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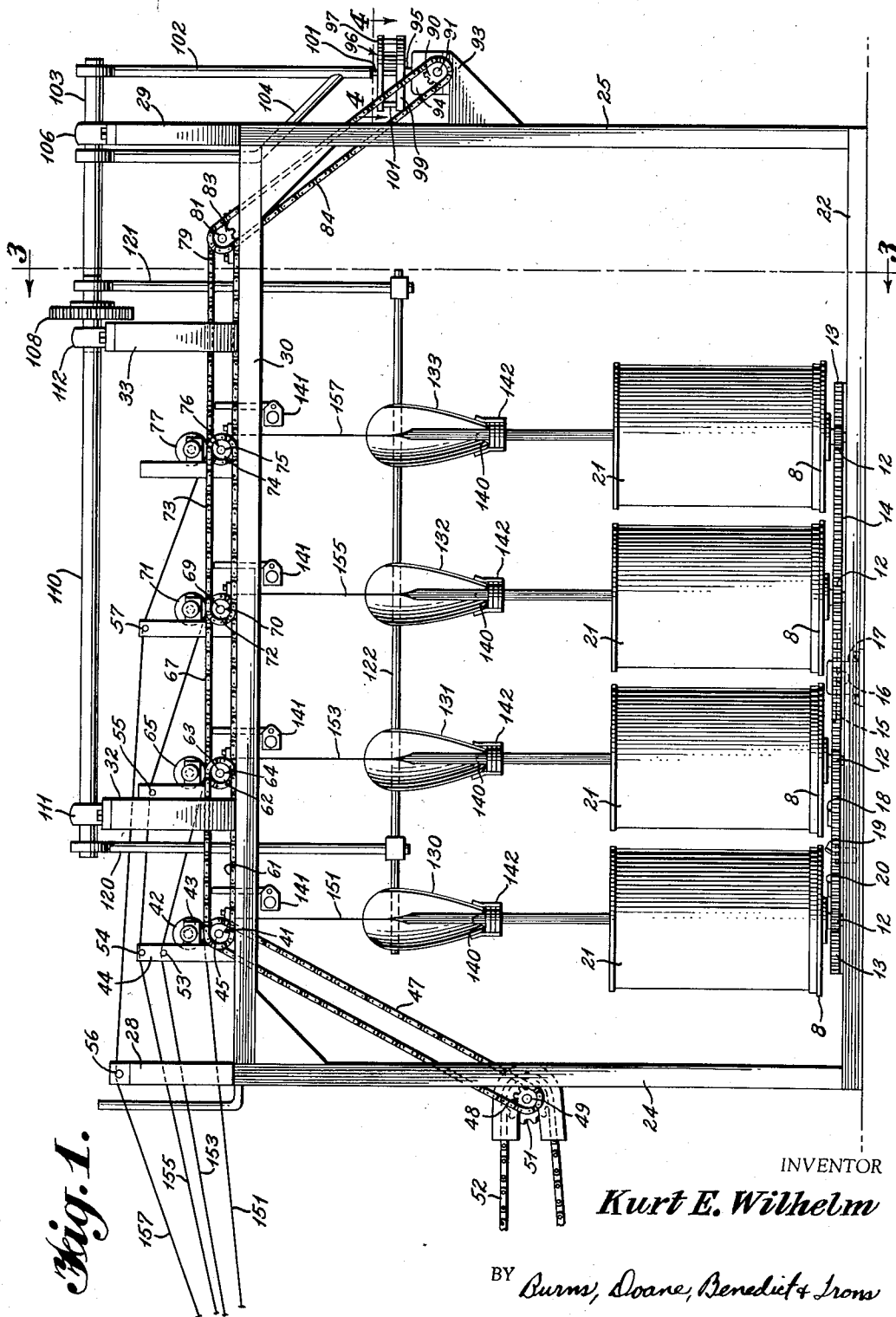
K. E. WILHELM

