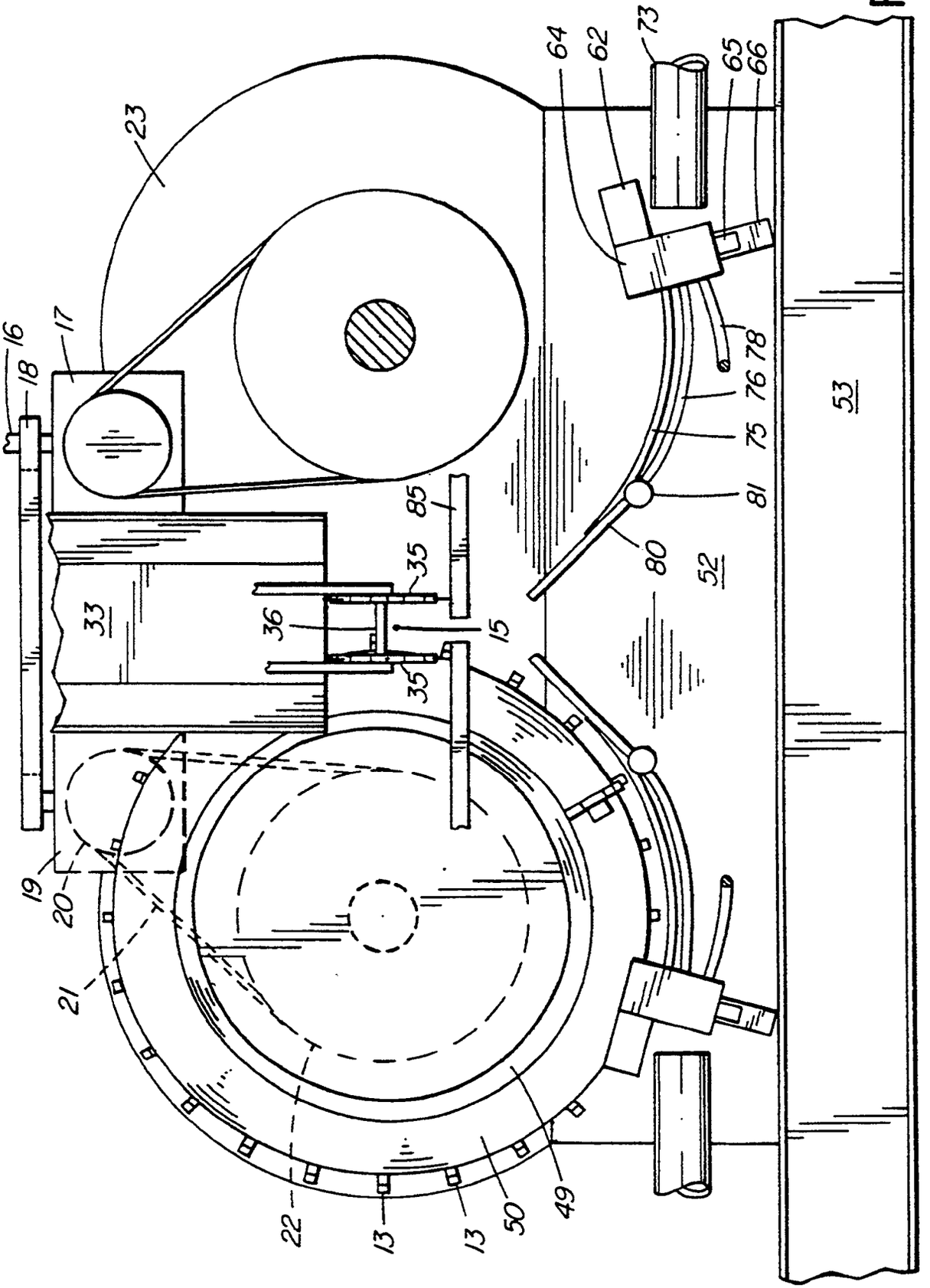
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FIG. I

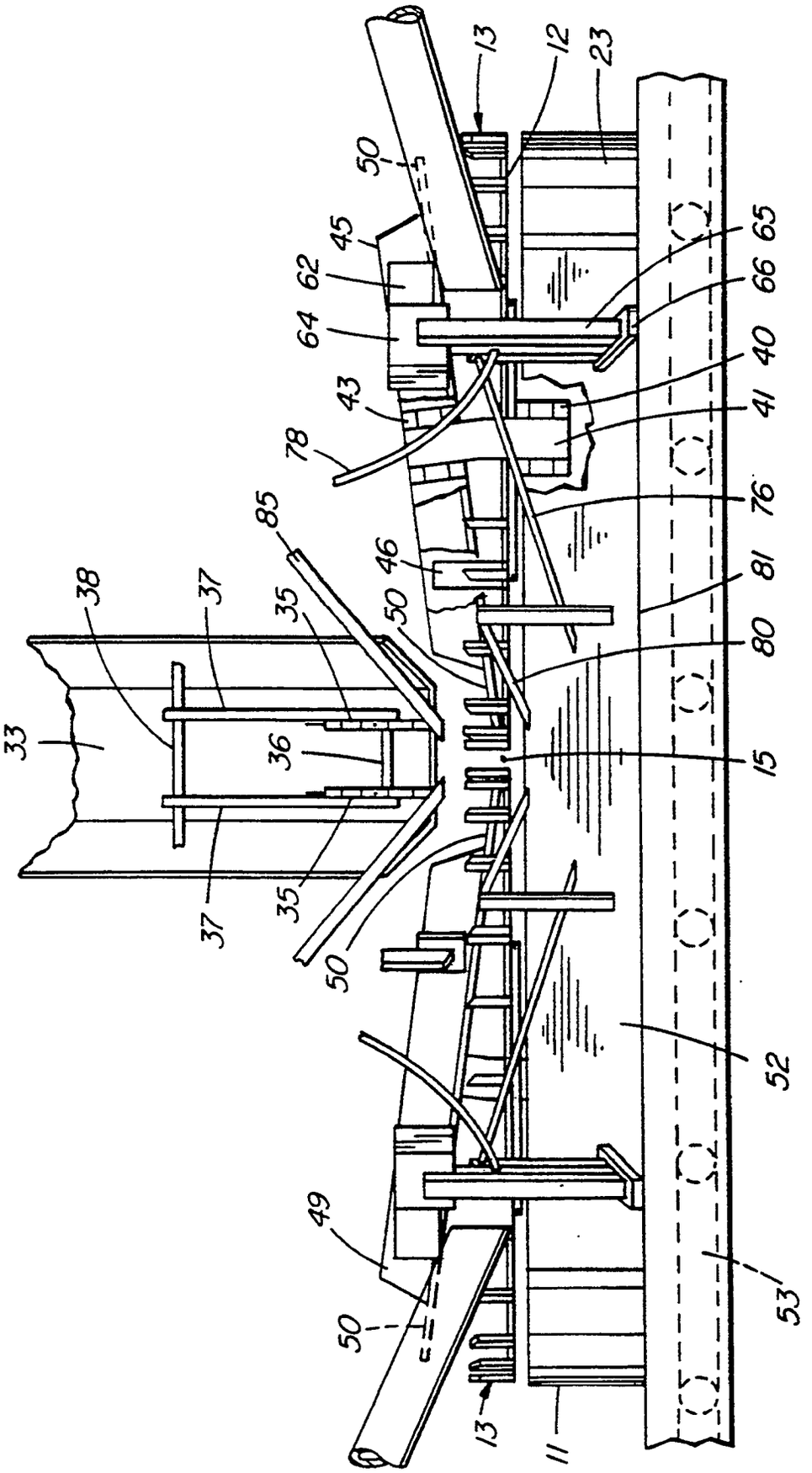
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FIG. 2

