United States Patent

Voss et al.

[15] **3,683,759**

[45] **Aug. 15, 1972**

[54] **METHOD FOR SHAPING TUBE ENDS**

[72] Inventors: **Joseph A. Voss**, Denver, Colo.; **Carl W. Johnson**, Neenah, Wis.

[73] Assignee: **Kimberly-Clark Corporation**, Neenah, Wis.

[22] Filed: **Dec. 10, 1970**

[21] Appl. No.: **97,047**

Related U.S. Application Data

[62] Division of Ser. No. 690,001, Dec. 12, 1967, Pat. No. 3,568,577.

[52] **U.S. Cl.**.....**93/94 FC**, 93/36.1

[51] **Int. Cl.**.....**B31c 7/02**

[58] **Field of Search**.....93/36.1, 36, 94 FC, 77, 36.5

[56] **References Cited**

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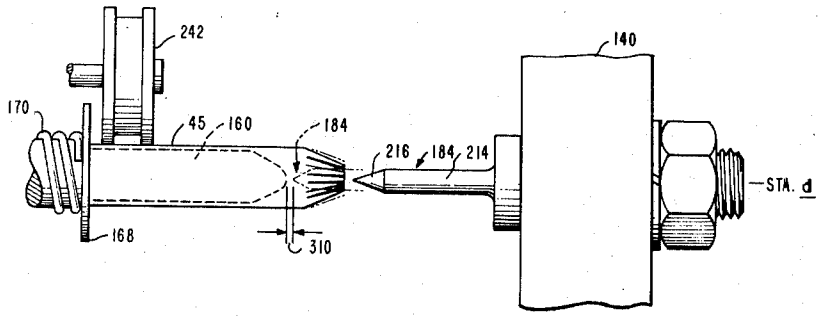
Primary Examiner—Bernard Stickney

Attorney—Fraser & Bogucki

[57] **ABSTRACT**

A method is disclosed for the fabrication of tampon applicator tubes in which the forward ends of thin-walled tube blanks are crimped to provide a plurality of longitudinal fold lines, folded and compressed to form a plurality of pleats, exercised to weaken the fold lines to facilitate ejection of the tampon and refolded under compression to form a pleated, generally conically shaped forward tube end having a relatively smooth exterior surface.

4 Claims, 45 Drawing Figures



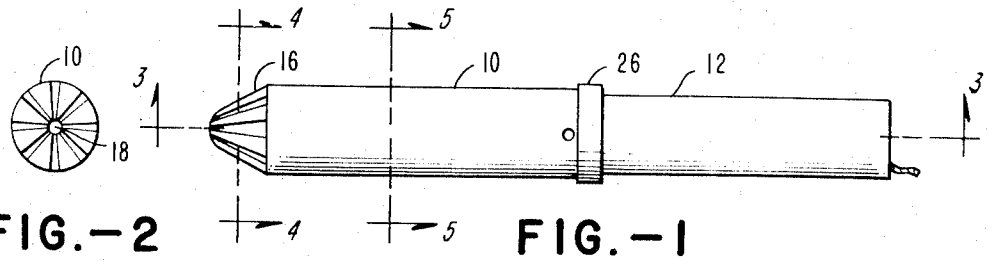


FIG.—2

FIG.—1

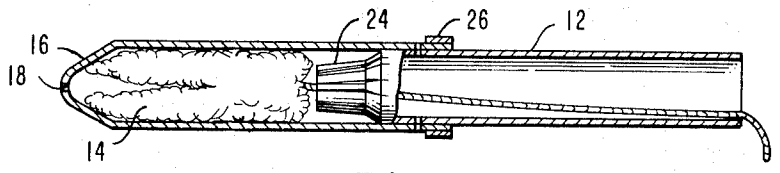


FIG.—3

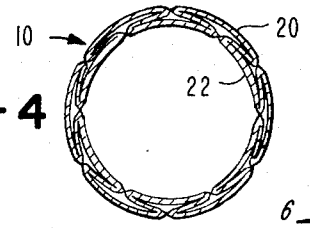


FIG.—4

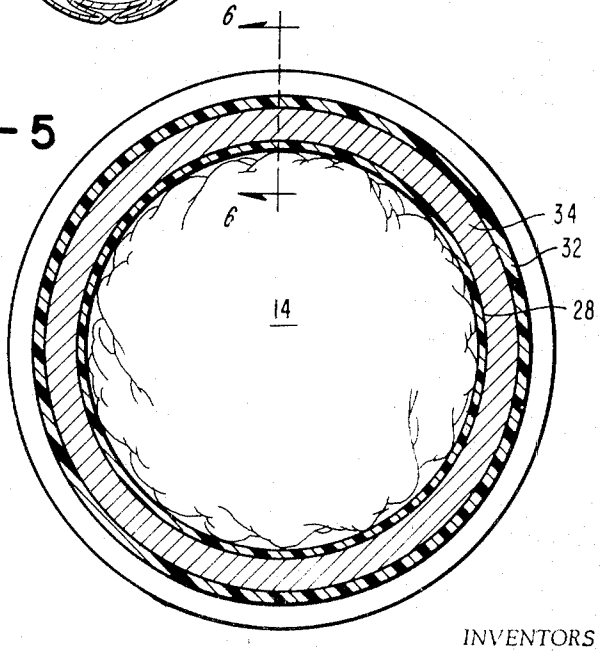
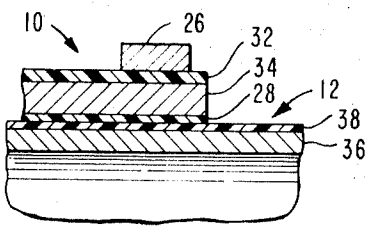


FIG.—5

FIG.—6



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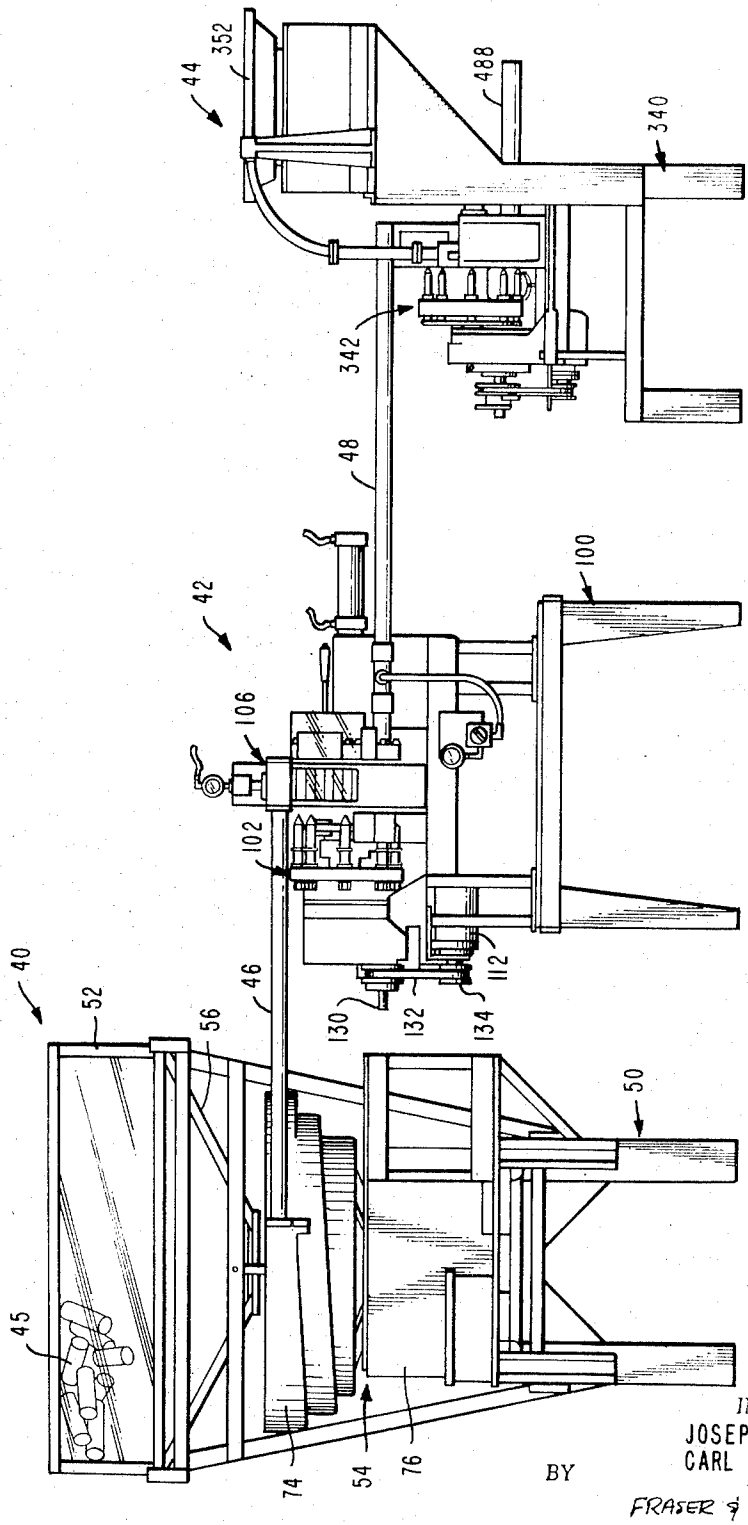


FIG. — 7

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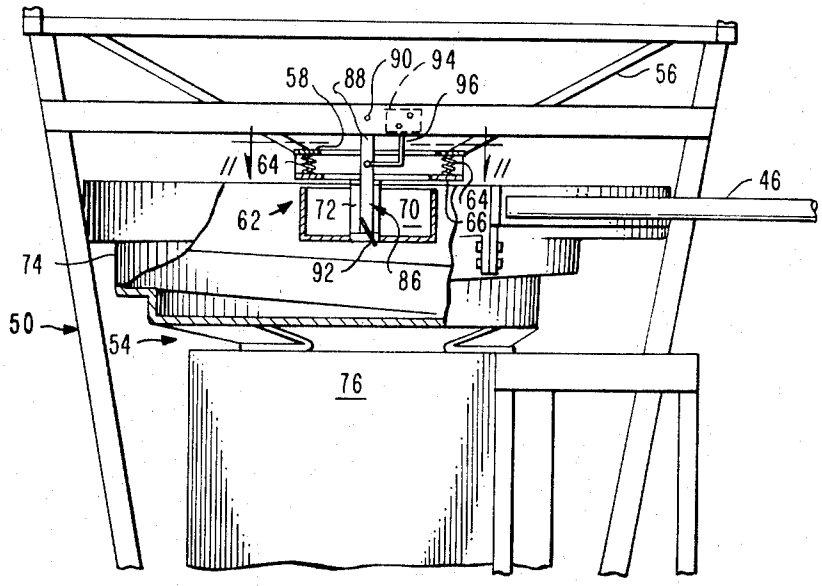


FIG.—8

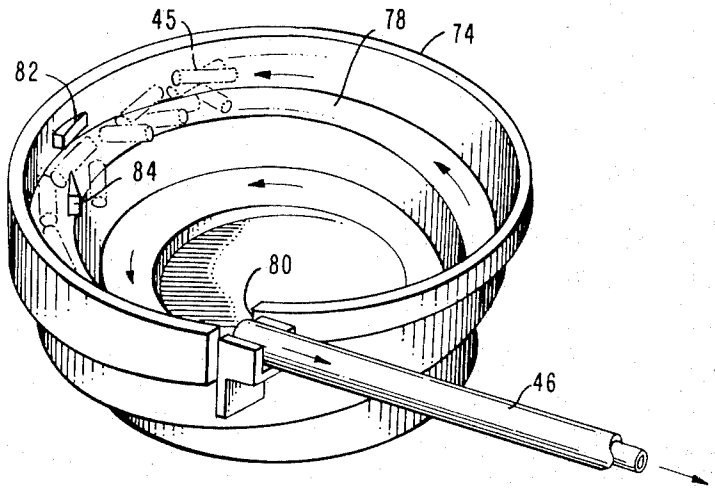


FIG.—9

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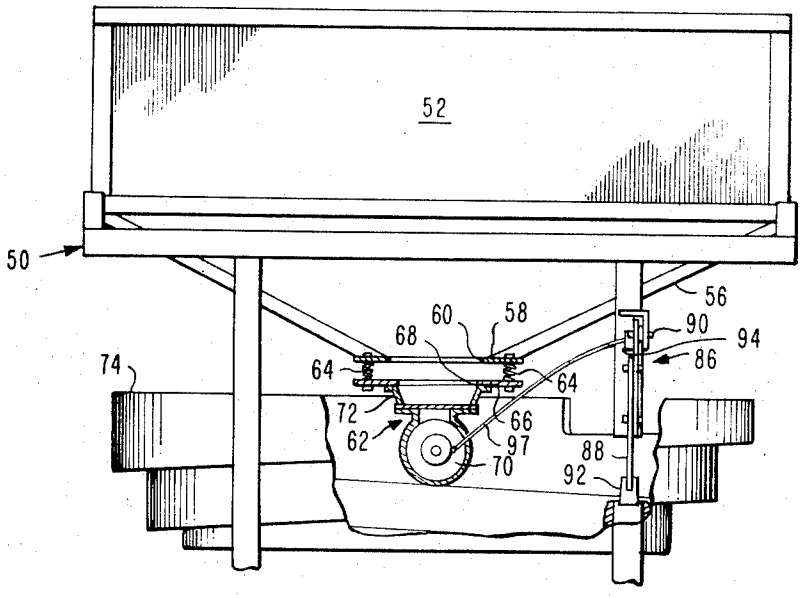
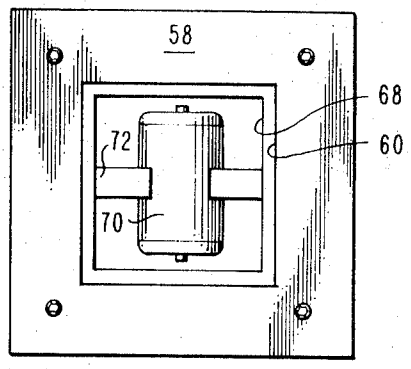