2,722,729

METHOD AND APPARATUS FOR PACKAGING STRANDS OF FLEXIBLE
MATERIAL INTO CYLINDRICAL CONTAINERS

Filed July 9, 1954

4 Sheets-Sheet 1



INVENTOR

Kurt E. Wilhelm

BY *Burns, Doane, Benedict & Irons*
ATTORNEYS

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K. E. WILHELM

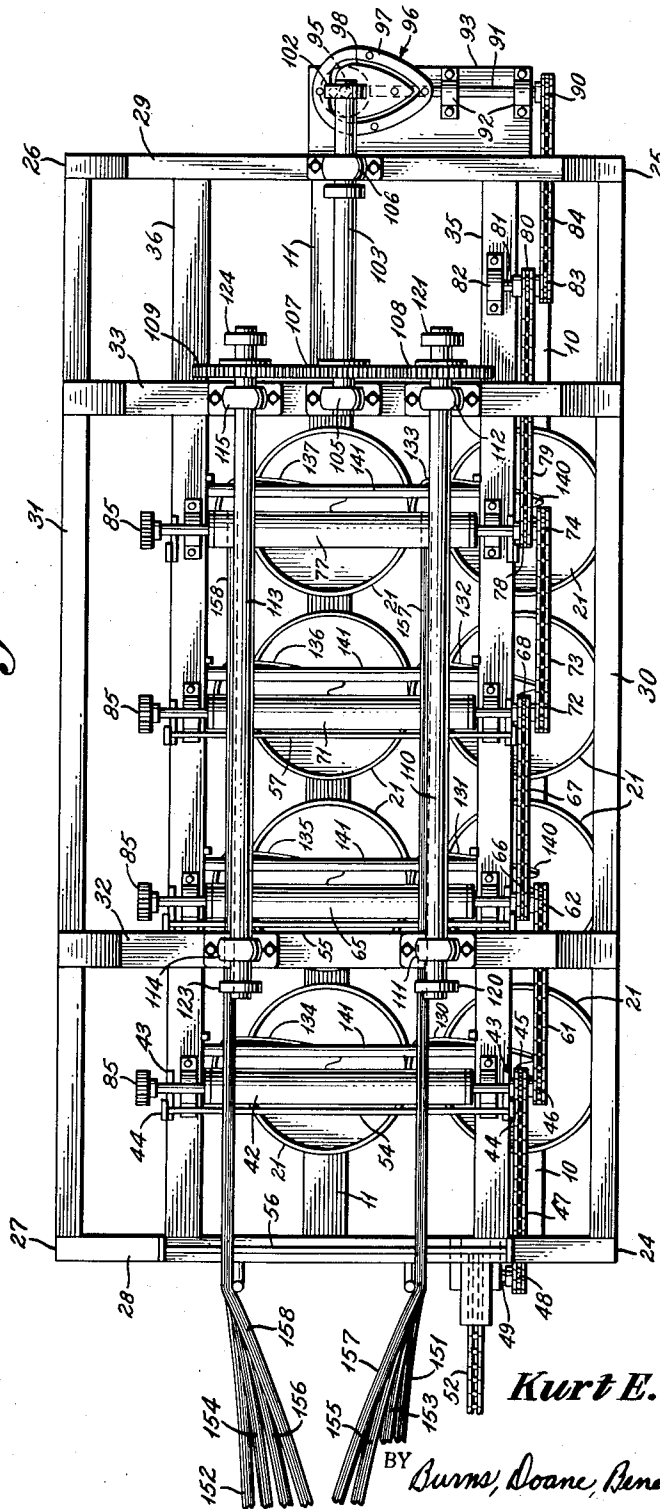
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4 Sheets-Sheet 2

Fig. 2.



INVENTOR

Kurt E. Wilhelm

BY

Curran, Doane, Benedict & Irons

ATTORNEYS

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K. E. WILHELM

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4 Sheets-Sheet 3

Fig. 3.