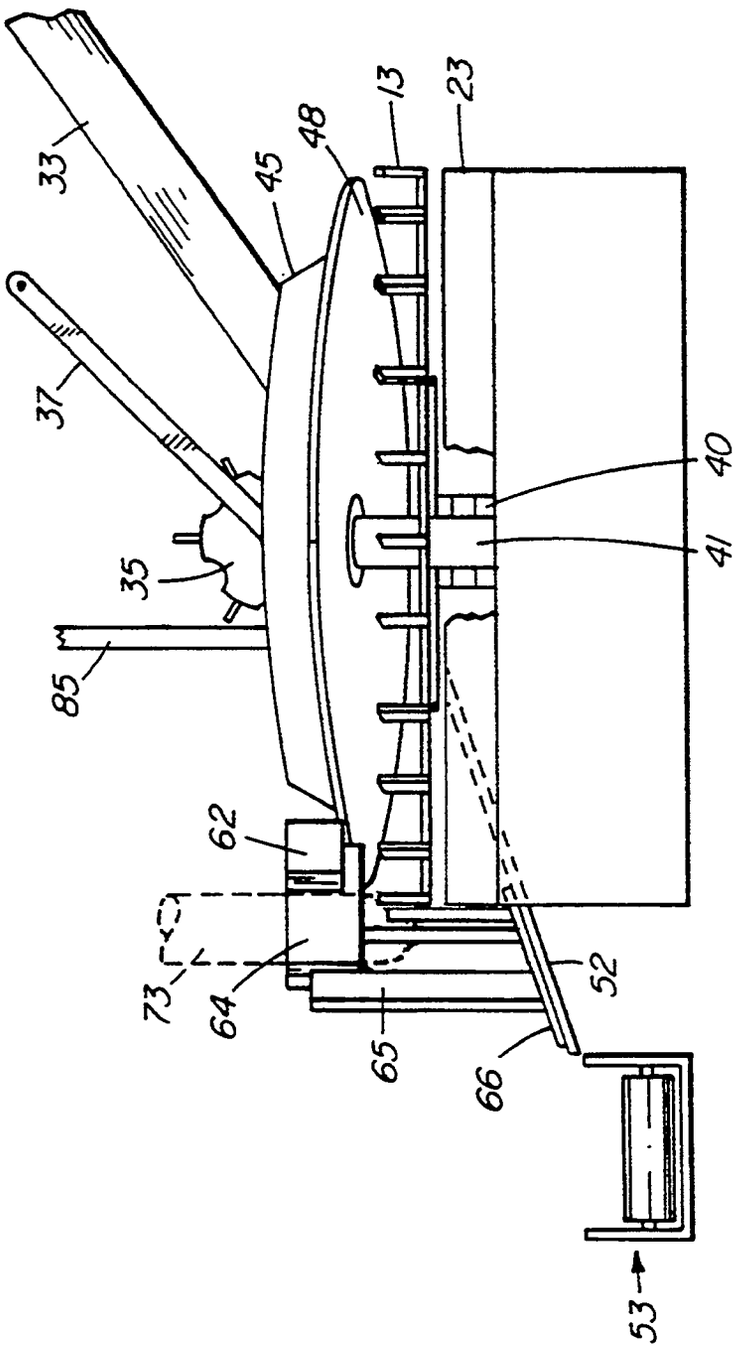


FIG. 3

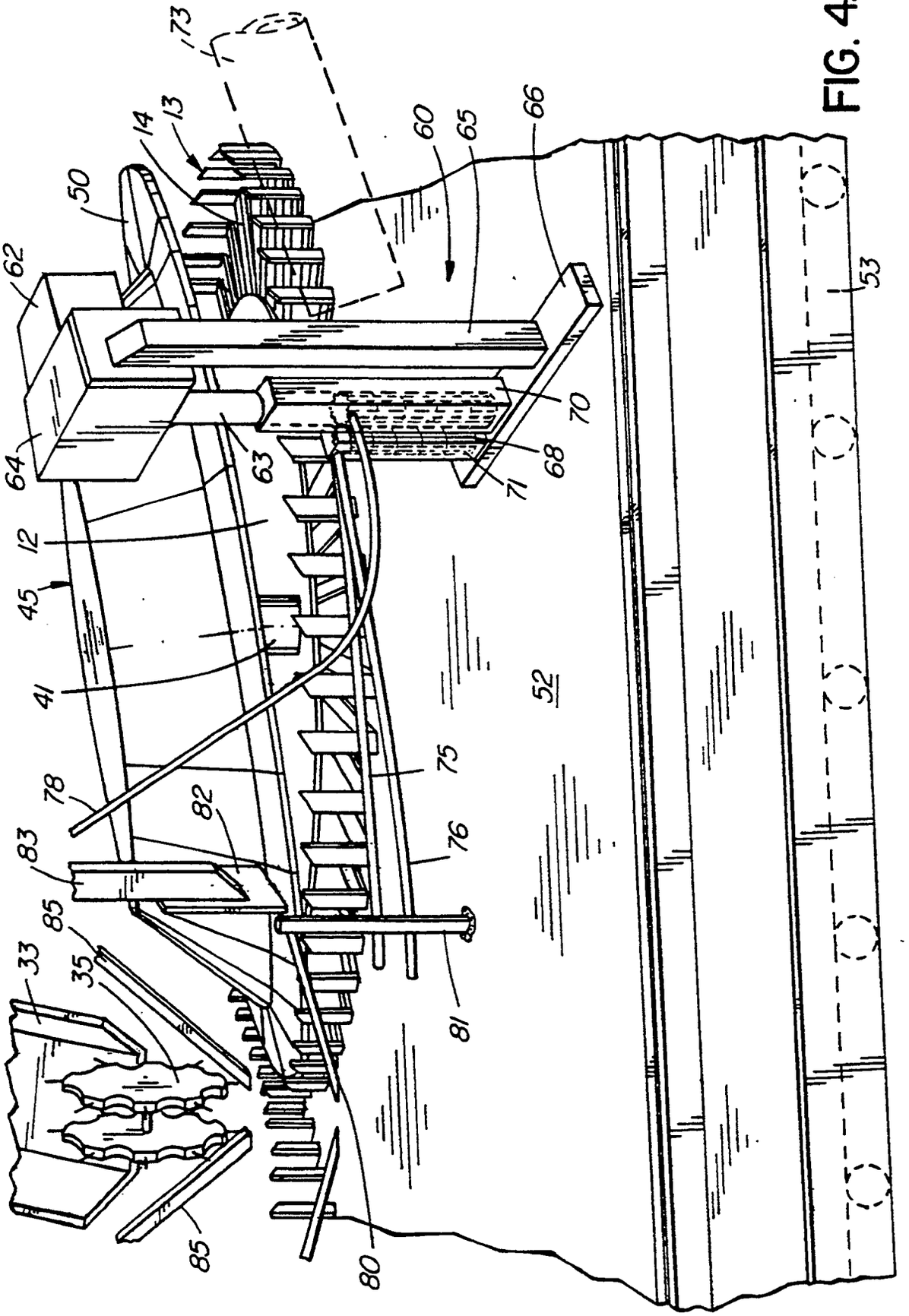
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