FIG.—10

FIG.—11



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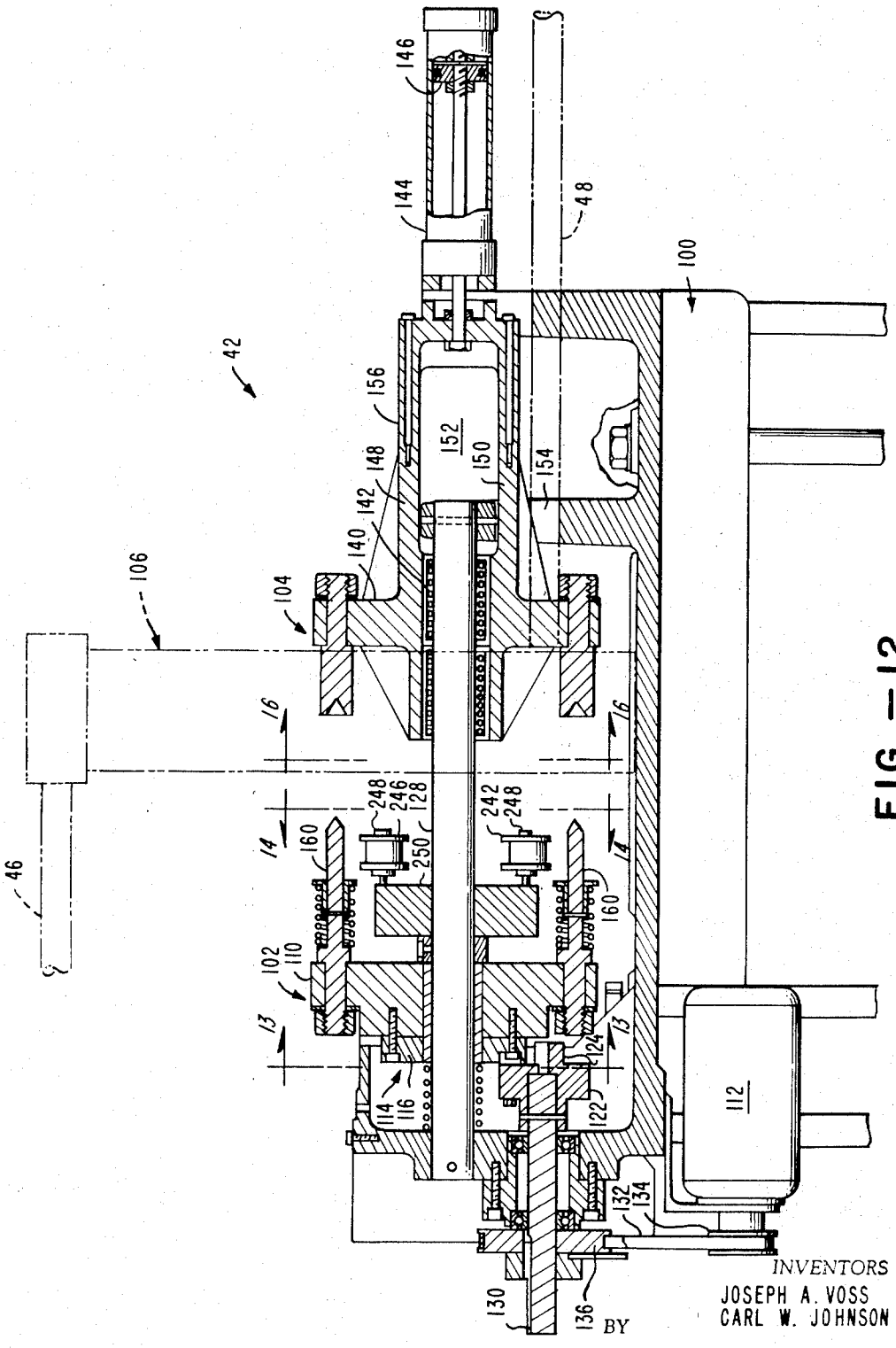
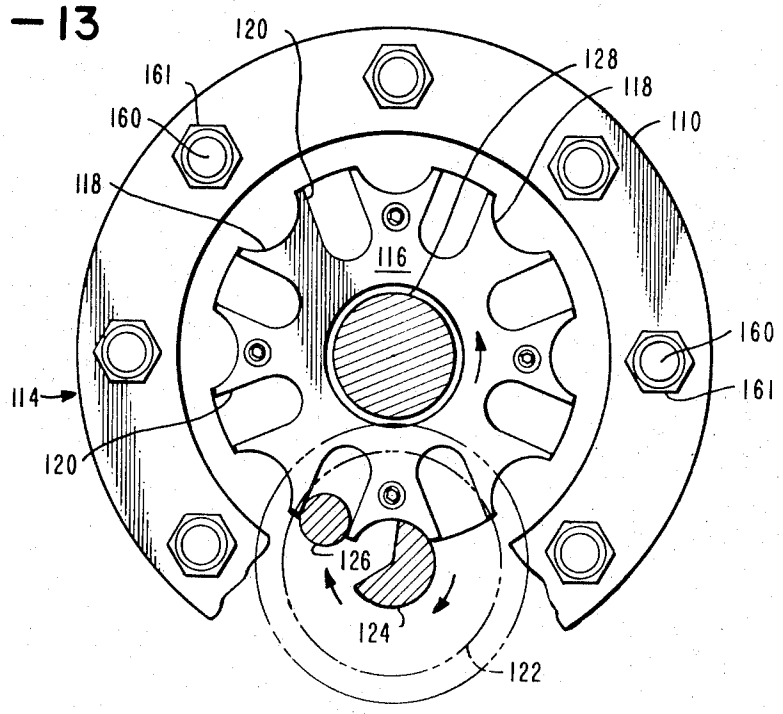


FIG. — 12

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FIG. — 13



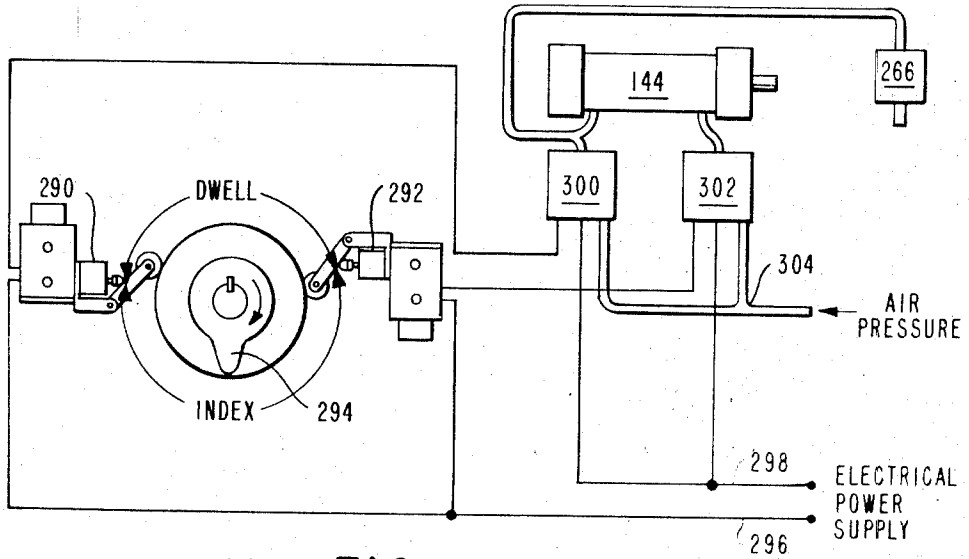
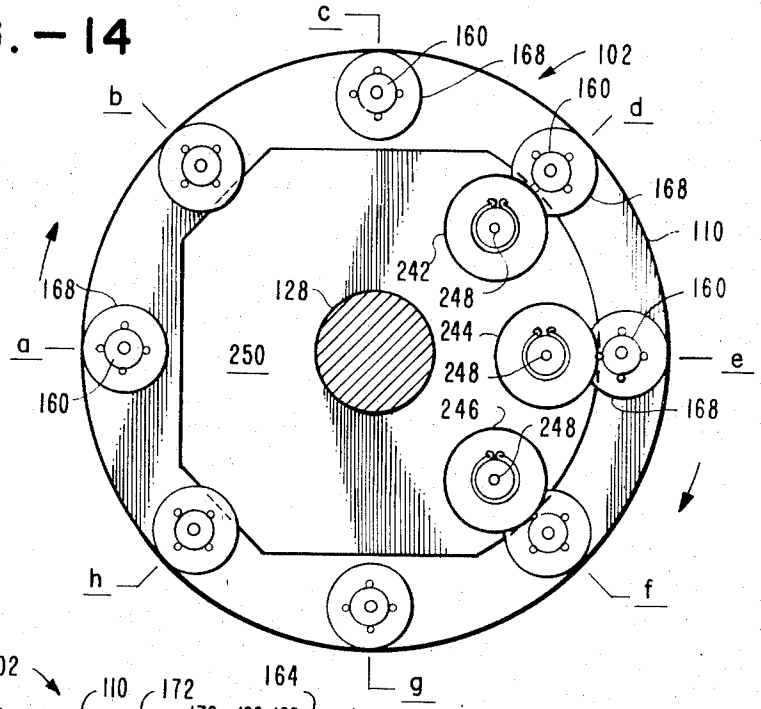


FIG. — 29

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FIG. — 14



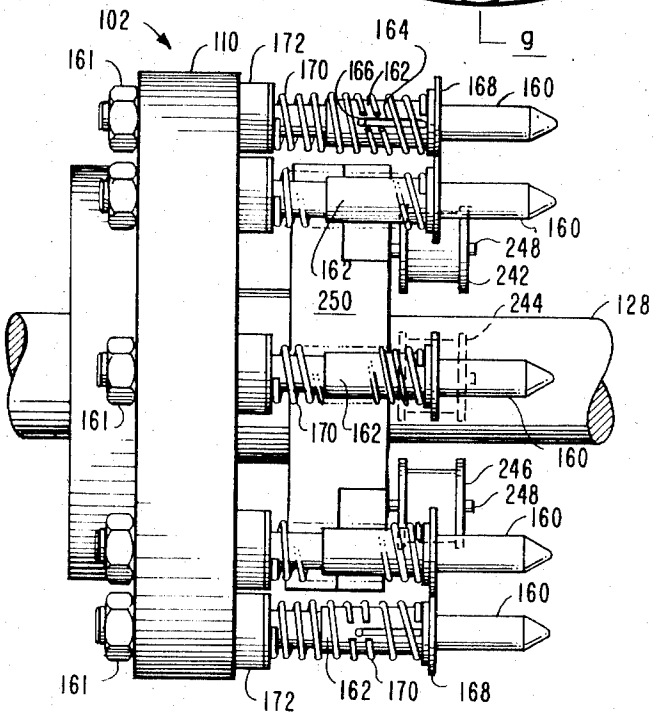


FIG. — 15

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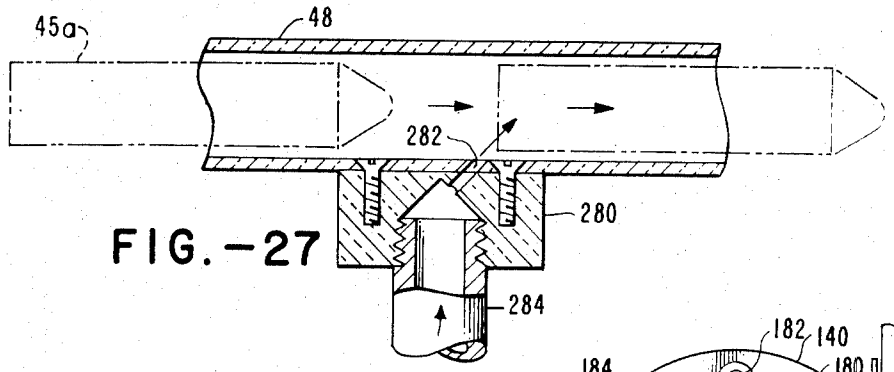