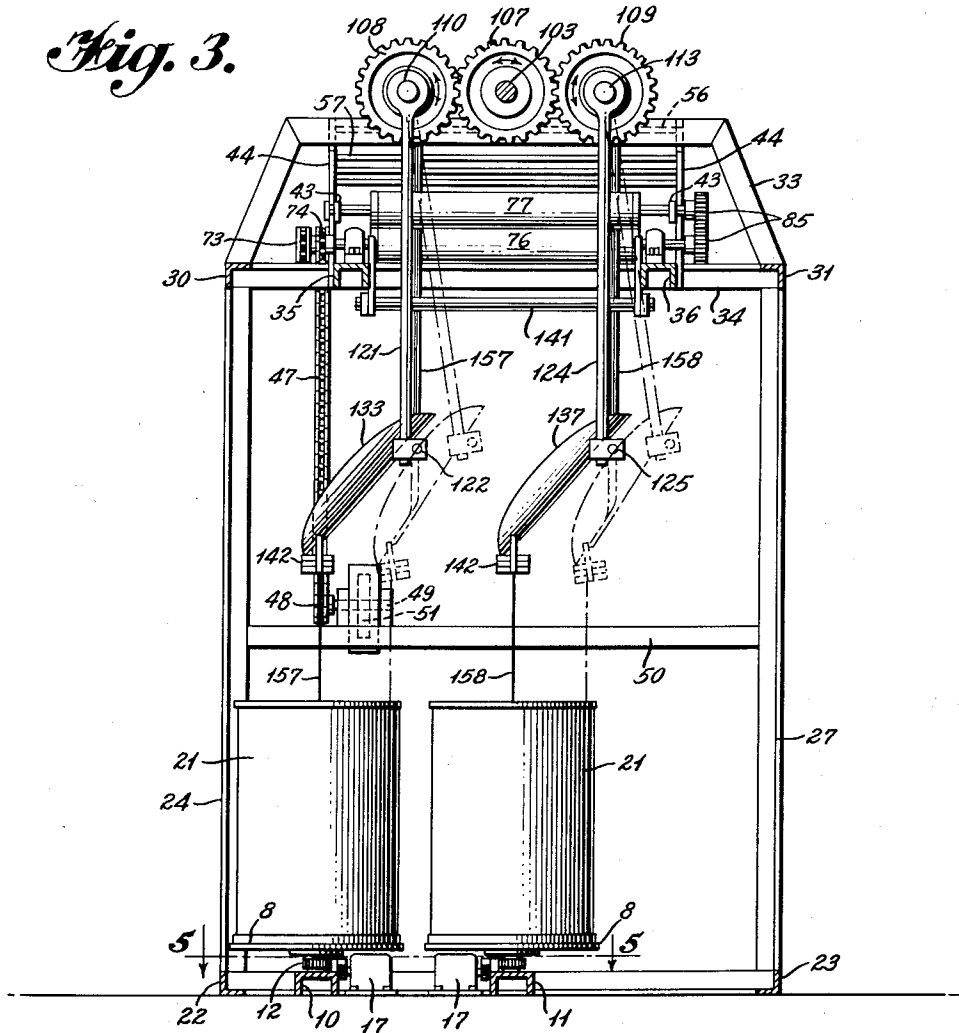
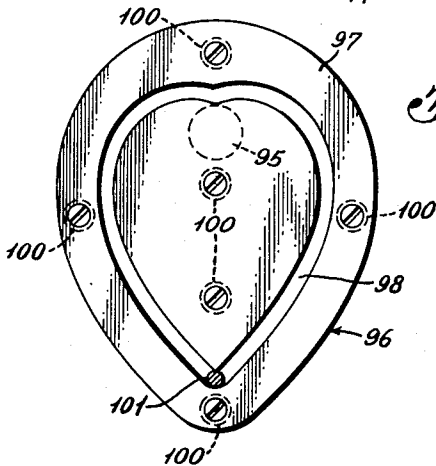


Fig. 4.



INVENTOR

Kurt E. Wilhelm

BY

Burns, Doane, Benedict & Irons

ATTORNEYS

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METHOD AND APPARATUS FOR PACKAGING STRANDS OF FLEXIBLE MATERIAL INTO CYLINDRICAL CONTAINERS

Kurt E. Wilhelm, Warren, R. I., assignor to Rhee Elastic Thread Corporation, Warren, R. I., a corporation of Rhode Island

Application July 9, 1954, Serial No. 442,306

10 Claims. (Cl. 28—21)

The present invention relates to a method and apparatus for packaging strands of flexible material into cylindrical containers and to the resulting packages. The invention is particularly concerned with the packaging of strands of rubber into cylindrical containers.

Cut rubber thread may be manufactured from rubber sheets by use of a slitting machine. The output of the slitting machine may be in ribbon form in which the ribbon is partially cut through to define the individual threads, which are readily separable from each other. Alternatively, the slitting machine may cut entirely through the sheet in which case the output consists of a plurality of separate threads or single ends. The present invention is applicable to the packaging of both types of output from the slitting machine. For convenience, the output of the slitting machine will be generically referred to as strands. This term includes both the ribbons of incompletely severed threads and the plurality of parallel single ends.