FIG. 4A

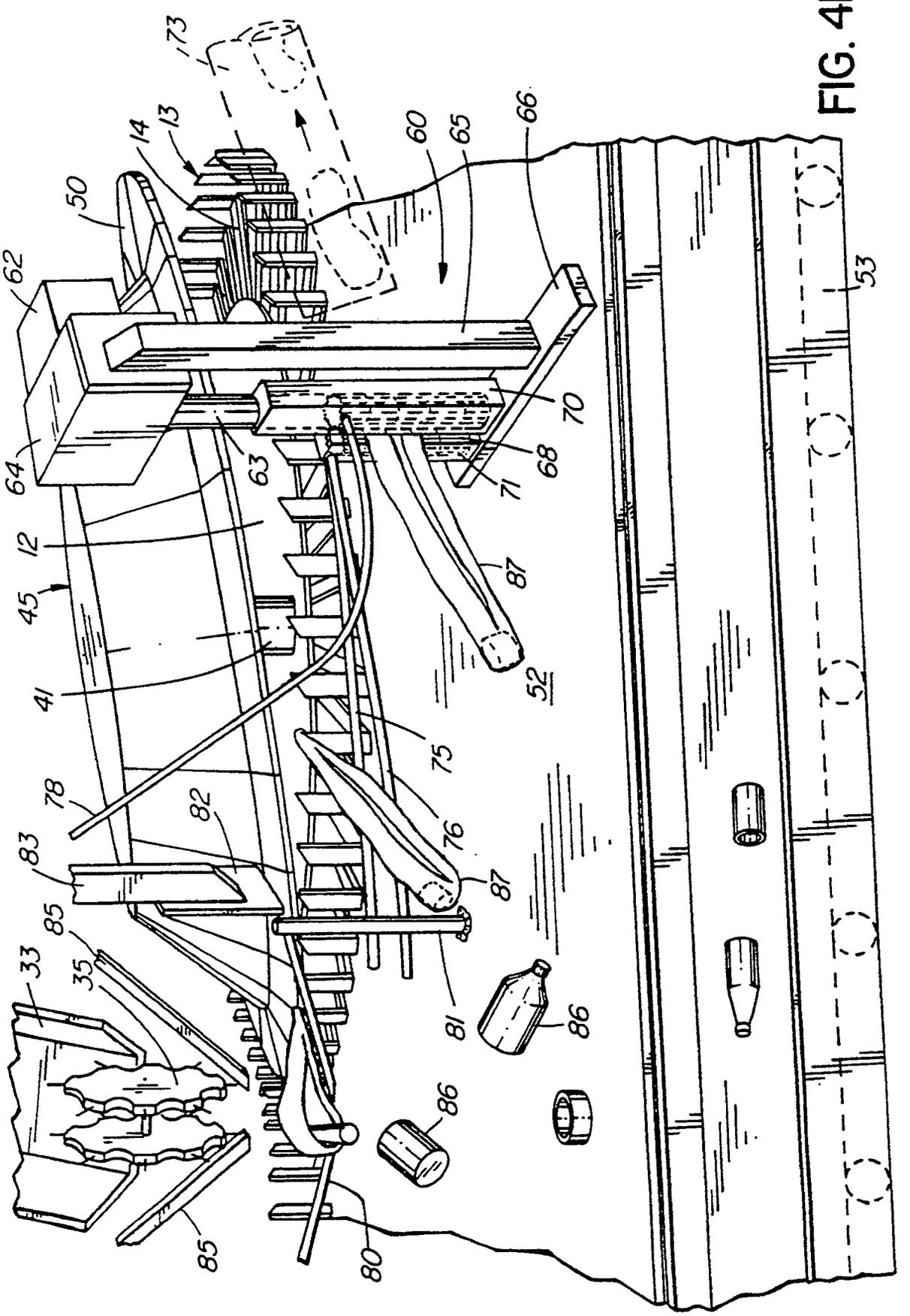
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FIG. 4B