FIG.-27

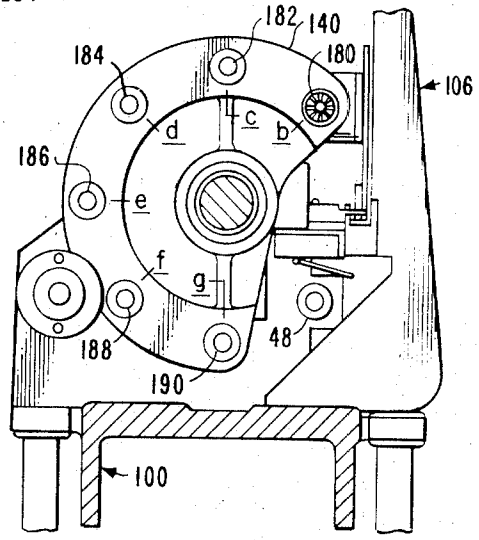


FIG.-16

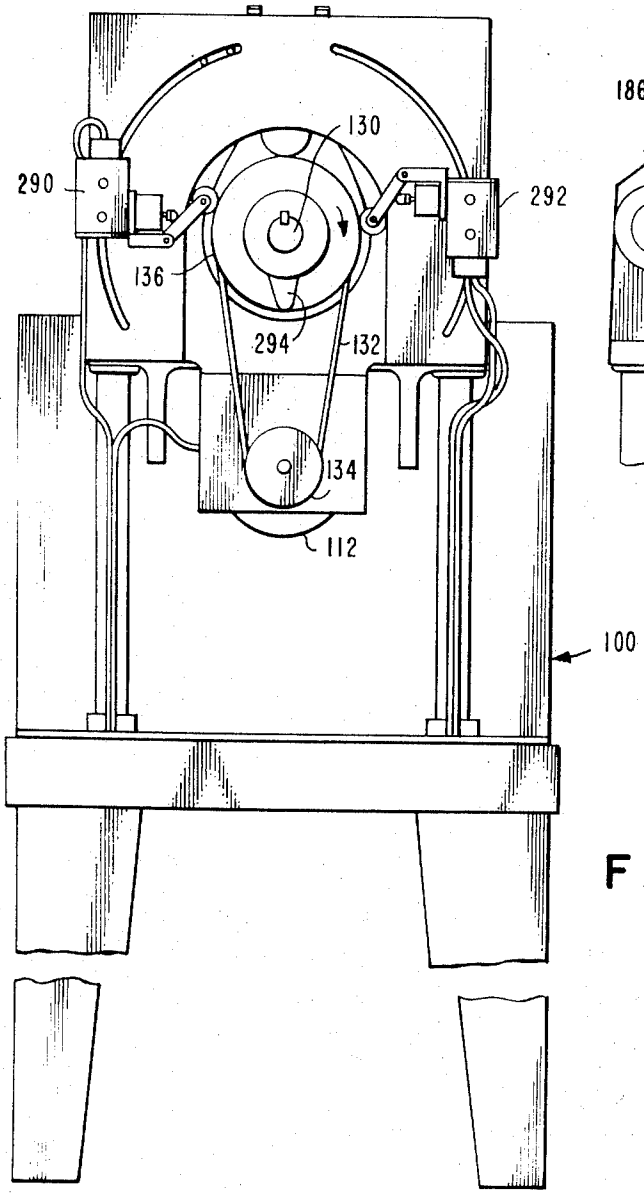


FIG.-28

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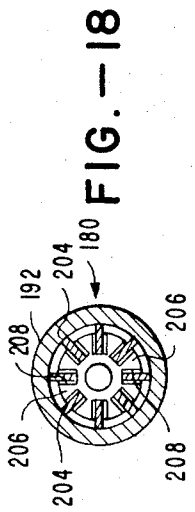


FIG. — 18

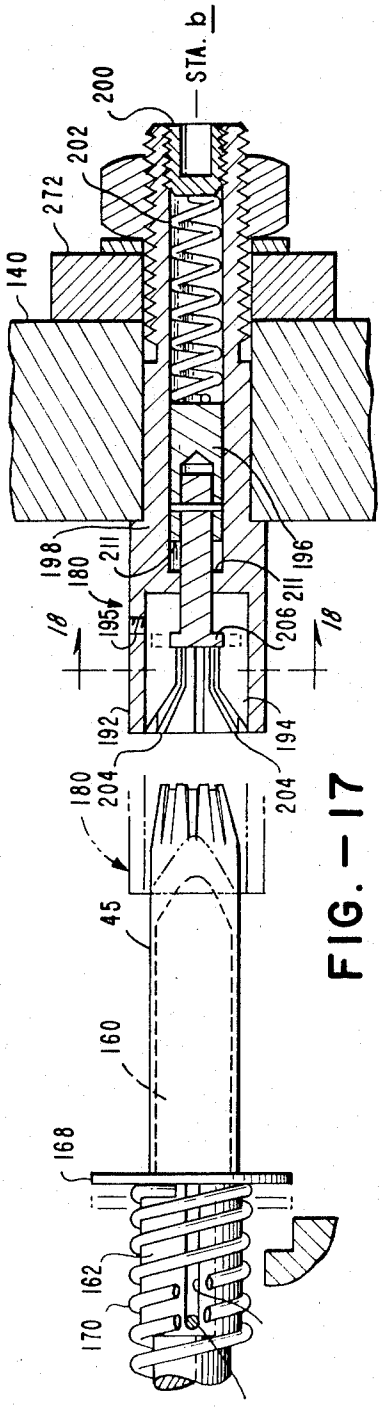


FIG. — 17

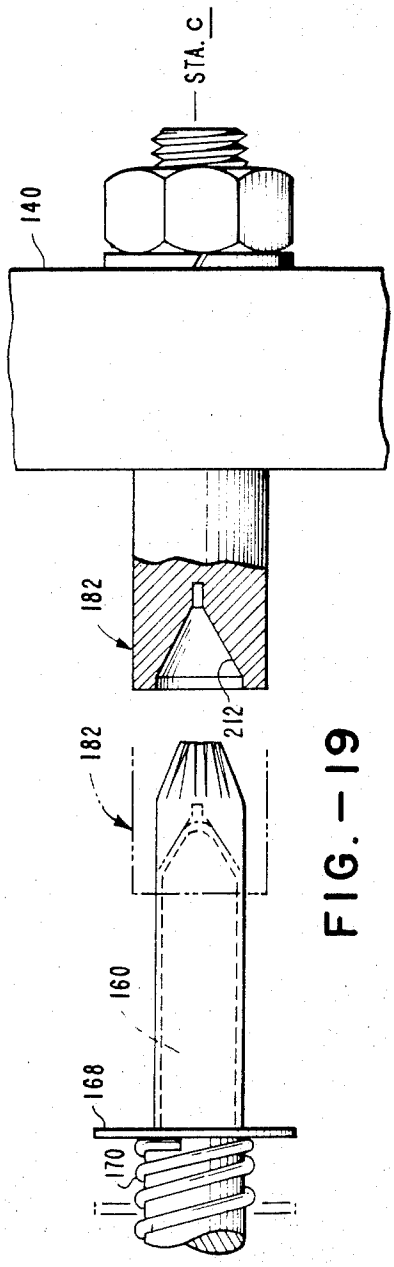


FIG. — 19

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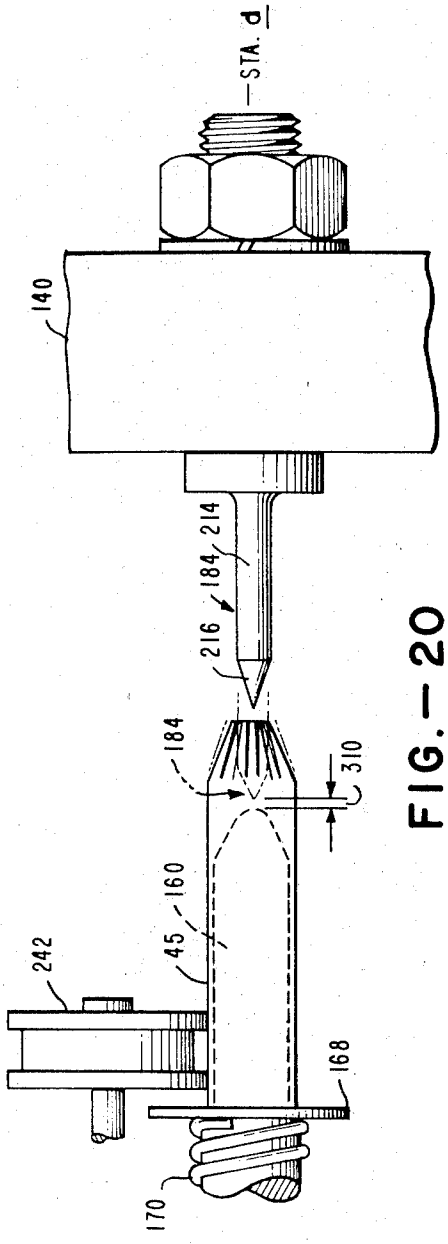


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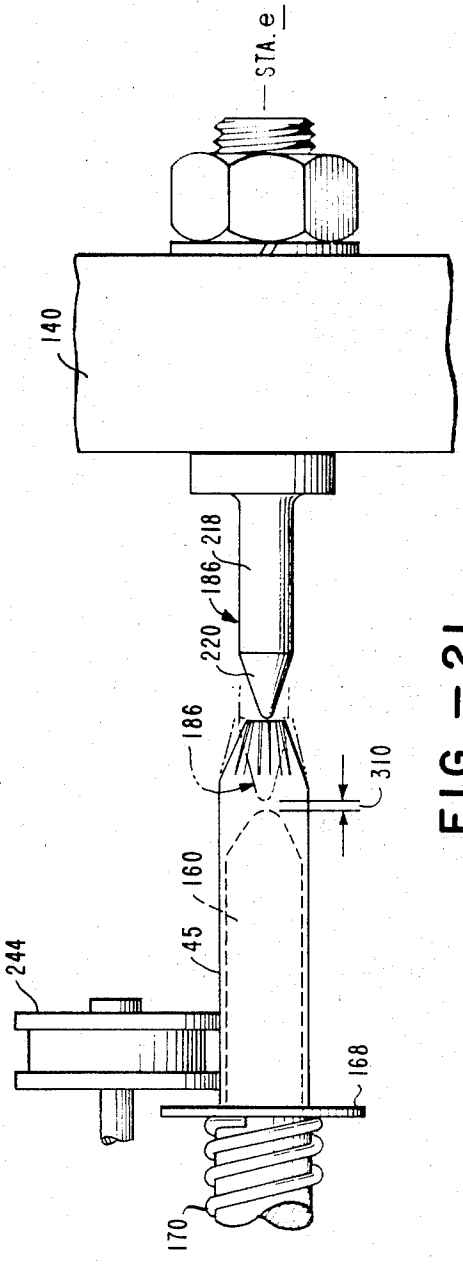


FIG. — 21

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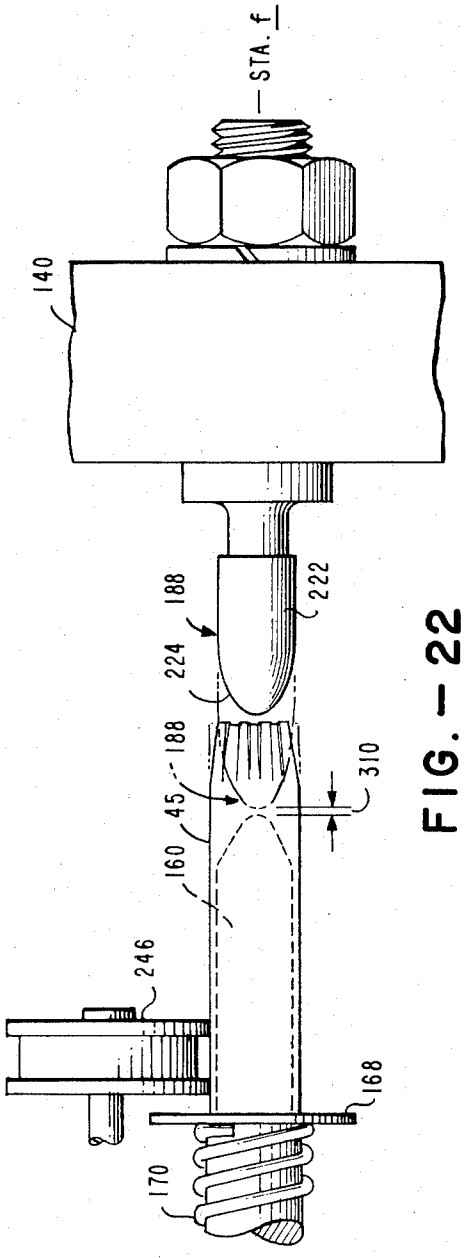


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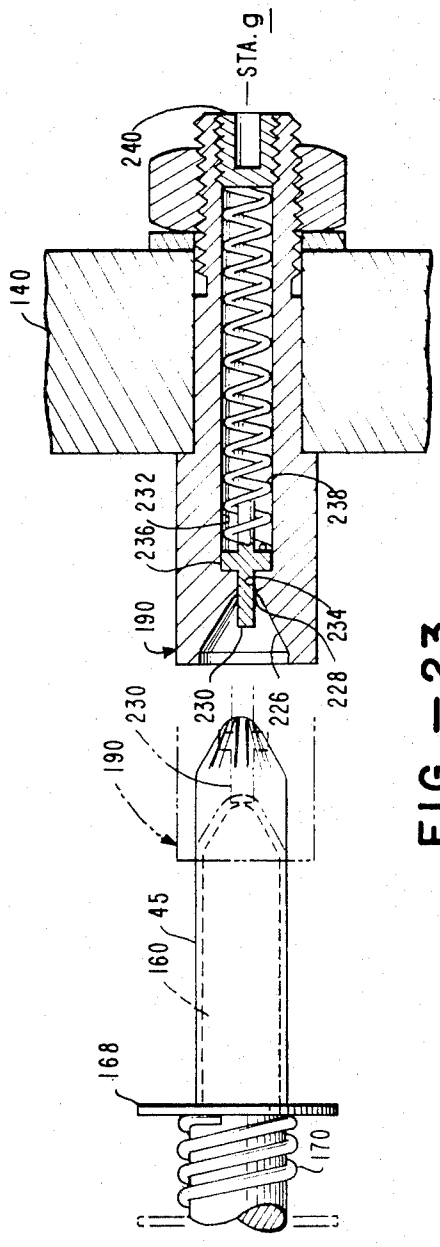