It has heretofore been common practice to package the ribbons in containers by permitting the ribbon to fall freely from a fixed point. If the ribbon is relatively coarse and the cross-sectional area of the container is not too great, the container can be filled fairly evenly in this manner. Proposals have heretofore been made to periodically shift the point from which the ribbon falls relative to the container. This can be done either by moving the container or by holding the container stationary and moving the point from which the thread falls. However, such procedures have not proven satisfactory for the filling of cylindrical containers with ribbons of fine size.

When the output of the slitting machine is in the form of single ends, the thread has been taken directly from the slitting machine to a spooler. Alternatively, the single ends have been hand-fed into barrels, a procedure which requires considerable skill in order to evenly cover the cross-sectional area of the barrel and to avoid snarls when withdrawing the thread from the container.

Cylindrical containers are much to be preferred in the trade for the reason that there are no corners in which the thread can catch or snarl and such containers have greater strength and are less expensive as compared to other containers having equivalent crushing resistance. The present invention provides a method and apparatus for evenly filling cylindrical containers with either ribbons or single ends of rubber thread by means of a novel combination of motions of the cylindrical container and of the point from which the thread falls. It will be understood that the point from which the thread falls determines the position of the zone of deposition of the thread in the container. According to the present invention the zone of deposition is caused to move from the longitudinal central axis of the cylindrical container to the periphery of the container and back again to the longitudinal axis. This cycle of movement of the zone of deposition is accompanied by rotation of the container about its longitudinal axis. There is a plurality of

2

cycles of movement of the zone of deposition for each revolution of the container. This results in the strand being deposited in the container in generally flower petal patterns. The velocity of movement of the zone of deposition is not constant but is such that the time that the zone of deposition is in any particular area of the container is proportional to the magnitude of that area. This can be stated differently by saying that the velocity of the zone of deposition is inversely proportional to the square of the distance of the zone of deposition from the longitudinal axis of the container. This control of the velocity or rate of movement of the zone of deposition causes the container to be substantially uniformly filled throughout its cross-sectional area. The ratio of the rotation of the container to the cycle of movement of the zone of deposition is preferably so controlled that the flower petal patterns do not build up exactly on top of one another. In this way the formation of voids within the container is substantially eliminated. From 6 to 8 cycles of movement of the zone of deposition for each revolution of the container have been found satisfactory. The rotation of the barrel is not continuously uni-directional. It is preferred that the container make one revolution in one direction and that the direction of rotation then be reversed for one revolution. This reversal of direction of rotation of the container avoids putting a twist in the strand. I have found that there is considerable latitude in the number of cycles of movement of the zone of deposition for each revolution of the container. I have also found that it is not essential for the zone of deposition to occupy any particular position at the time the container reverses direction. I have also found that it is desirable that for each revolution of the container the number of cycles of movement in the zone of deposition should be a whole number plus a fraction. This relationship prevents the flower petal patterns from building up directly on top of each other.

An important object of the invention is to provide a method and apparatus for filling cylindrical containers with strands of flexible material which causes the strands to build up evenly within the container, to substantially fill the container, and to avoid snarling of the strands during packaging or withdrawal from the container.

Another object of the invention is to provide a package consisting of a cylindrical container having therein a strand of flexible material with the strand forming repetitive flower petal patterns radiating from the longitudinal central axis of the container to thereby increase the quantity of material within the package without danger of snarling of the strand. Another object of the invention is to provide a method and apparatus for filling a cylindrical container with a strand of flexible material in which the zone of deposition of the strand is moved during rotation of the container and in which the velocity of movement of the zone of deposition is controlled in such manner as to substantially uniformly fill the cross-sectional area of the container. A further object of the invention is to provide apparatus for simultaneously filling a plurality of cylindrical containers with strands of flexible material in the manner described above.

Other objects and advantages of the invention will be referred to in the following detailed description of an exemplary form of the invention. This description has reference to the accompanying drawings wherein:

Figure 1 is a side elevational view of apparatus embodying the invention and intended to simultaneously fill eight cylindrical containers;

Figure 2 is a top plan view of the apparatus shown in Figure 1;

Figure 3 is a vertical sectional view taken in the direction of the arrows along the line 3—3 of Figure 1;

Figure 4 is a horizontal sectional view taken in the direction of the arrows along the line 4—4 of Figure 1;

Figure 5 is a horizontal sectional view taken in the direction of the arrows along the line 5—5 of Figure 3;

Figure 6 is a vertical sectional view taken in the direction of the arrows along the line 6—6 of Figure 5; and

Figure 7 is a top plan view of a container filled in accordance with the present invention and diagrammatically illustrates the flower petal patterns formed by the strand of flexible material.