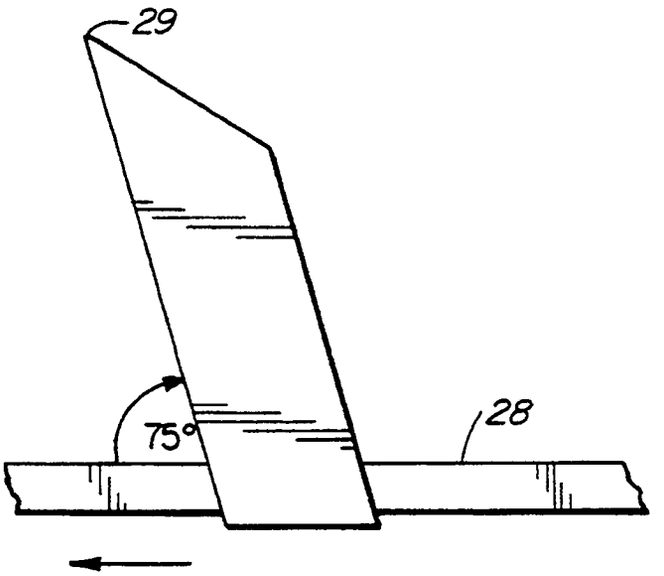


FIG. 5

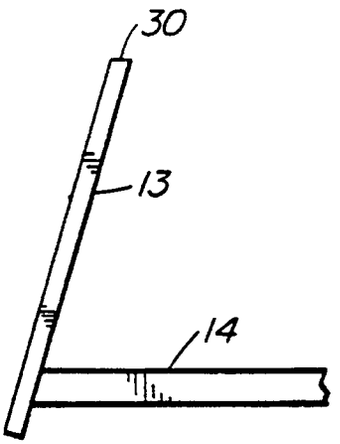


FIG. 6

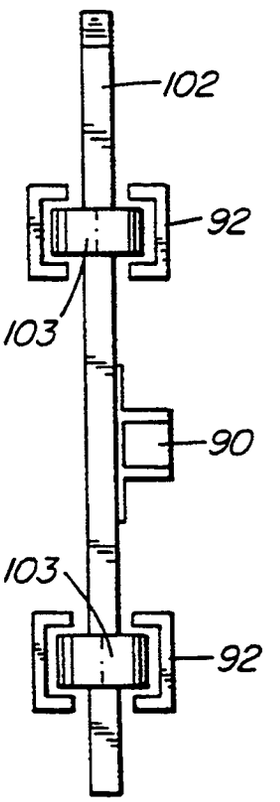


FIG. 9

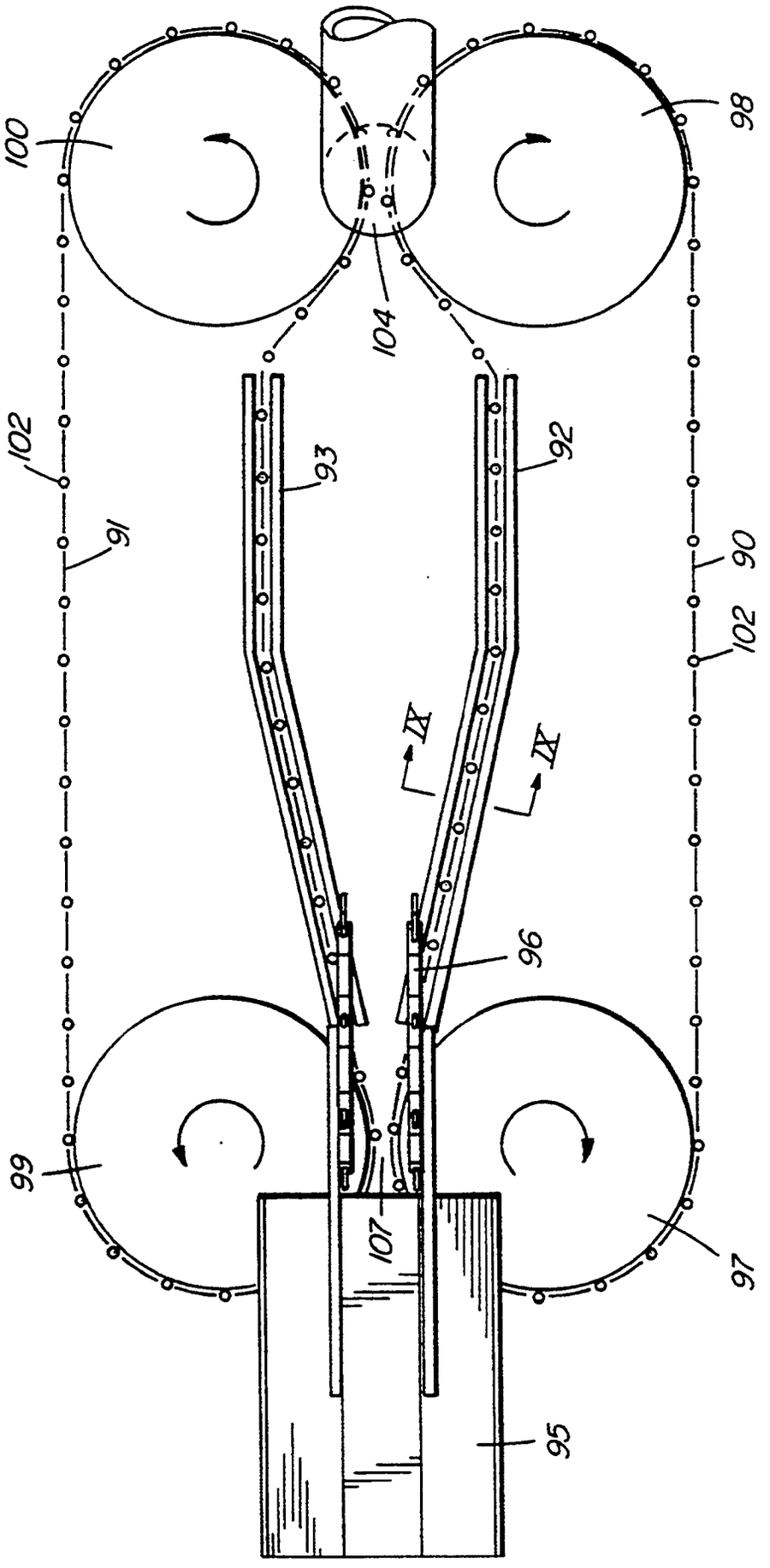