FIG. — 23

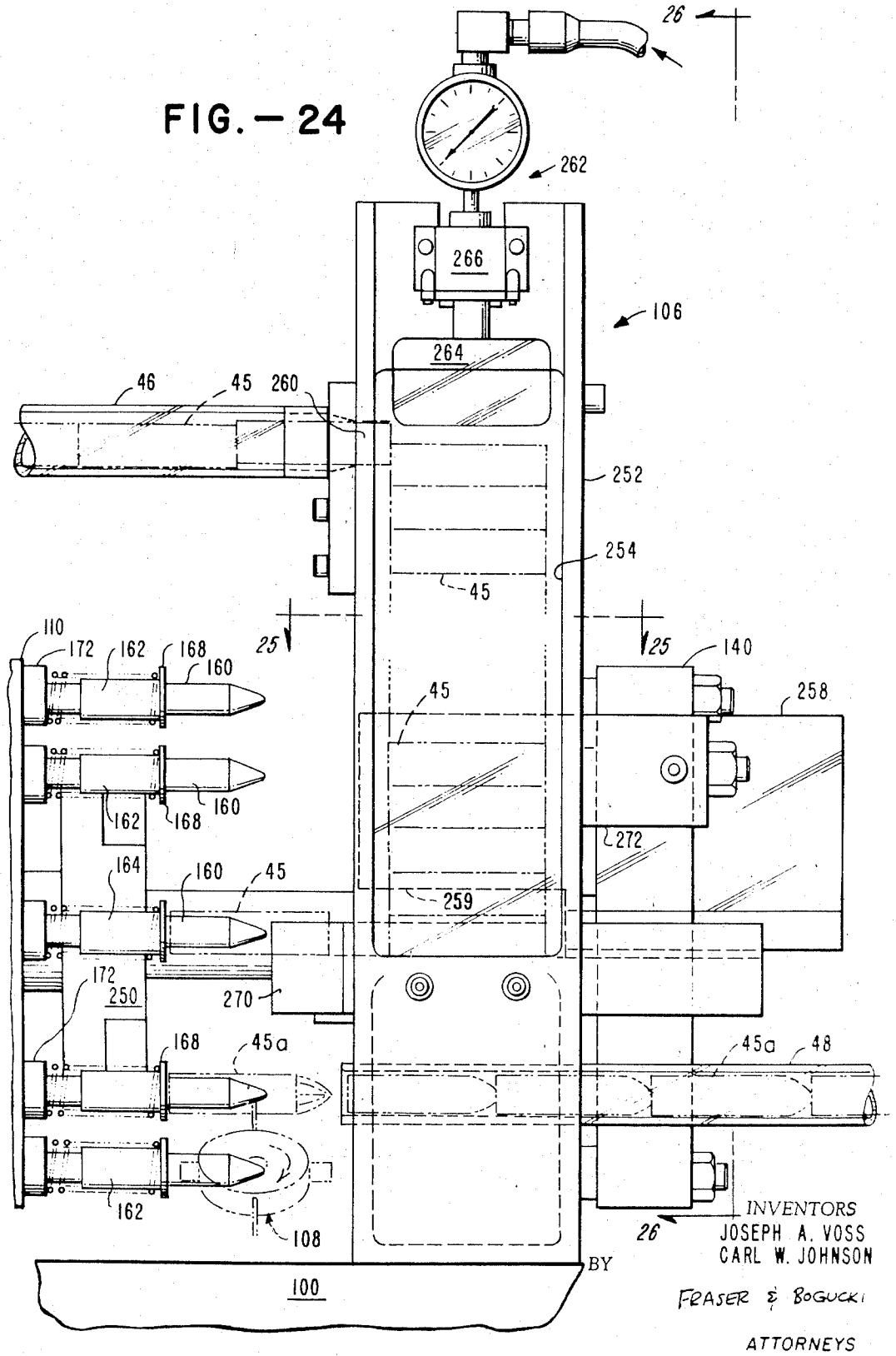
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FIG. — 24



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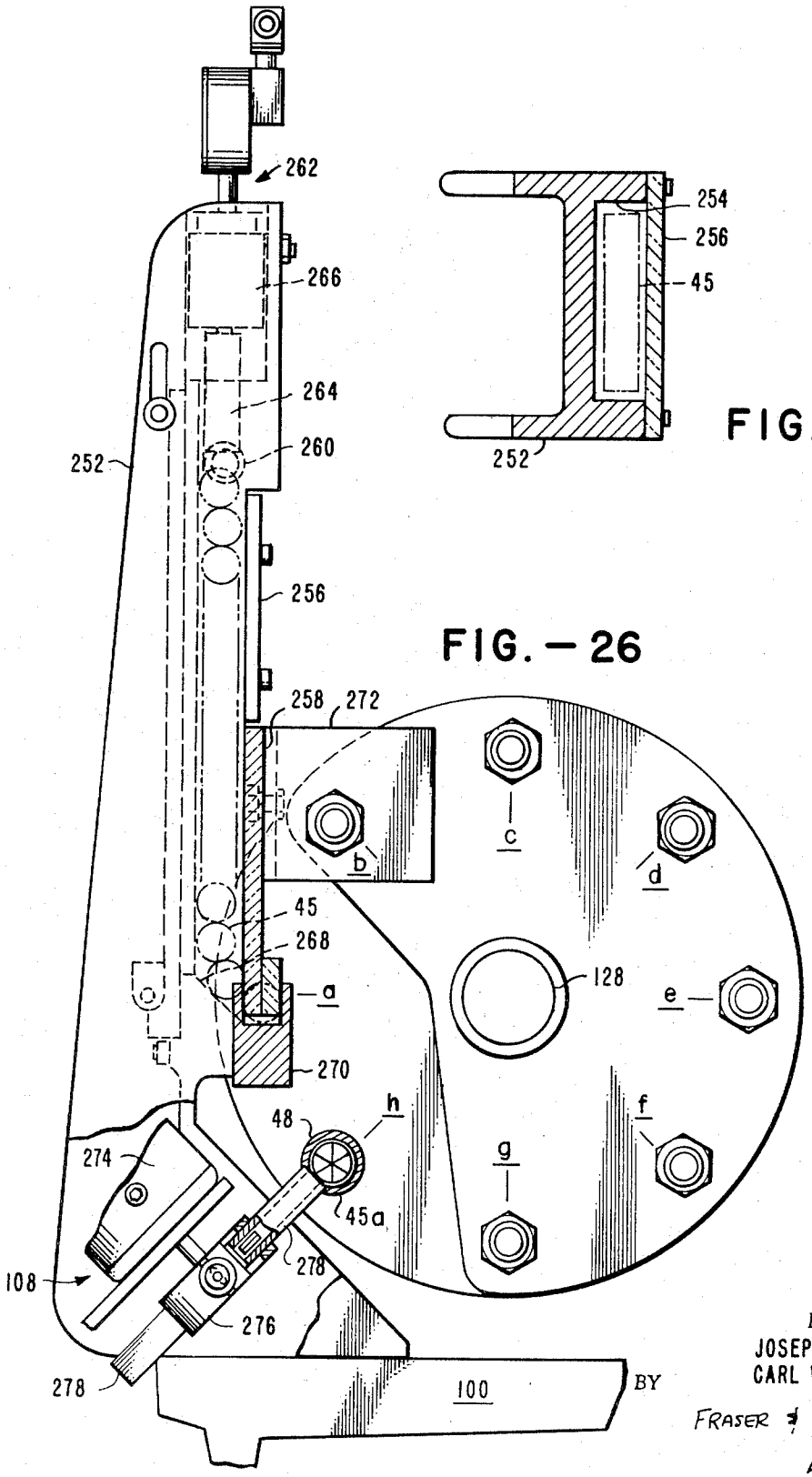


FIG.—26

FIG.—25

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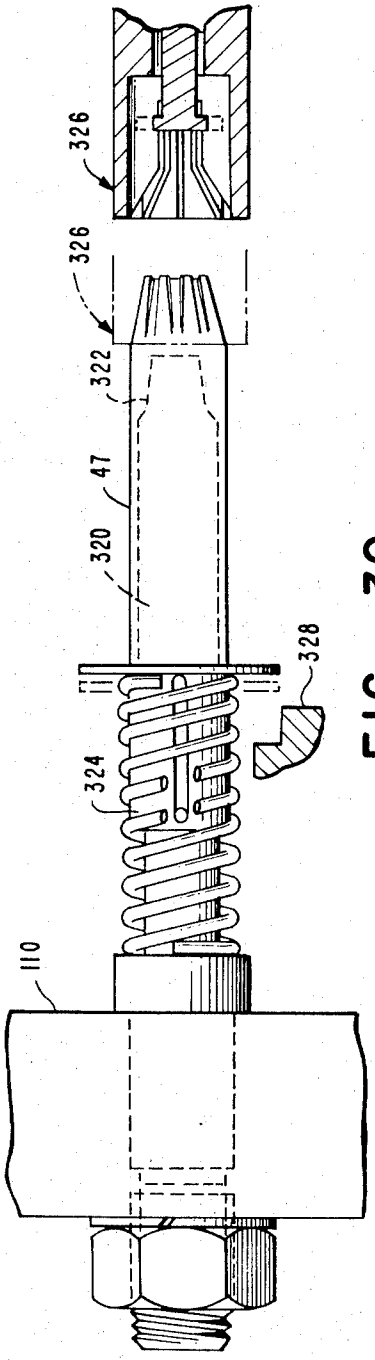


FIG. — 30

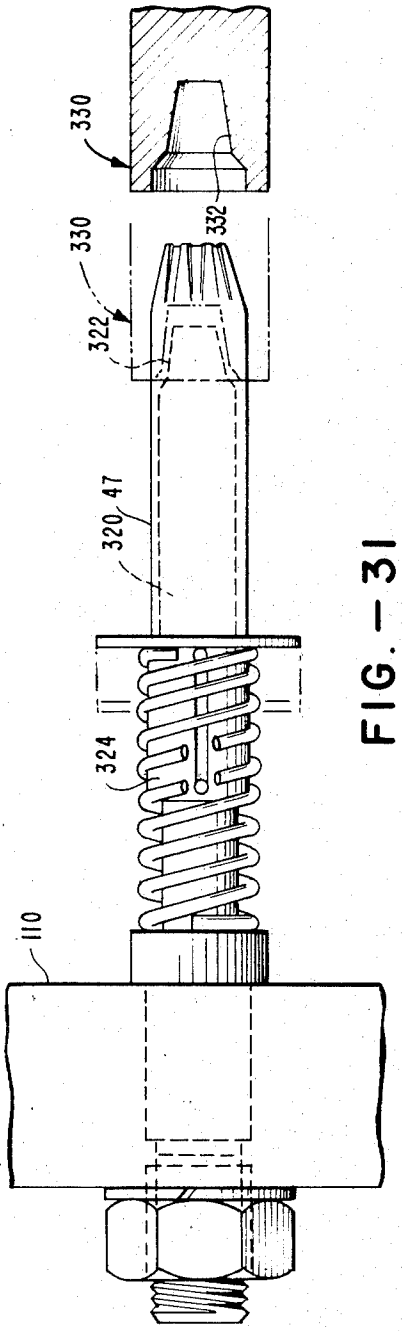


FIG. — 31

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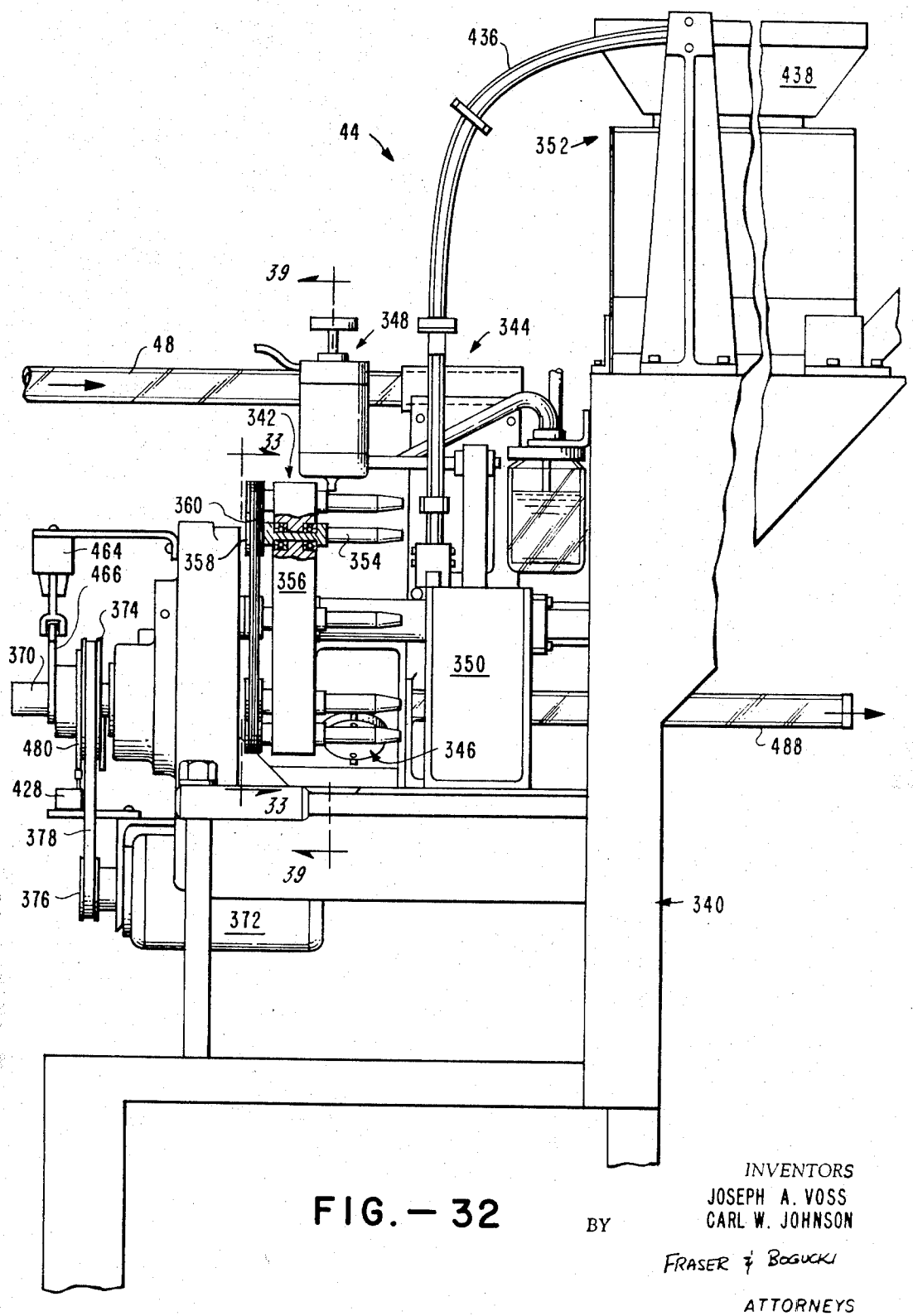