The apparatus comprises eight similar turntables, all of which are designated by the reference numeral 8. Each turntable is provided with a stub shaft 9. The turntables are arranged in two banks of four each and the stub shafts 9 are journaled in parallel longitudinally extending rails 10 and 11. It will be sufficient to describe the drive arrangement for one bank of turntables, since the drive for the other bank is similar. Fixed to each stub shaft 9 is a spur gear 12 which meshes with a rack 13. The rack 13 is slidable in a longitudinally extending seat 14 fixed to the rail 10. Secured to the rack 13 is a rack gear 15 which meshes with a spur gear 16 mounted on the shaft of a reversible electric motor 17. Rotation of the electric motor 17 in one direction will drive the turntables 8 in one direction through the medium of the spur gear 16, the racks 15 and 13 and the spur gear 12. After the turntable 8 has made a complete revolution in one direction, a stop 18 carried by the rack 13 engages a reversing switch 19 which causes the motor 17 to reverse direction. The turntable 8 will then be rotated in the opposite direction for one revolution at which time a stop 20 engages the reversing switch 19 and causes the motor 17 to again reverse direction. The rotation of the turntable 8 is preferably rather slow and I have found that it is satisfactory for the turntable to make one revolution in approximately one-half minute.

Each turntable 8 supports a cylindrical, vertically disposed container, these containers being designated by the reference numeral 21. The containers are open at their upper ends during filling.

The apparatus includes a frame consisting of lower side rails 22 and 23 and upright corner posts 24, 25, 26 and 27. The upper ends of the corner posts 24 and 27 are joined by a truss-like member 28. The upper ends of the corner posts 25 and 26 are joined by a truss-like member 29. An upper side rail 30 connects the upper end of the corner post 24 to the upper end of corner post 25 and a similar upper side rail 31 joins the upper end of the corner post 27 to the upper end of the corner post 26. Truss-like members 32 and 33 extend between the upper side rails 30 and 31 in the positions best shown in Figures 1 and 2. An upper end rail 34 extends horizontally from the upper end of the corner post 24 to the upper end of the corner post 27 and a similar upper end rail (not shown) extends from the upper end of the corner post 25 to the upper end of the corner post 26. These upper end rails support intermediate rails 35 and 36 which extend in parallel relationship longitudinally of the machine.

The relatively wide sheet of cut rubber is divided at the slitting machine into a plurality of strands. These strands are designated by the reference numerals 151 to 158 inclusive. The strands 151 to 158 may be completely severed into individual threads extending longitudinally thereof or the threads of each strand may be only partially severed. In the latter case, the extent of severance is such that the threads of each strand may be easily torn longitudinally into individual threads.

The strands 151 and 152 pass over the driven roll 41 and beneath a weighted roll 42. The bearings 43 for the roll 42 are supported for free vertical movement by means of standards 44. The roll 42 is thus readily removable from the machine, and in use its weight rests on the upper surface of the strands 151 and 152 to main-

tain the lower surface of those strands in intimate contact with the surface of the driven roll 41. The shaft of the roll 41 is provided with a pair of sprockets 45 and 46. The sprocket 45 is driven by means of a chain 47 and a sprocket 48 mounted on a shaft 49 journaled in bearings carried by cross frame member 50. The shaft 49 has mounted thereon a sprocket 51 which is driven from any suitable source of power (not shown) through the medium of a chain 52.

A chain 61 engages the sprocket 46 and a sprocket 62 fixed to the shaft 63 of a driven roll 64. A roll 65 is mounted for vertical movement in a manner similar to that of the roll 42 described above. The shaft 63 of the driven roll 64 also has fixed thereon a sprocket 66 which drives a chain 67 and a sprocket 68 fixed to the shaft 69 of a driven roll 70. Roll 71 is mounted in a manner similar to the mounting of the rolls 42 and 65. The shaft 69 of the driven roll 70 also carries a sprocket 72 which is engaged by a chain 73. Chain 73 engages a sprocket 74 which is fixed to the shaft 75 of a driven roll 76. A roll 77 is associated with the driven roll 76 in the manner described above in connection with roll 42. The shaft 75 of the driven roll 76 also carries a sprocket 78 which drives a chain 79 and a sprocket 80 fixed to a shaft 81 mounted in a bearing 82 carried by the rail 35. The shaft 81 also has fixed thereto a sprocket 83 which drives a chain 84.