FIG. 7

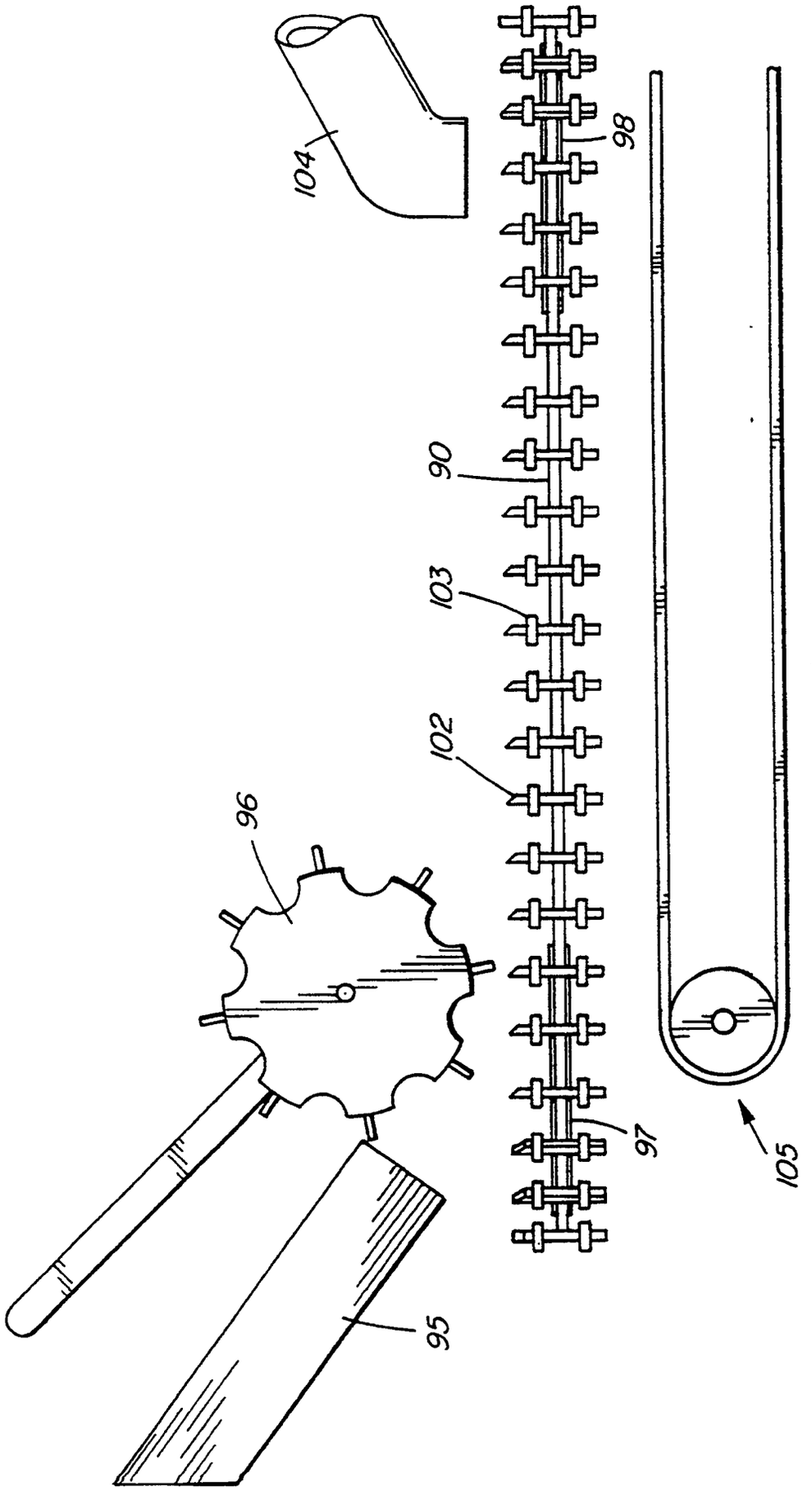


FIG. 8

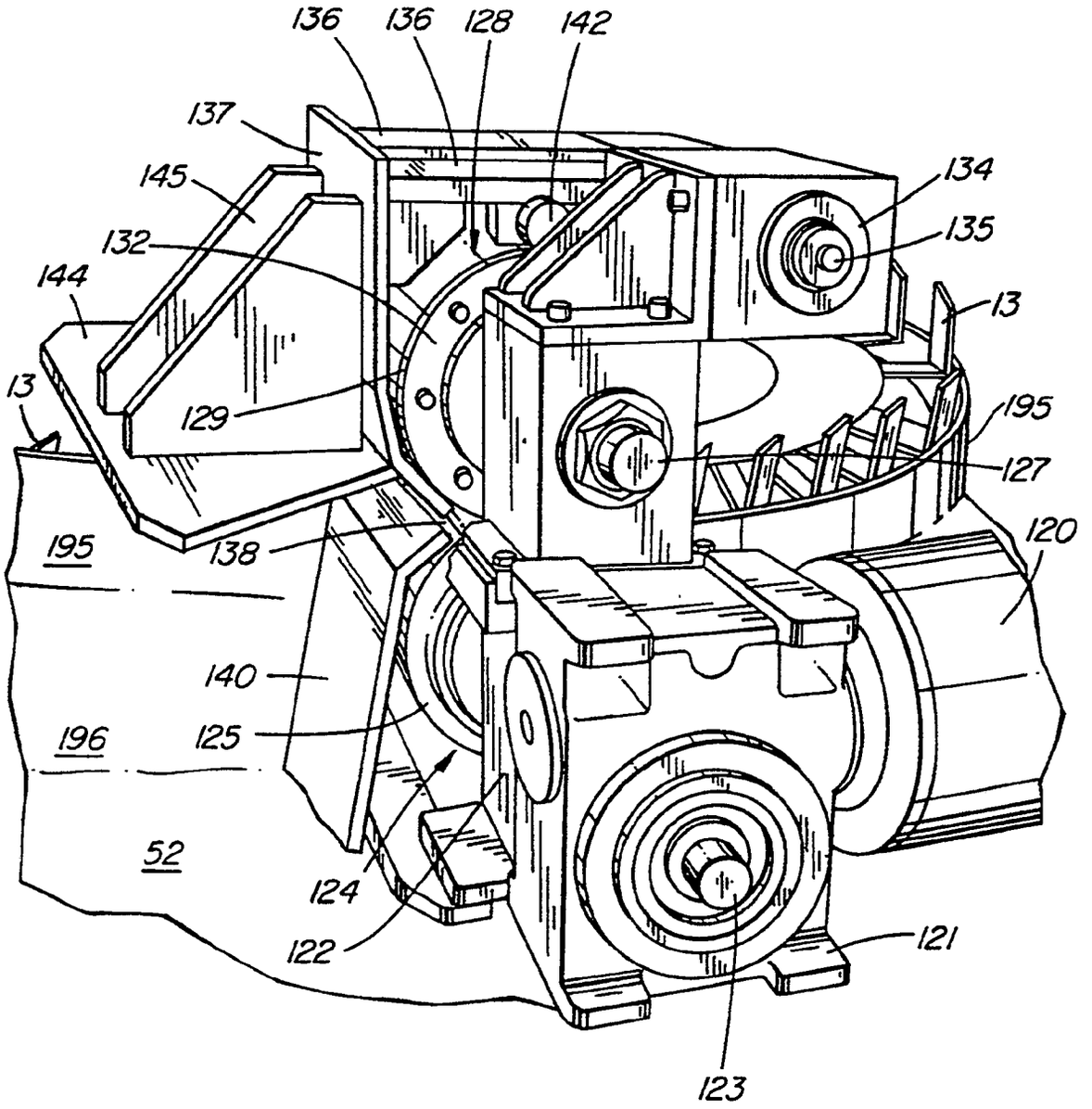
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FIG. 10