FIG.—32

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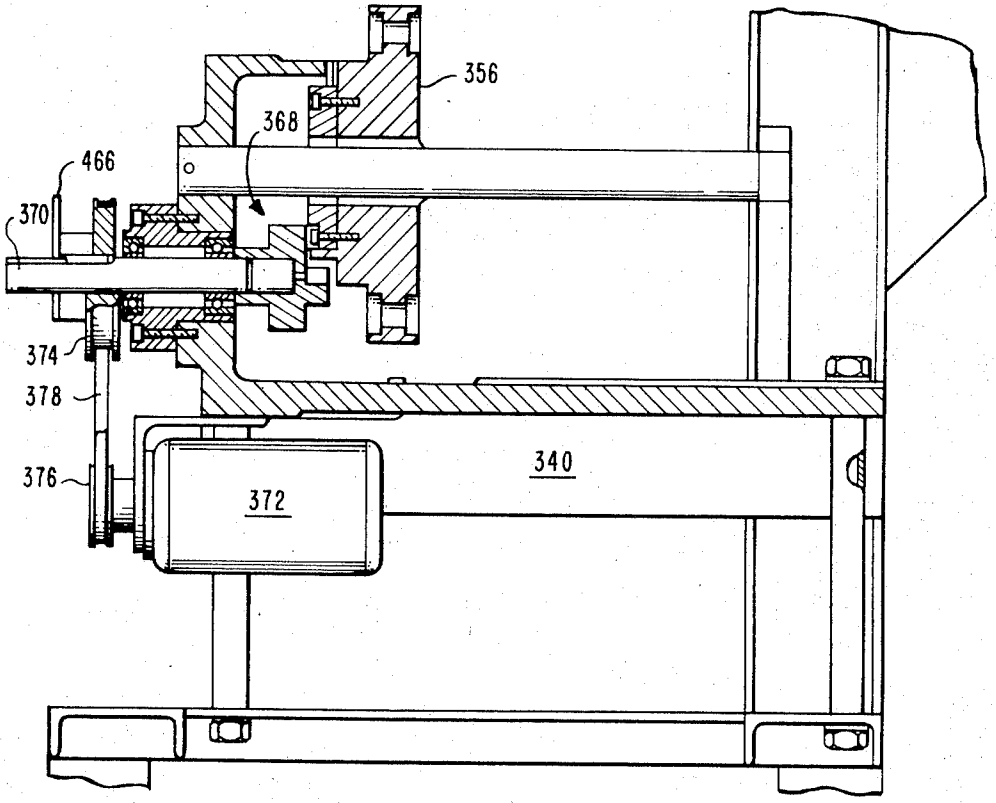


FIG. — 35

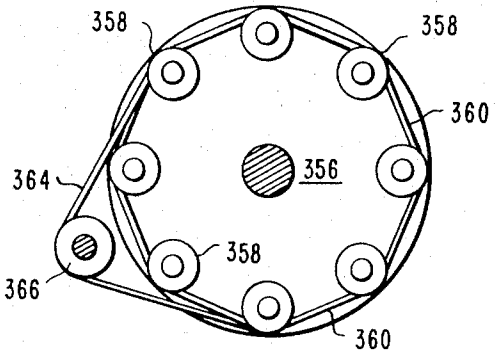


FIG. — 33

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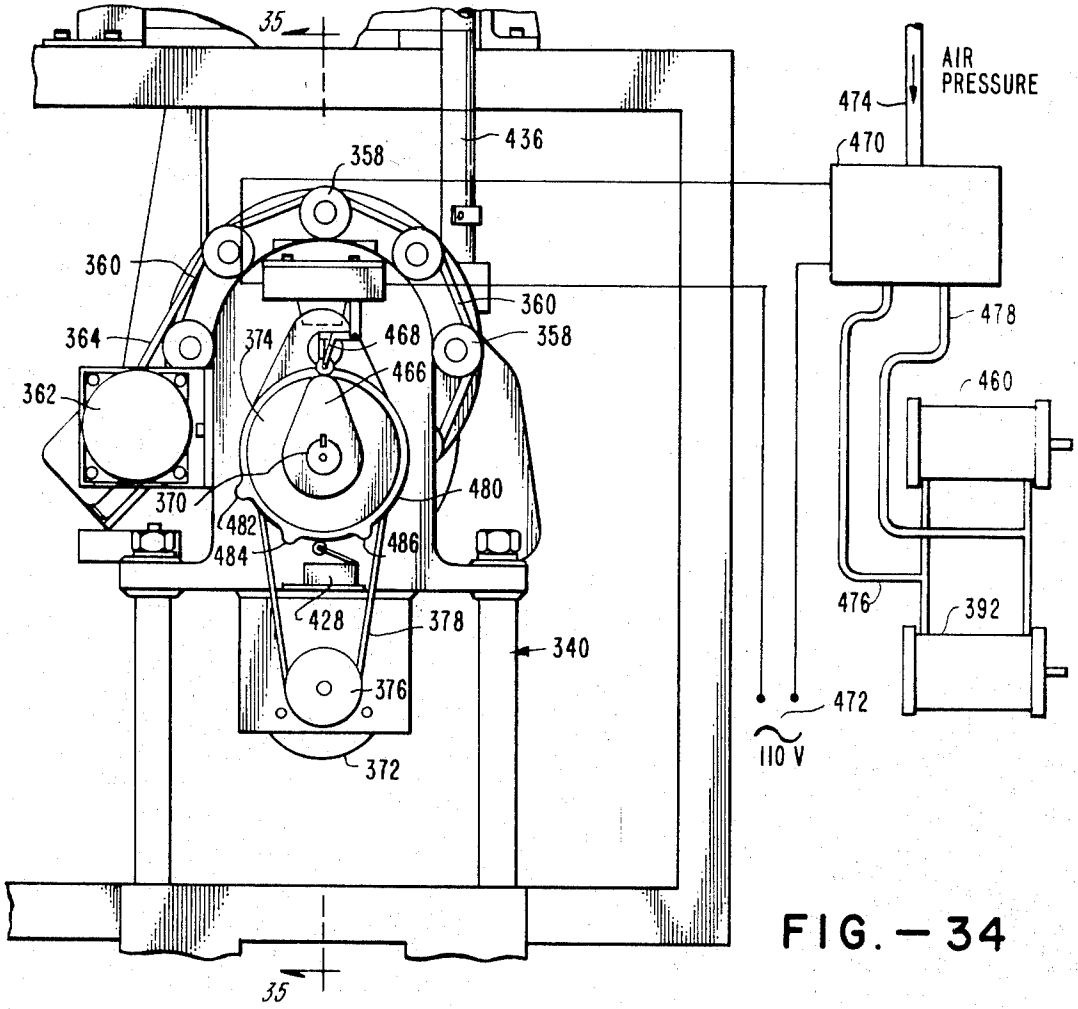


FIG. — 34

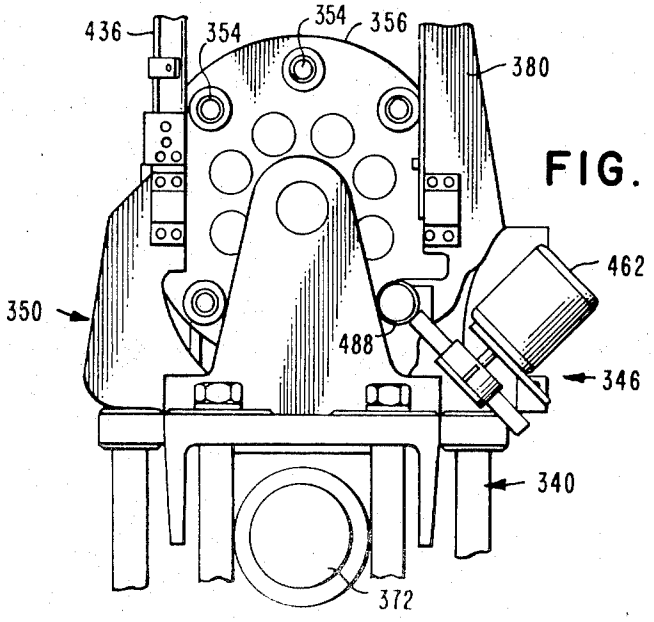


FIG. — 43

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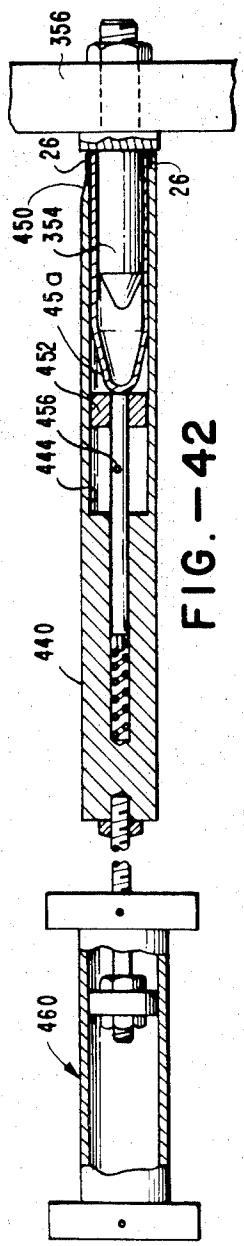


FIG.—42

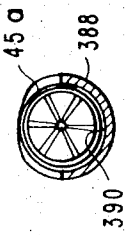


FIG.—38

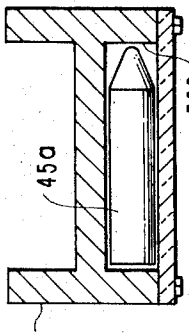


FIG.—37

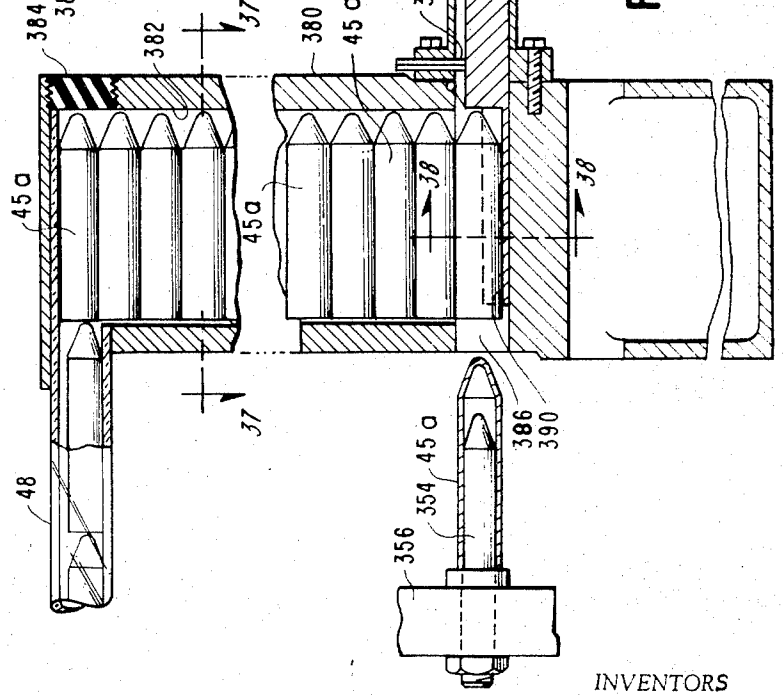


FIG.—36

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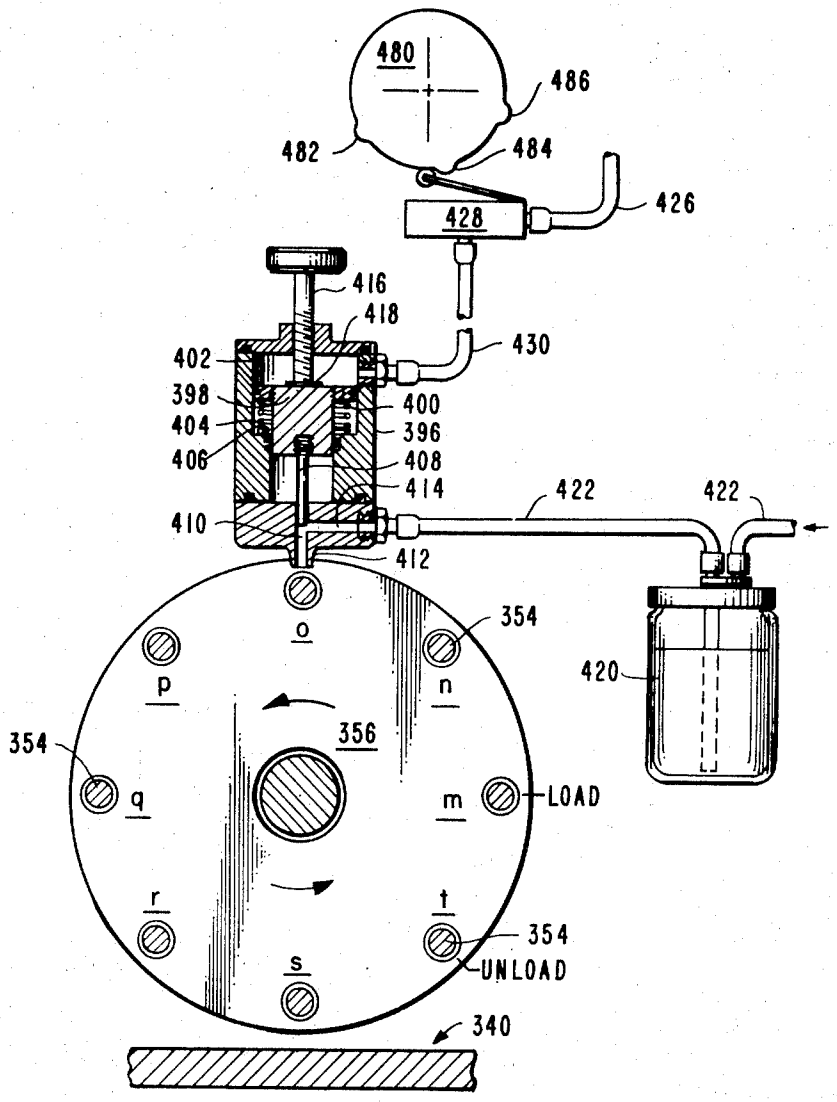