The rolls 42, 65, 71 and 77 may be driven by the rolls 41, 64, 70 and 76 respectively by meshing spur gears 85.

The chain 84 engages a sprocket 90 which is fixed to a shaft 91. The shaft 91 is journaled in bearings 92 carried by a shelf 93 fixed to the frame of the machine. The shaft 91 drives a gear reduction unit 94 having a vertical output shaft 95 which drives a cam designated generally by the reference numeral 96. The cam 96 is provided with an upper cam plate 97 having a generally heart-shaped groove 98 therein. The specific configuration of the groove 98 is described in greater detail below. The cam plate 97 is vertically spaced from a lower plate 99 by means of a plurality of posts 100.

A cam follower 101 is positioned within the groove 98. The cam follower 101 is secured to a lever 102 which is fixed at its upper end to a horizontally extending shaft 103. The lever 102 may be provided with a bifurcation 104 which is also secured to the shaft 103 to lend rigidity to the lever. The shaft 103 is mounted in bearings 105 and 106 which are supported by the truss-like members 32 and 29 respectively. A gear 107 is fixed to the shaft 103 and meshes with gears 108 and 109 which are identical in size to each other and to the gear 107. The gear 108 is fixed to a shaft 110 which is mounted in bearings 111 and 112 carried by the truss-like members 32 and 33 respectively. The gear 109 is fixed on a shaft 113 journaled in bearings 114 and 115 which are also mounted on the truss-like members 32 and 33 respectively. It will be seen from the foregoing description that the shafts 110 and 113 will rotate in a direction opposite to that of the shaft 103 but that the extent of angular movement of the three shafts will be equal.

Fixed to the opposite ends of the shaft 110 are parallel levers 120 and 121. These levers extend generally downwardly from the shaft 110 and are joined at their lower ends by a horizontally extending bar 122 which extends longitudinally of the machine. The shaft 113 has fixed to its opposite ends levers 123 and 124 which are parallel and which extend generally downwardly from the shaft 113. The lower ends of the levers 123 and 124 are joined by a bar 125.

The bar 122 has fixed thereto four scoops or strand guides 130, 131, 132 and 133. The scoops 130 to 133 are positioned above four of the containers 21. A second group of scoops 134, 135, 136 and 137 are fixed to the rod 125 and are positioned above the other four of the containers 21. Each of the scoops 130 to 137

5

is provided with a discharge lip 140. The scoops are so positioned that the motion of the cam 96 will cause the discharge lips 140 to move relative to their associated containers 21 in repeated cycles of movement in the manner hereinafter described.

A static eliminator 141 is positioned adjacent each of the rolls 41, 64, 70 and 76 to prevent the rubber from wrapping around those rolls. The static eliminators 141 may be of a commercial type that depend on the ionizing action of a faint electric discharge from needle points to nearby rods. A static eliminator 142 is attached to each scoop 130 to 137 inclusive and is positioned just below the discharge lip 140. The purpose of the static eliminators 142 is to eliminate static from the strands after leaving the scoops to prevent the strands from clinging to the sides of the containers 21. The static eliminators 142 may be of the polonium type which ionizes air by emission of alpha particles.

The operation of the apparatus can now be described. The strands 151 and 152 coming from the slitting machine pass first between the rolls 41 and 42. The strand 151 descends into the scoop 130 and is discharged into the container 21 beneath that scoop. The strand 152 passes downwardly into the scoop 134 and is guided into the container beneath that scoop. The strands 153 and 154 pass over a horizontal rod 53 and between the rolls 64 and 65. The strand 153 then descends into scoop 131 and is guided into the container 21 beneath that scoop. The strand 154 is guided by the scoop 135 into the container 21 beneath that scoop. The strands 155 and 156 pass over horizontal rods 54 and 55 and between the rolls 70 and 71. The strand 155 is guided by the scoop 132 into the container 21 beneath that scoop. The strand 156 is guided by the scoop 136 into the container 21 beneath that scoop. The strands 157 and 158 pass over horizontal rods 56 and 57 and between the rolls 76 and 77, the strand 157 being guided by the scoop 133 into the container 21 beneath that scoop and the strand 158 being guided by the scoop 137 into the container 21 beneath such scoop.