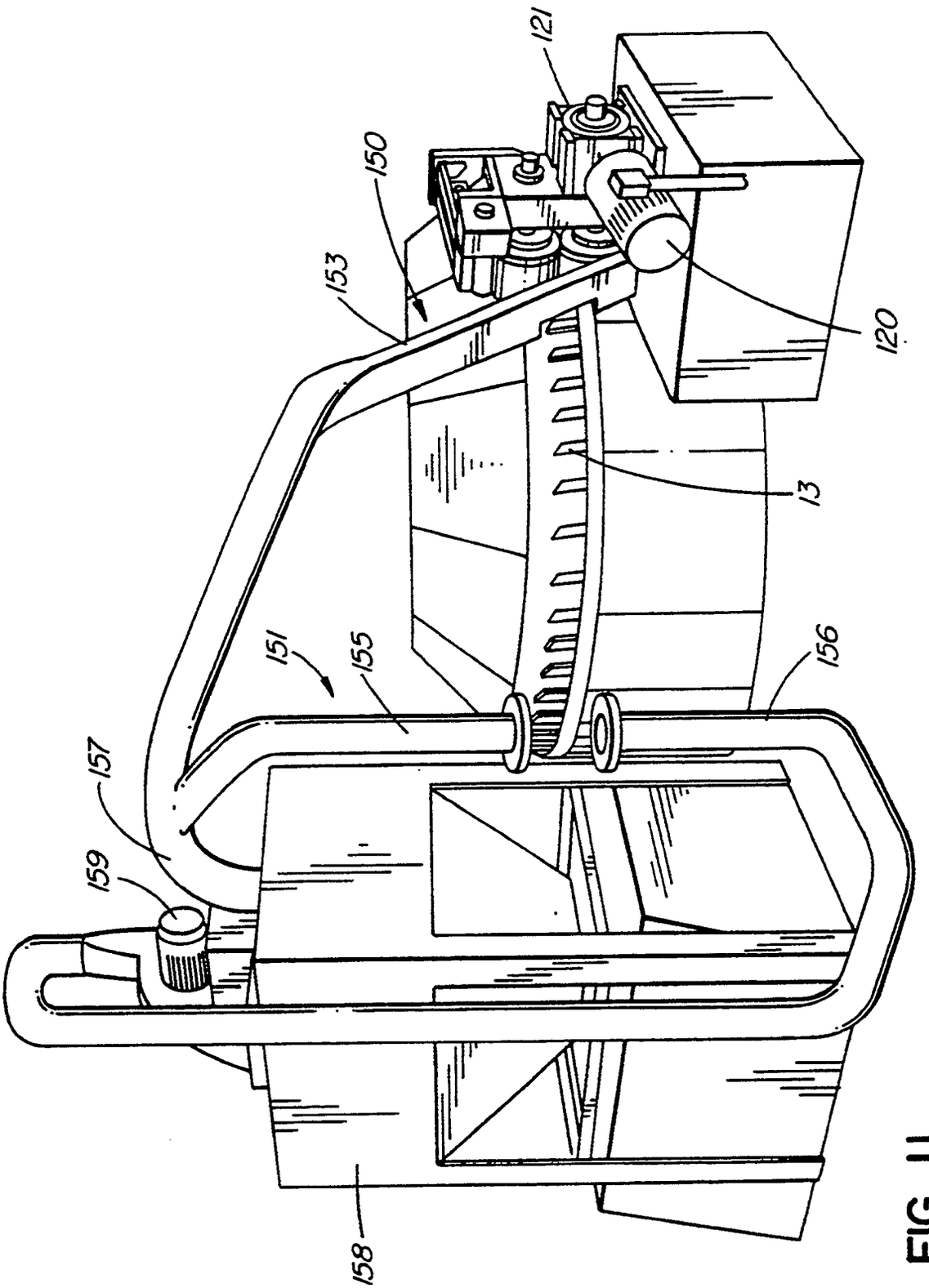


FIG. 11

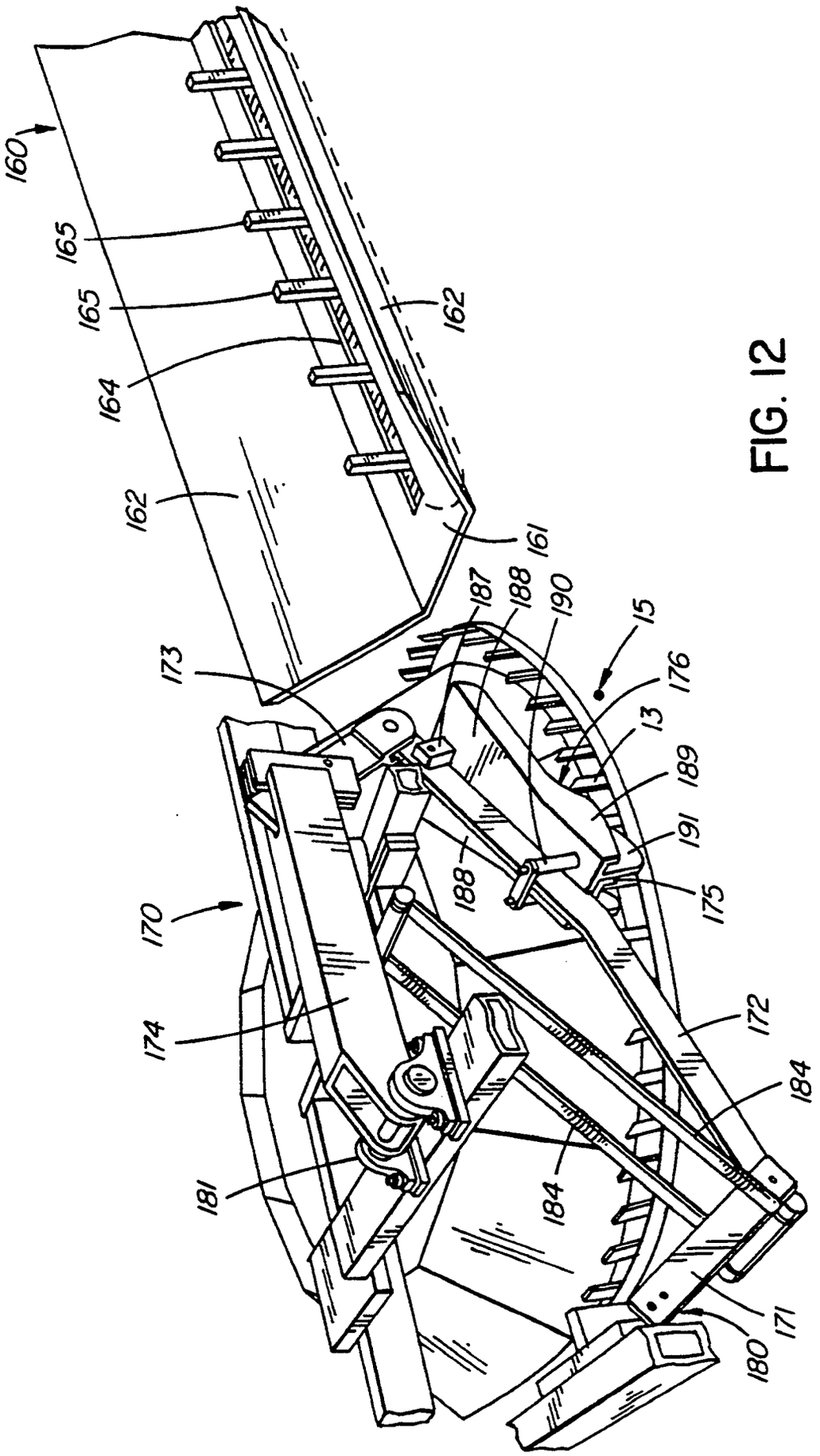
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