FIG.-39

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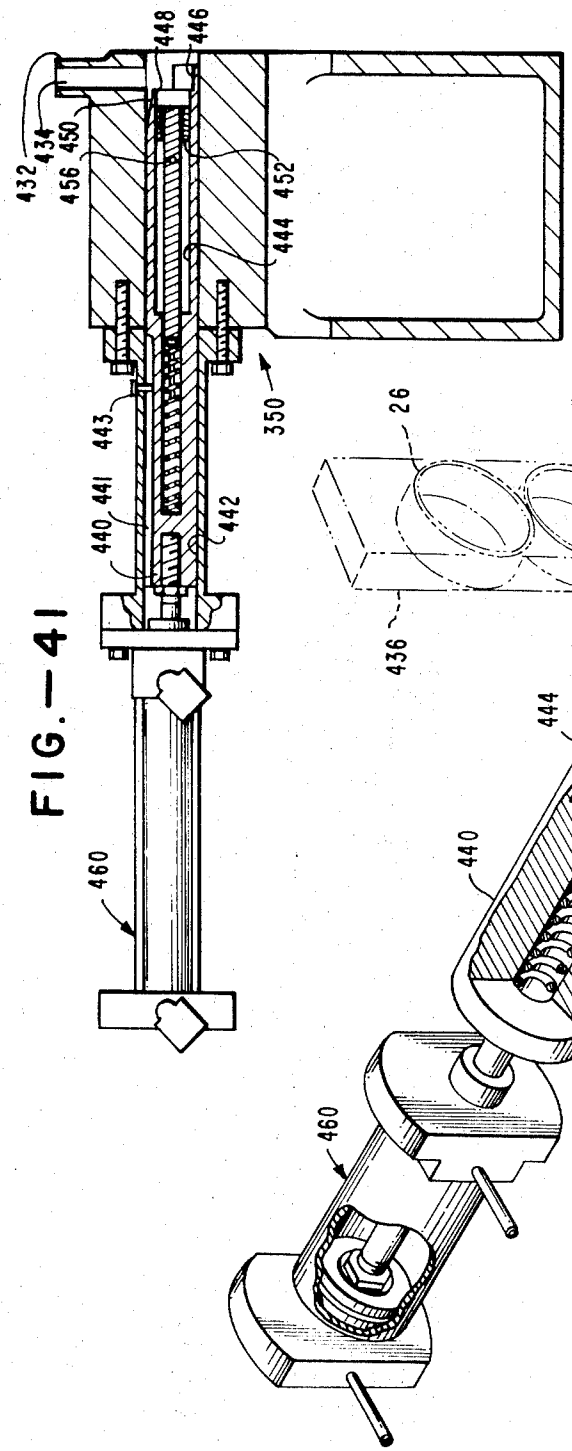


FIG.—41

FIG.—40

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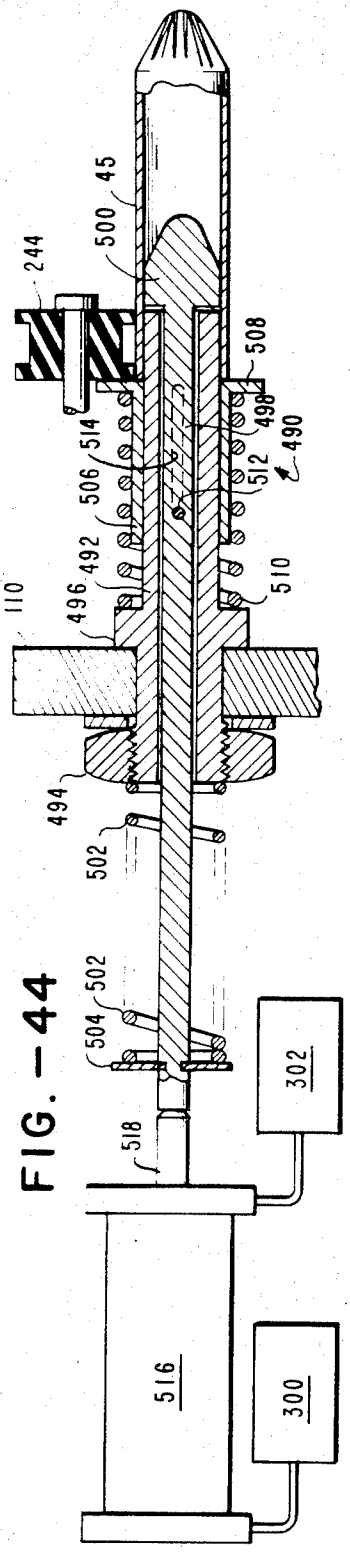


FIG. — 44

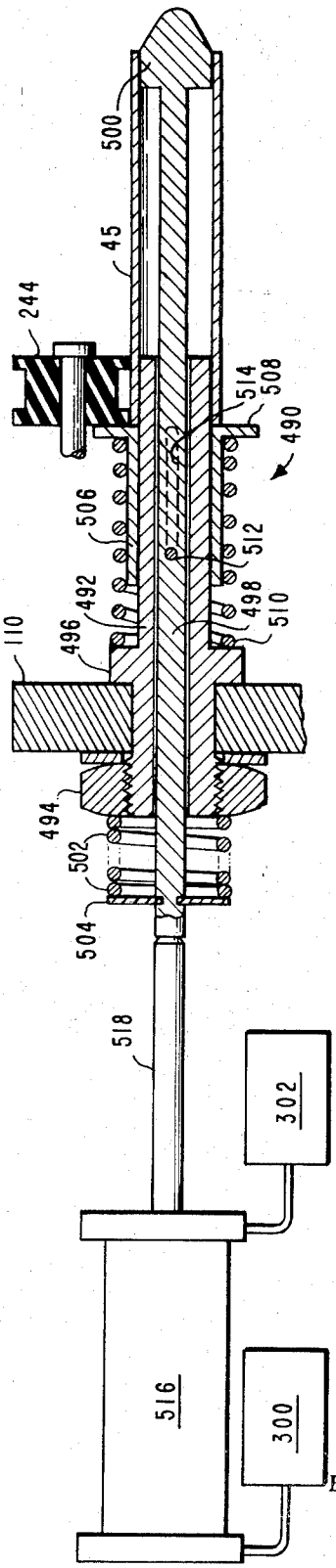


FIG. — 45

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METHOD FOR SHAPING TUBE ENDS

This application is a division of copending application Ser. No. 690,001, filed Dec. 12, 1967, now U.S. Pat. No. 3,568,577, issued on Mar. 9, 1971.

BACKGROUND OF THE INVENTION

The present invention relates generally to catamenial tampon devices and more particularly to an improved method and apparatus utilized in the fabrication of applicator tubes containing such devices.

Application Ser. No. 266,914 (now U.S. Pat. No. 3,204,635 issued on Sept. 7, 1965), entitled "Hygienic Devices" and filed on Mar. 21, 1963 by the present applicants, and application Ser. No. 464,127, filed by the present applicants on June 15, 1965, entitled "Methods of Making Hygienic Devices" and to be issued on Dec. 19, 1967 as U.S. Pat. No. 3,358,354 disclose, respectively, an improved catamenial tampon applicator of the type utilizing an outer tube for containing the tampon and an inner, tampon-ejecting tube slidably received within the outer tube, and a method for forming the ends of these tubes. According to the aforementioned applications, the forward end of the outer tube is provided with a generally conical shape to facilitate insertion of the applicator into the vagina. The conically shaped forward end of the outer tube comprises a plurality of dovetailed folds or pleats which provide a structure easily opened from the inside, thereby permitting the user to eject the tampon without having to exert undue pressure or force. The inner, tampon-ejecting tube includes a tampon-engaging forward end having a reduced diameter and structured similarly to the forward end of the outer tube, in that it constitutes a plurality of folded or pleated sections.

U.S. Pat. No. 3,347,234, entitled "Hygienic Devices", issued Oct. 17, 1967 to Joseph A. Voss, one of the joint inventors herein, and based on application Ser. No. 387,590 filed Aug. 4, 1964, relates to an improved applicator in which a ring is secured to the outer surface of the outer tube member. The ring has a dual function, acting to both improve gripping of the applicator and to reinforce the outer tube to prevent deformation because of gripping pressure during use of the device. The ring allows relatively thin sheet material to be used for the outer tube. This facilitates the shaping of the generally conical forward end and reduces the overall, outer diameter of the applicator while retaining a relatively large internal diameter to accommodate a tampon having a large menstrual flow absorbing capacity.

One problem which arises as a result of using thin walled tubes however, is that such tubes tend to distort easily and handling techniques must be devised to prevent such distortion or deformation during fabrication of the applicator tubes. On the other hand, it is also desirable to produce the applicator tubes rapidly, on an automatic basis, to minimize fabrication costs and thereby minimize cost to the consumer. It is further desirable that the tampon applicator tubes all be uniform in appearance and dimension.

BRIEF SUMMARY OF THE INVENTION

One aspect of the present invention relates to apparatus including a tube blank feeder unit, a tube forming or shaping unit, and a ring applying and bonding unit. These cooperate to automatically fabricate, on an economical production basis with minimal losses due to damage, a relatively thin walled, outer tampon applicator tube having a pleated, conically-shaped forward end, as disclosed in the aforementioned U.S. Pat. No. 3,204,635 and having a reinforcing and gripping ring near the rear extremity, broadly in accordance with the teachings of the aforementioned U.S. Pat. No. 3,347,234.

Broadly, the tube blank feeder unit comprises a hopper for holding a supply of tampon applicator tube blanks, the hopper having means for controlling the discharge of the tube blanks from the hopper. A tube blank orienting and feeding mechanism is positioned to receive the tube blanks from the hopper. A sensing means is further provided to sense the level of the tube blanks in the orienting and feeding mechanism, the sensing means having an output operatively connected to control the tube discharge rate from the hopper, so as to avoid damage to the tubes.

The tube blanks are automatically transported from the feeding unit to the tube forming or shaping unit. Broadly, this machine includes a first structure having tube supporting means projecting therefrom and a second structure, disposed opposite the first structure, carrying tube forming dies. The structures are indexed through a series of dwell stations and reciprocated relative to one another through one cycle per dwell period so that the dies work substantially simultaneously and in sequence on the ends of the tubes held by the tube supporting means. The basic process performed by this machine includes initially crimping the projecting tube end, compressing or folding the tube end into dovetailed folds or pleats, exercising the tube ends one or more times by expanding the crimped and folded end followed by a refolding operation. In the last operation, a pin, located coaxially within the die leaves a small, centrally located aperture in the forward extremity of the tube. This assures that the folds will be symmetrical about the axis of the tube and uniform in appearance and further aids in reducing the force required to eject the tampon.

The tube support means on the shaping unit forms another aspect of the invention. The rear portion of each tube blank is slidably received on a punch fixed to and projecting from the first structure. The rear extremity of each tube bears against resilient means carried by the punch so that the tube may move back over the punch during treatment by the various die means. In the case of the initial crimping or folding operation, the tube may move back a small distance and this serves to accommodate manufacturing tolerances in the overall length of the tube, increases the time of contact between the die and the tube and prevents collapse of the tube. In the folding operations, the female die, which projects further from the second structure than the crimping die, forces the tube substantially all the way back over the punch against the bias of the resilient means to compress and squeeze the folded forward end of the tube against the forward end of the punch to thereby form the desired pleats.

The tubes thus formed are next transferred to a ring-applying unit which broadly includes an indexing turret having a series of projecting punches for receiving and holding the tubes. The turret is intermittently rotated or indexed through various dwell stations including a

glue-applying station at which an automatically operated glue dispenser places several drops of glue on the outer surface of the tube near the rear end thereof. The turret is then indexed to a succeeding station at which a ring is placed about the tube adjacent the rear end thereof, after which the tube is unloaded at an unloading station.