Each scoop is so positioned that at the limit of its oscillatory movement in one direction, its discharge lip 140 will lie above the center of the associated container 21, and at the limit of its oscillatory movement in the opposite direction, the discharge lip will lie above the inner periphery of the container. The scoops 133 and 137 are shown in such positions respectively by full lines and by dot-dash lines in Figure 3. The zone of deposition of the strand within the container always lies vertically below the discharge lip 140 of the associated scoop. As indicated above, the velocity of movement of the discharge lip 140 and of the zone of deposition within each container is not constant but is inversely proportional to the square of the radial distance of the zone of deposition from the central longitudinal axis of the container. The rate of feeding of the strands into the containers is correlated to the rate of rotation of the cam 96 because of the fact that the various feed rolls and the cam are driven from a common source. This varying velocity of the zone of deposition while the rate of feed of the strands remains constant assures uniform filling of the container because of the fact that the zone of deposition remains in any particular area for a time interval which is proportional to that area.

The appropriate design of the cam groove 98 can be determined by mathematical considerations as follows:

Let t_2-t_1 be the time interval required for the zone of deposition to move from a distance r_1 from the center of the container to a distance r_2 from the center of the container. The area of the container to be covered during the time interval t_2-t_1 is proportional to $r_2^2-r_1^2$ or (t_2-t_1) is proportional to $(r_2^2-r_1^2)$ and in general:

$$t=ar^2+b$$

where t is elapsed time and a and b are constants.

6

The cam 96 rotates at constant speed, so the angle θ through which the cam moves is proportional to t and

$$\theta=Ar^2+B$$

where A and B are constants.

The cam may be designed so that one revolution of the cam will cause the zone of deposition to move from the center of the container to the periphery of the container and back again to the center. Let $\theta=0$ when the zone of deposition is at the center of the container, so

$$\theta=0 \text{ when } r=0$$

hence $B=0$ and $\theta=Ar^2$.

Also, when $\theta=180^\circ$, $r=r_3$, where r_3 is the radius of the container.

Hence

$$\theta=\frac{180r^2}{r_3^2}$$

or

$$r^2=\frac{\theta r_3^2}{180}$$

or

$$r=\sqrt{\frac{\theta r_3^2}{180}}$$

The cam is designed to cause the center of the cam follower to follow a curve having the following formula:

$$R=h \tan \left[\sin^{-1} \frac{(s-r)}{L} \right]$$

wherein:

R is the distance (for any angle θ of the cam) from the center of rotation of the cam to the center of the cam follower;

h is the distance from the plane of the cam plate 97 to the center of the shaft 103;

L is the distance from the center of shaft 110 or 113 to the lip 140 of a scoop controlled by such shaft;

s is the horizontal projection of the distance from the longitudinal axis of any container 21 to the center of the shaft 110 or 113 which controls the scoop for that container; and

$$r=\sqrt{\frac{\theta r_3^2}{180}}$$

In this manner the value of R can be found for any value of θ .

Figure 7 diagrammatically illustrates the flower petal patterns which are formed by the strand then being deposited in a container. In this diagrammatic illustration the strand is illustrated by lines rather than by ribbons. This has been done for clarity of illustration. In the diagrammatic representation of Figure 7 it has been assumed that the zone of deposition has partaken of one cycle of movement for each 54 degrees of revolution of the container. The flower petal designs represented by the full lines 161 may be considered as the patterns formed in the container during initial filling thereof and during the first revolution of the container. The flower petal patterns 162 shown by the dotted lines may be considered as the patterns formed during the next revolution of the container in the opposite direction. The flower petal patterns represented by the dot-dash lines 163 may be considered as the patterns formed during the third revolution of the container. It will be noted that the petal designs illustrated by the dotted lines 162 do not completely overlie any of the designs represented by the full lines 161. It will also be noted that the petal designs represented by the dot-dash lines 163 do not exactly overlie the petal designs represented by either the full lines 161 or the dotted lines 162.

It will be noted that the drive for the turntables 8 is independent of the drive for the cam 96. This arrange-

ment may result in the ratio of the rotation of the cam to the rotation of the turntables being not exactly constant but, as indicated above, I have found that there is considerable latitude in this ratio and as a practical matter I have found that the ratio need not be constant.

I have illustrated and described what I now consider to be the preferred embodiment of the invention. It is to be understood, however, that the broader aspects of the invention are not limited to the precise details of the disclosure but are defined by the following claims.