FIG. 12

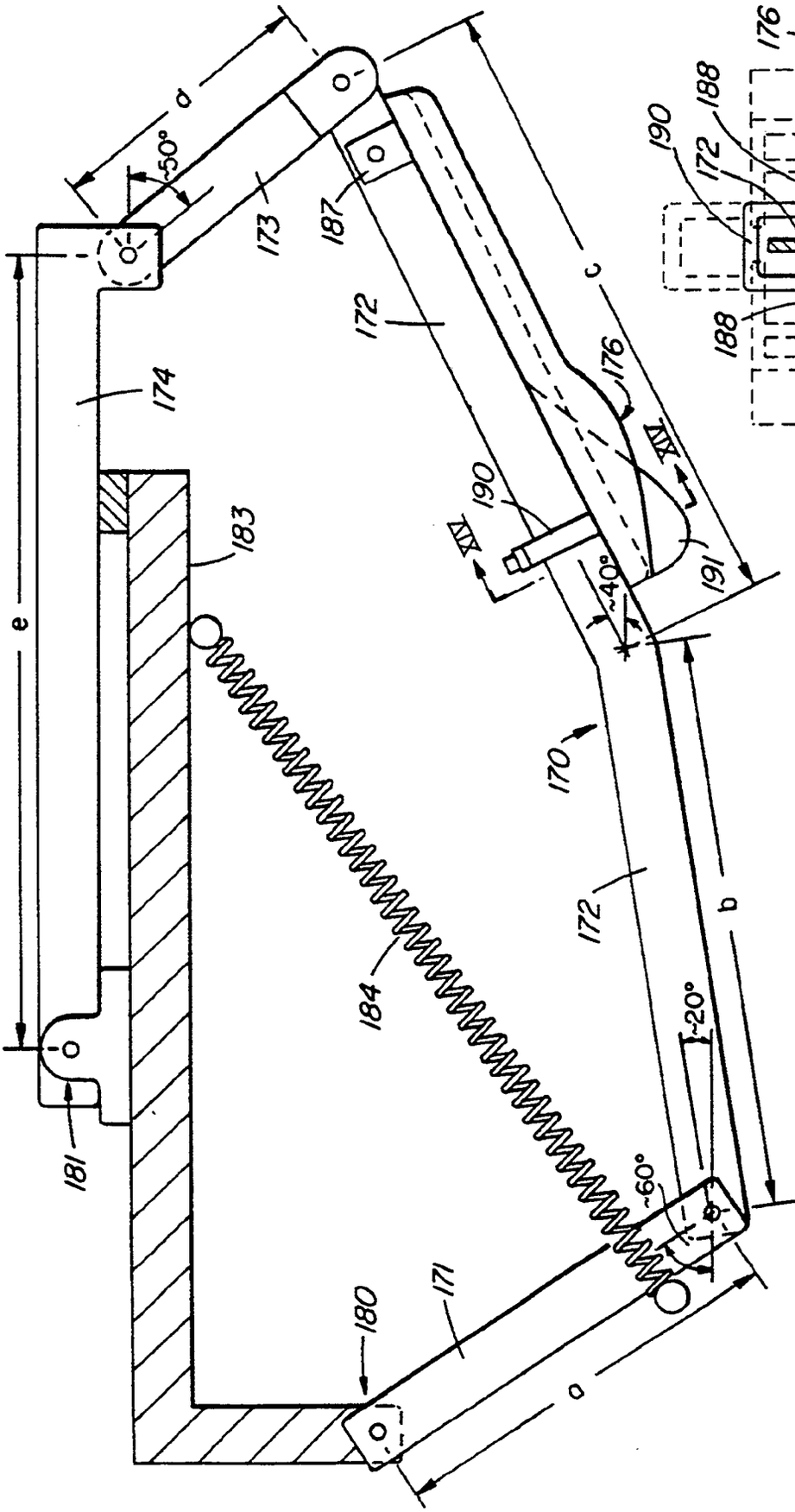
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FIG. 13