According to another aspect of the invention, relating to the tube unloader device for both the tube forming unit and the ring applying and bonding machine, a motor driven paddle wheel is positioned at the respective unloading stations of the tube forming and ring applying and bonding units. The paddle wheel has a plurality of rubber jacketed paddles projecting therefrom which comes into frictional engagement with the tubes during rotation of the unloader motor to propel the tubes off the tube supports, as they arrive at the unloading station.

BRIEF DESCRIPTION OF THE DRAWINGS

Other aspects of the invention, along with other objects and advantages thereof, will become apparent from a reading of the detailed description, below, in connection with the drawings in which:

FIG. **1** is a side elevation view of a tampon applicator device fabricated in accordance with the present invention;

FIG. **2** is a front elevation view of the device of FIG. **1**;

FIG. **3** is a longitudinal, sectional view of the device of FIG. **1** along with the plane **3—3**;

FIG. **4** is a transverse, sectional view of the device of FIG. **1** along the plane **4—4**;

FIG. **5** is an enlarged, transverse, sectional view of the device of FIG. **1** along the plane **5—5** in which the ring is glued in place;

FIG. **6** is a longitudinal, sectional view of a portion of the device of FIG. **5** along the plane **6—6**;

FIG. **7** is a schematic, side elevation view of an apparatus embodying the various aspects of the present invention;

FIG. **8** is a side elevation view, partially cut away and in section, of a tube blank hopper and feeder unit in accordance with certain aspects of the invention;

FIG. **9** is a perspective view of a vibrating bowl feeder device used in connection with the apparatus of FIG. **8** for feeding tube blanks;

FIG. **10** is an end elevation view, partially cut away and in section, of the apparatus of FIG. **8**;

FIG. **11** is a plan view, in section of a portion of the apparatus of FIG. **8** as taken along the plane **11—11**;

FIG. **12** is a side elevation view, in section, of a tampon applicator tube shaping machine in accordance with certain aspects of the invention;

FIG. **13** is a transverse, sectional view of the apparatus of FIG. **12** along the plane **13—13** showing an example of a turret indexing mechanism;

FIG. **14** is a transverse, sectional view of the apparatus of FIG. **12** along the plane **14—14** showing certain details of the punch turret assembly;

FIG. **15** is a side, elevation view of the punch turret assembly showing aspects of the present invention including details of the punch assemblies;

FIG. **16** is a transverse, sectional view of the apparatus of FIG. **12** as taken along the plane **16—16** showing certain details of the die casting assembly;

FIG. **17** is a longitudinal, sectional view of a crimping die assembly in accordance with the invention, for forming the forward ends of the tubes, shown in operating relationship with a tube blank and punch carrying the tube;

FIG. **18** is a transverse, sectional view of the crimping die shown in FIG. **17** along the plane **18—18**;

FIG. **19** is a side elevation view, partly in section, of a conical folding or compression die shown in operating relationship with a tube and punch;

FIG. **20** is a side elevation view of an exercising die shown in operating relationship with a tube and punch;

FIG. **21** is a side elevation view of another exercising die shown in operating relationship with a tube and punch;

FIG. **22** is a side elevation view of still another exercising die shown in operating relationship with a tube and punch;

FIG. **23** is a longitudinal, sectional view of a folding and hole-forming die shown in operating relationship with a tube and punch;

FIG. **24** is a front elevation view of a tube loading magazine assembly used in connection with the tube shaping machine;

FIG. **25** is a plan view, in section, of the assembly of FIG. **24** as taken along the plane **25—25**;

FIG. **26** is a side elevation view, partly cut away, of the assembly of FIG. **24** showing also details of a tube unloading mechanism according to the invention;

FIG. **27** is a schematic representation, in section, of an air ejector device used to assist the transfer of tubes from the tube shaping unit to the ring applying unit;

FIG. **28** is an end elevation view of the apparatus of FIG. **12** showing certain details pertaining to the electrical/pneumatic control system;

FIG. **29** is a block and schematic representation of an electrical/pneumatic system utilized in controlling the apparatus of FIG. **12**;

FIG. **30** is a side elevation view, party in section, of an alternative punch and crimping die arrangement for forming the forward end of inner applicator tubes;

FIG. **31** is a side elevation view, party in section, of an alternative punch and folding die arrangement used in connection with the crimping apparatus of FIG. **30** for folding and compressing the crimped, forward end of inner applicator tubes;

FIG. **32** is a side elevation view of the exterior of a ring applying and bonding machine in accordance with certain aspects of the present invention;

FIG. **33** is a transverse, sectional view of a portion of the machine of FIG. **32** along the plane **33—33**;

FIG. **34** is an end elevation view of the machine of FIG. **32** including a schematic and block representation of an electropneumatic circuit utilized in connection with the operation of the ring applying and bonding machine;

FIG. **35** is a side elevation view, in section, of a portion of the machine shown in FIG. **34** along the plane **35—35**;

FIG. **36** is a partial, front elevation view, partly in section, of a tube magazine and loader mechanism for use with the ring applying machine;

FIG. **37** is a plan view, in section, of the mechanism of FIG. **36** along the plane **37—37**;

FIG. **38** is a transverse, sectional view of a portion of the mechanism of FIG. **36** along the plane **38—38**;

FIG. 39 is a partial, transverse sectional view of the machine of FIG. 32 as taken along the plane 39—39;

FIG. 40 is a perspective view, partially in section and partly cut away, of a ring applying mechanism;

FIG. 41 is a partial side elevation view, partly in section, of the ring applying mechanism of FIG. 40 in the retracted position;

FIG. 42 is a partial side elevation view, partly in section, of the ring applying mechanism of FIG. 40 in the extended or advanced position;

FIG. 43 is an end elevation view, partly cut away, of the ring applying machine of FIG. 32 showing the tube unloader mechanism;

FIG. 44 is a longitudinal, partial sectional view of an alternative tube exercising means shown in the retracted position;

FIG. 45 is a longitudinal, partial sectional view of the device of FIG. 44 shown in the advanced position.

DETAILED DESCRIPTION

The apparatus of the present invention is particularly suitable for fabricating the outer and inner, thin walled tubes 10 and 12, respectively, of a tampon applicator assembly such as that depicted in FIGS. 1—5 of the drawings, and disclosed in the aforementioned U.S. Pat. Nos. 3,204,635 and 3,347,234. The applicator houses a tampon 14 contained in the forward portion of the outer tube 10 and the inside tube 12 is slidably telescoped within the outer tube 10 behind the tampon 14. The forward end of the tube 10 has been crimped and folded into a conical tip 16 with a small central aperture 18. The tip 16, as best shown in FIG. 4, comprises a dovetail or pleated arrangement including a series of outer folds 20 overlapping a series of inner folds 22. This structure, in combination with the thinness of the wall, facilitates ejection of the tampon as the conical end opens easily. The forward end of the inner tube 12 is crimped and folded to form a forward section 24 of reduced diameter. Like the conical tip 16 of the outer tube, the necked down section 24 consists of a series of overlapping pleats such as that depicted in FIG. 4.

To facilitate gripping of the outer tube 10 by the user, and to reinforce the tube 10, which because of its thin wall would otherwise be easily deformable, a ring 26 is bonded about the rear end of the tube. The ring 26 makes possible the use of a smooth textured exterior tube surface; it aids the user in locating the rear extremity of the outer tube and thereby provides a means for orienting the applicator to positively guide its insertion.

As shown in FIGS. 5 and 6, the outer tube 10 may comprise, by way of example, a laminated structure including an inner layer 28 of kraft paper, foil or plastic or the like, and an outer layer 32 of glazed paper, foil, or smooth polyethylene plastic film or the like. An intermediate layer 34, of paper, for example, may also be used. The inner tube 12 may be constructed, for example, of a main lamination 36 of kraft paper enveloped in an outer layer 38 of polyethylene plastic or the like. The ring 26 may be fabricated of any suitable material such as paper, paperboard, rubber, emery board, plastic, metal, ceramic or the like. It is dimensioned to lightly frictionally engage the outer surface of the tube 10, and is suitably bonded in place as well as described in detail later.

Referring to FIG. 7, the apparatus according to certain aspects of the present invention, includes generally a tube blank feeder unit 40, a tube forming unit 42 and a ring applying unit 44. A first conduit 46 is provided for transporting cylindrical tube blanks 45 from the feeder unit 40 to the forming unit 42; the formed tubes are transferred from the forming unit 42 to the ring applying unit 44 by means of a second conduit 48.

Referring now also to FIGS. 8—11, the feeder unit 40 comprises a frame 50 on which a tube blank hopper 52 and vibratory bowl feeder assembly 54 are supported. The hopper 52 is rigidly supported by the frame 50 and is provided with a downwardly tapering funnel section 56 at its bottom. The funnel 56 terminates at its lower extremity in a plate 58 provided with an opening 60, which opening may be square, as shown.

A vibrator assembly 62 is suspended from the funnel 56 beneath the opening 60 by springs 64. The assembly 62 comprises a support plate 66 having a central opening 68, which opening is in vertical alignment with the opening 60 and may also be square, and a vibrator motor 70 is suspended from the bottom of the plate 66 by means of struts 72. The motor 70 may be of conventional construction and may, for example, be of the type including an eccentrically rotated weight to give a large displacement at a relatively low frequency.

The vibratory bowl feeder assembly 54 includes a bowl 74 mounted on a vibrator 76. The assembly 54 may be a commercially available unit of the type sold, for example by the Syntron Company, Homer City, Pa. The bowl 74 is formed with a spirally inclined track 78 which terminates at an exit opening 80 along the upper rim of the bowl 74. The vibrator 76 vibrates the bowl 74 in such a manner that the cylindrical tube blanks 45, out of which the applicator tubes 10 or 12 are to be formed, are induced to advance upwardly in generally end-to-end relation along the spiral track 78. The bowl 74 is provided with a pair of wedges 82 and 84 for the purpose of assuring that only a single line of tube blanks 45 travel to the outlet opening 80. The wedge 82 is disposed at a height of about one tube diameter above the spiral track 78 to peel off any tube layer above the lowest layer. The wedge 84 is so disposed on the track 78 so that this wedge 84 peels off all adjacent rows of tube blanks except one.

Energization of the motor 70 is controlled by means of a tube level sensing means 86. A lever 88 is pivoted on the frame 50 at the point 90 and extends downwardly into the interior of the bowl 74. The lever 88 has a paddle 92 mounted on its lower end to extend to a selected depth into bowl 74. The lever 88 is connected to a switch 94 by a linkage rod 96, the switch 94 being coupled by electrical connection 97 in the electrical supply circuit of the motor 70.

In the operation of the feeder unit 40, the tube blanks 45 are first loaded into the hopper 52. The tube blanks 45 accumulate in the funnel section 56 and tend to clog the opening 60 so that the tube blanks do not pass through. The opening 60 is of sufficiently small size with respect to the dimensions of the tubes 45 that clogging will always occur. It may now be assumed that there is an insufficient supply of tube blanks 45 within the bowl 74, that is, the tube level has dropped below the selected depth to which the paddle 92 extends. The lever 88 is then oriented vertically as shown in FIG. 8, and the switch 94 is actuated to energize the vibratory

motor **70**. The motor **70** with the plate support **66** now vibrates on the springs **64**. This vibration shakes the clogged tubes loose, and they fall gently through the openings **60** and **68** and on top of the motor **70**. The gentle oscillation of the motor **70** then causes the tubes **45** to fall off the motor and into the bowl **74**. The presence of the tubes **45** to the selected level results in the tubes making contact with the lever **88** to move it off center to open the switch **94** and stop the motor **70**. It has been found that for proper feeding of tubes there should be at least one layer of tubes on the bottom of the bowl **74** and the paddle **92** and lever **88** are so adjusted vertically as to maintain this level of tube blanks. There thus is a constant, measured supply of tubes **45** within the bowl **74**, the vibrator **70** vibrating the bowl **74** in such a manner as to cause the tubes to move slowly upwardly in continuous, end-to-end fashion on the inclined track **78** until they reach the exit opening **80**. As already explained, the wedges **82** and **84** function to assure that only a single row of tube blanks **45** reaches the exit opening **80**; it will be apparent, however, that appropriate repositioning of the wedges would provide multiple rows of tubes which may be useful, for example, for feeding multiple tube forming units exemplified by the unit **42**.

Turning now to FIGS. **12—29**, a tube forming unit **42** is depicted which comprises, in general, a base **100**, an intermittently rotatable turret assembly **102**, a reciprocating die plate assembly **104**, a tube blank loading magazine assembly **106** and a tube removal assembly **108**.

The rotatable turret assembly **102** comprises a turret wheel **110** which is intermittently rotated to successive dwell stations by a motor **112** operating through a Geneva mechanism **114**, best shown in FIGS. **12** and **13**. The Geneva mechanism **114** includes a Geneva wheel **116** having a plurality of arc-shaped peripheral depressions **118** and radially extending slots **120** in one of its faces. A continuously rotatable driver **122** is provided with a concentric, cutaway hub **124** which rides within the depressions **118** and also carries an eccentric shaft **126** adapted to enter the slots **120** in succession to index the wheel **116**. The Geneva wheel **116** is fixedly secured to the turret wheel **110** and both wheels **116** and **110** are rotatably disposed on a central shaft **128** which is fixed with respect to the base **100**. The driver **122** is mounted on a jackshaft **130** which is rotatably disposed in the base **100**. The shaft **130** and driver **122** are driven by means of a timing belt **132** which extends over pulleys **134** and **136** respectively driven by the motor **112** and fixed on the shaft **130**.