Having thus described my invention, I claim:

1. A method of filling a cylindrical container with a strand of flexible material which comprises rotating the container about its vertically disposed longitudinal axis, feeding the strand through the open upper end of the container, moving the zone of deposition of the strand laterally from the center of the container to its periphery and back again to the center, varying the rate of movement of such zone of deposition in such manner that the rate of movement at any given instant is substantially inversely proportional to the square of the distance of the zone of deposition from the longitudinal axis of the container, and repeating the cycle of movement of the zone of deposition a plurality of times for each revolution of the container to thereby deposit said strand in generally flower petal patterns in the container.

2. A method as described in claim 1 in which the container is rotated approximately one revolution in one direction and is then reversed and rotated approximately one revolution in the opposite direction.

3. A method of filling a vertically disposed cylindrical container with a strand of flexible material which comprises rotating the container about its central longitudinal axis, feeding the strand into the container through the open upper end thereof, moving the zone of deposition of the strand laterally from the center of the container to its periphery and back again to the center, varying the rate of movement of such zone of deposition in such manner that the rate of movement is a maximum at the center of the container, progressively decreases to a minimum at the periphery of the container, and then progressively increases to such maximum at the center of the container and repeating such cycle of movement of the zone of deposition a plurality of times for each revolution of the container to thereby deposit said strand in generally flower petal patterns in the container.

4. A method as defined by claim 3 in which the number of cycles of movement of the zone of deposition of the strand during each revolution of the container is the sum of an integer and a fraction.

5. A method of filling a vertically disposed cylindrical container with a strand of flexible material which comprises rotating the container about its longitudinal axis first through approximately one revolution in one direction and then through approximately one revolution in the opposite direction, feeding the strand longitudinally of its length through the open upper end of the container, moving the zone of deposition of the strand laterally from the center of the container to its inner periphery and back again to the center, varying the rate of movement of such zone of deposition in such manner that the rate of movement is a maximum at the center of the container, progressively decreases to a minimum at the periphery of the container, and then progressively increases to such maximum at the center of the container and repeating such cycle of movement of the zone of deposition a plurality of times for each revolution of the container.

6. A method of filling a vertically disposed cylindrical container with strands of flexible material which comprises rotating the container about its central longitudinal axis, feeding the strands of flexible material into the con-

tainer through the open upper end thereof, moving the zone of deposition of the strands laterally from the center of the container to its inner periphery and back again, and varying the rate of movement of such zone of deposition in such manner that the rate of movement at any given instant is substantially inversely proportional to the square of the distance of the zone of deposition from the central longitudinal axis of the container.

7. Apparatus for filling a cylindrical container with a strand of flexible material comprising a turntable, a cylindrical container in vertically disposed position on said turntable, means for rotating said turntable, feed rolls for advancing the strand of flexible material, a strand guide positioned above said turntable for guiding the strand from said feed rolls into the open upper end of said container, and mechanism for moving said strand guide laterally from the vertical longitudinal axis of the container and back again a plurality of times for each revolution of said turntable, said mechanism including motion rate modifying means imparting a varying rate of movement to said strand guide such that the rate of movement is a maximum at the longitudinal axis of the container, progressively decreases to a minimum as said strand guide moves laterally away from such longitudinal axis and progressively increases to such maximum as said strand guide approaches such longitudinal axis.

8. Apparatus as defined in claim 7 in which said mechanism moves said strand guide laterally at a varying rate which at any given instant is substantially inversely proportional to the square of the lateral distance of the strand guide from the longitudinal axis of the container.

9. Apparatus for filling a plurality of cylindrical containers with strands of flexible material comprising a plurality of turntables, means for rotating said turntables, a vertically disposed cylindrical container supported by each of said turntables, feed rolls positioned for advancing a plurality of strands of flexible material longitudinally above said containers, a strand guide positioned above each container and arranged to guide into its respective container a portion of the plurality of strands being advanced by said feed rolls, and mechanism for moving each strand guide laterally from the vertical longitudinal axis of its respective container and back again a plurality of times for each revolution of its respective container, said mechanism including motion rate modifying means imparting a varying rate of movement to each strand guide such that the rate of movement of each strand guide is a maximum at the longitudinal axis of its respective container, progressively decreases to a minimum as each strand guide moves laterally away from such longitudinal axis, and progressively increases to such maximum as each strand guide approaches such longitudinal axis.

10. Apparatus as defined by claim 9 in which said mechanism moves each strand guide laterally at a varying rate which at any given instant is substantially inversely proportional to the square of the lateral distance of the strand guide from the longitudinal axis of its respective container.

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