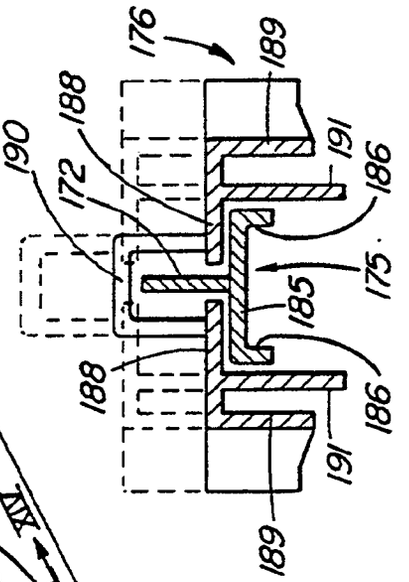
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FIG. 14

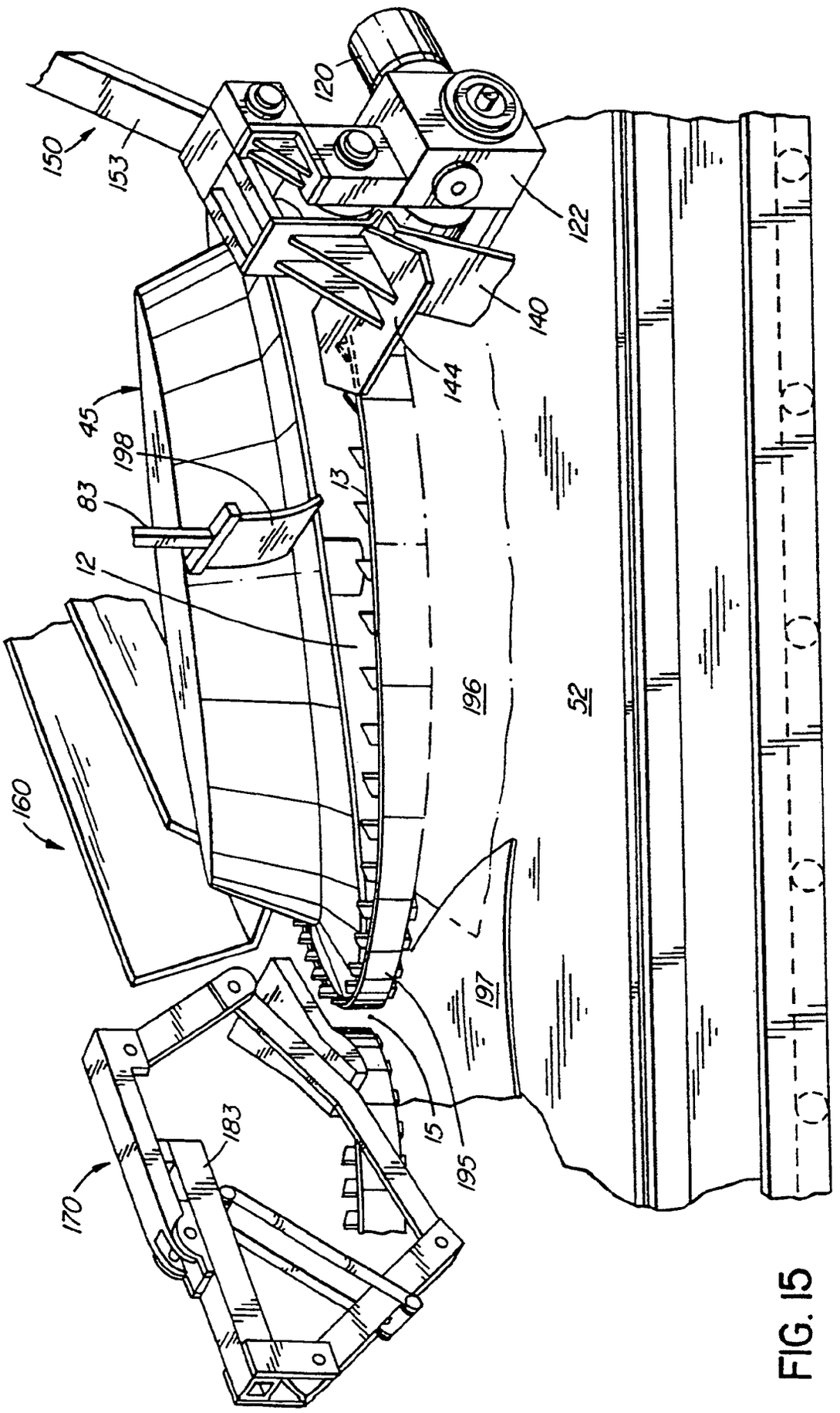
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FIG. 15

European Patent Office

# EUROPEAN SEARCH REPORT

Application Number

EP 91 85 0028

## DOCUMENTS CONSIDERED TO BE RELEVANT

| Category | Citation of document with indication, where appropriate, of relevant passages | Relevant to claim | CLASSIFICATION OF THE APPLICATION (Int. Cl.5) |
|---|---|---|---|
| A | DE-A-2 554 659 (LUCO-TECHNIC)<br>* Page 15, line 1 - page 16, line 9; fig. * | 1,10,11,12,14,15 | B 65 B 69/00 |
| A | US-A-2 803 361 (W. EDWARDS)<br>* Column 2, line 6 - column 3, line 20; fig. * | 1,10,11,15 | |

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

B 65 B

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 21-05-1991 | JAGUSIAK A.H.G. |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
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P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P0401)