The die plate assembly **104** comprises a generally cylindrically shaped casting **140** which is reciprocably mounted on the central shaft **128** by means of linear ball bushings **142**. An air cylinder **144** has its piston **146** connected to the casting **140** and is fixed onto the base **100**. The casting **140** is provided with two symmetrical, rearwardly extending clevis leg portions **148** and **150**. The base **100** has a rib portion **152** to which one end of the shaft **128** is fixed and the clevis leg **150** extends through an opening **154** in the rib portion **152**. A U-shaped casting **156** is connected to the two clevis legs **148** and **150** and the piston **146** is fixed to the casting **156** so as to, in effect, connect the piston **146** to the casting **140**. It is to be understood that other means, such as a rotating cam acting on a cam follower carried by the casting **140**, may be used to reciprocate the casting **140**.

In the example depicted in the drawings, specifically FIGS. **12**, **14** and **15**, the turret wheel **110** has eight substantially identical punches **160** affixed to it by nut fasteners **161**. The punches **160** are equally spaced with respect to each other and symmetrically disposed in a circular pattern about the center of the shaft **128** and extend from the turret **110** parallel with the shaft **128**. It will be apparent from the description which follows that virtually any number of punches may be provided, depending upon the number of processing steps to be performed. In FIG. **15**, it will be noted that each of the punches **160** has a sleeve **162** slidably disposed on it. Each sleeve **162** is provided with an axially extending slot **164** which slidably receives a transverse pin **166** extending through the punch **160** to limit the axial displacement of the sleeve. The sleeve **162**, at its forward end, has a radially extending flange **168** and a spring **170** is disposed between the flange **168** and a shoulder **172** on the punch for the purpose of resiliently biasing the sleeve **162** away from the turret wheel **110**. The punches **160** are substantially identical in length, diameter, tip profile, etc., and the springs **170** and sleeves **162** are also substantially identical. In connection with the springs **170**, the spring rate and mechanical performance are preferably identical.

As will hereinafter be more fully described in the example under discussion, the tube blanks **45** are loaded on the punches **160** when the turret wheel **110** is at dwell station *a* (see FIG. **14**); the forward ends of the tubes are crimped at the next dwell station *b;* the tube ends are then folded inwardly into generally conical shapes at a station *c;* the tubes are next partially opened at a first exercise station *d;* opened further at a second exercise station *e;* opened still further to approximate their original diameters at a third exercise station *f;* the tubes are then refolded into the conical shape at station *g* and the tip of the tube provided with a spherical profile and a small, centrally located hole; and the tubes are lastly unloaded at position *h*, all of these stations being angularly displaced from each other by 45°.

Referring to FIGS. **16–23**, the casting **140** is provided with axially extending dies **180**, **182**, **184**, **186**, **188** and **190**. In the example being considered, these dies are spaced **45°** apart, and they are mounted so as to be in axial alignment with six of the punches **160** when the turret wheel is positioned at dwell stations *b*, *c*, *d*, *e*, *f* and *g*.

As best shown in FIGS. **17** and **18**, the die **180** comprises a tubular outer housing **192** having a crimp insert **194**, secured by a set screw **195**, a piston **196** slidably disposed within the housing **192** and having a portion **198** extending into the insert **194**. An abutment screw **200** is disposed within the other end of the housing **192** and a compression spring **202** is interposed between the screw **200** and the piston **196**. The insert **194** is provided with eight axially extending blades **204**, and the piston extension **198** terminates in a segmented head **206** provided with slots **208** that receive the blades **204**. The piston **196** has an end shoulder **210** that is adapted to abut against a shoulder **211** within the housing **192** so as to prevent the piston **196** from moving too far outwardly from the crimp insert **194**.

The die **182** (FIG. **19**) is provided with a concentric, generally conical cavity **212** within its outer end, which cavity forms the female counterpart of the conical tips of the punches **160**. The die **182** is a one piece unit, having no moving parts.

The dies **184**, **186** and **188** (FIGS. **20**, **21** and **22**, respectively) are generally similar but are of increasing diameter. The die **184** has a relatively small diameter body portion **214** with a pointed tip **216**. The die **186** has a body portion **218** which is of larger diameter than the body portion **214** and has a relatively blunt tip **220**. The die **188** has a body portion **222** that is larger in diameter than the body portion **218** and has a rounded tip **224**.

The last die **190** (FIG. **23**) has in its outer end a concentric, conical cavity **226** having a rounded bottom **228**. A pin **230** is disposed within an axially extending bore **232** in the die **190**, the pin **230** extending through a central aperture **234** into the conical cavity **226**. The pin **230** is provided with a shoulder **236**, and a compression spring **238** is disposed within the bore **232** extending between the shoulder **236** and a screw **240** closing the bore **232** to bias the pin **230** toward the conical cavity **226**.

Referring to FIGS. **12**, **14** and **15**, rollers **242**, **244** and **246** may be provided for frictionally retaining the paper tubes on the punches **160** during the exercising steps at the dwell stations *d*, *e* and *f*. Each of the rollers **242**, **244**, **246** is rotatably disposed on an axle **248** carried by a block **250** which in turn is fixed to the central shaft **128**. The rollers **242**, **244** and **246** prevent the tubes from being pulled off the punches **160** when the exercising dies are withdrawn, as will be further explained later.

Turning to FIGS. **24–26**, the tube blank loading assembly **106** comprises a rigid magazine body **252** which has a channel **254** formed therein. The channel **254** is closed by a fixed plate **256** and a longitudinally reciprocating plate **258**. The magazine body **252** has an opening **260** which is connected to the exit opening **80** of the vibrating bowl feeder assembly **54** by means of the first conduit **46**, preferably in the form of a Plexiglas tube. The plates **256** and **258** may also be made of a transparent material such as Plexiglas to facilitate viewing of the tube blank supply.

As will be hereinafter described in greater detail, the tube blanks **45** are fed under longitudinal pressure through the tube **46** into the channel **254** and a vertical displacement assembly **262** is provided for pushing the individual tubes **45** downwardly into the magazine channel **254**. The assembly **262** comprises a displacement block **264** movable vertically for approximately the diameter of a tube **45** within the channel **254** and an air cylinder **266** for vertically moving the displacement block **264**.

The channel **254** is provided with a sloping bottom **268**, and a trough **270** is provided in communication with the bottom **268** to receive tubes **45** one at a time by gravity feed. The reciprocating plate **258**, which extends downwardly into the trough **270**, is connected directly to the reciprocable casting **140** of the die plate assembly **104** by means of a right-angle bracket **272**. The trough **270** is located so that a tube **45** within the trough is in axial alignment with a punch **160** positioned in the loading station *a*.

The tube removal assembly **108**, depicted in FIG. **26**, comprises a constantly running motor **274** mounted on the base **100** and a paddle wheel **276** driven by the motor **274**. Four paddles **278** of soft rubber tubing are fixed equidistantly about the periphery of the wheel **276**, and the wheel **276** is so oriented that the outer extremities of paddles **278** will frictionally engage a finished tube **45***a* carried by a punch **160** at the unloading station *h*, the direction of rotation of the motor **274** being such as to move the finished tube away from the turret wheel **110**. It will be noted in FIGS. **16** and **26**, for example, that the casting **140** has a cutaway portion to accommodate both the loading and unloading mechanisms.

The second conduit **48**, which may be in the form of a Plexiglas tube, is located in axial alignment with a punch **160** positioned at the unloading station *h* so that formed tubes **45***a* are propelled by the paddle wheel **276** into the tube **48**. The tube **48** is provided with a T-fitting **280**, as shown in FIG. **27**, and an air hole **282** is provided through the fitting **280** and through the wall of the tube **48**. The hole **282** is pointed downstream at an acute angle with respect to the longitudinal axis of the tube **48** to assist the movement of the tubes away from the tube shaping unit **42**. The fitting **280** is connected to a source of air pressure by means of an air hose **284**.

Turning now to FIGS. **28** and **29**, air pressure to the cylinders **144** and **266** is controlled by a pair of electrical switches **290** and **292**. The pulley **136** is provided with a cam **294** which is adapted to actuate each of the switches as the pulley **136** rotates. The switches **290** and **292** are a part of an electrical control circuit shown in FIG. **29** and are connected to a source of current by two electric leads **296** and **298**. The switches **290** and **292** are each connected to the lead **296**, and the switches **290** and **292** are respectively connected with pneumatic valves **300** and **302** which are also connected to the lead **298**. An air line **304** is connected to each of the pneumatic valves **300** and **302**, and the valves are respectively connected to opposite ends of the cylinder **144**. The air cylinder **266** is connected to the valve **300** as shown.

In operation, the tube forming unit **42** receives tube blanks **45** through the Plexiglas tube **46** and these tube blanks are fed into the upper end of the channel **254**. The tubes **45**, as they travel through the tube **46** from the vibrating bowl feeder unit **40**, are under axial pressure from the action of the vibratory bowl feeder assembly **54** and they do not, therefore, fall freely into the channel **254** without mechanical assistance. The assembly **262** provides this mechanical assistance and the air cylinder **266** has air pressure supplied to it, as will be hereinafter described, for each of the tubes **45** that are withdrawn from the lower end of the channel **254**.

The casting **140** is reciprocated by means of the air cylinder **144**, and for each forward reciprocation of the casting **140** toward the punches **160**, the loading magazine assembly **106** discharges a tube **45** onto a punch **160** in the loading station *a*. A tube **45** is positioned in the trough **270**, and the plate **258** is reciprocated forwardly along with the casting **140** since it is connected to the casting. The plate **258** receives a tube **45** in a cut out portion **306** and on forward movement of the plate **258** it slides a tube **45**, nested in a

notch **259** in plate **258**, onto a punch **160** then in the loading station *a*. The tube **45** is thus pushed into a carrying position in which the sleeve **162** is at its most forward position with the rear extremity of the slot **164** bearing against the pin **166**. The length of the portion of the punch **160** projecting forwardly from the flange **168** is considerably shorter than the overall length of the tube blank **45**, so that in the normal carrying position, the front portion of the tube **45** extends unsupported from the front tip of the punch.

As the operation continues, each of the punches **160** will eventually have one of the tubes **45** loaded on it by means of the reciprocating plate **258** and the various dies carried by the casting **140** perform various operations substantially simultaneously on the ends of the tubes **45** at the various stations *b* to *g*, inclusive.

Referring again to FIG. **17**, on the forward stroke of the casting **140** the die **180** crimps, that is, provides multiple folds in the forward end of the tube **45** at dwell station *b*. This crimping is performed by the blades **204** on the insert **194** that individually crease and fold the paper wall of the tube **45** inwardly. The head **206**, functioning as a stripper device, engages the forward extremity of the tube **45** as the die **180** moves over the tube, the spring **202** being thereby compressed. Upon retraction of the die **180** the head **206** under force from the spring **202**, will eject the tube **45** from within the crimp insert **194**. This is necessary because the blades **204** tend to be firmly grasped by the paper folds formed in the end of the tube **45**.

During the crimping operation by the die **180**, the die **180** slides the tube **45** and the sleeve **162** back on the punch **160** a short distance in opposition to the action of the spring **170**. It will be appreciated that the spring **162** allows compensation to be made for manufacturing tolerances in the overall length of the tubes; additionally, the resilient cushion provided by the spring **162** protects the tube from damage as a result of sudden impact upon contact by the crimping die, and increases the length of time that the die is in engagement with the tube end to assure that the crimped folds will have the required depth. The flange **168** of the sleeve **162** may be displaced until it engages stepped corner **308** of the block **250** which prevents further rearward movement of the tube **45**. This provides a positive limit on the travel of the tube **45** on the punch **160** and assures identical crimping length of successive tubes **45**. This is important inasmuch as the conical fold pattern in the tubes is established at least in part, by the length of the crimp and this could vary if such a positive limit on the rearward displacement of the sleeve **62** were not provided. When the casting **140** and the die **180** retract, the tube **45** moves forward to its initial position under the action of the spring **170** against the sleeve **162**.

At station *c*, the die **182** engages the crimped forward end of the tube **45** and presses the folds into overlapping, pleated relation to produce a generally conical shape. In this operation, the cone-shaped die **182**, which projects further from the casting **140** than the crimping die **180**, pushes the tube back against the increasing resistance of the spring **170**, until the die eventually squeezes and compresses the folded front end of the tube **45** against the generally cone shaped tip of the punch **160**. In contrast to the crimping operation at station *b*, no limit, other than that provided by the slot **164** and pin **166**, is placed on the rearward motion of the tube **45** and sleeve **162**. Upon retraction of the casting **140** and the die **182**, the spring **170**, acting through the sleeve **162** and flange **168**, moves the tube **45** back to its initial position.

At each of the following three stations, *d*, *e* and *f*, depicted in FIGS. **20–22**, the forward ends of the tubes **45** are "exercised," that is, the pleated forward ends of the tubes **45** are opened gradually by the successive action of exercising dies **184**, **186** and **188**, to weaken the fold lines. At each of the stations *d*, *e* and *f* the rollers **242**, **244** and **246**, respectively, frictionally restrain the paper tubes **45** from being pulled off the punches **160** during retraction of the exercising dies. In each case, the exercising dies **184**, **186** and **188** exert a relatively small force on the corresponding tube **45** upon retraction, so that the relatively light frictional force provided by rollers **242**, **244** and **246** is effective to prevent the tubes **45** from being drawn off the punches **160**.

The body portion **214** of the die **184** is relatively small in diameter compared to inside diameter of the tube **45**. In one practical example, the inside diameter of the tube **45** was 0.578 inch and the diameter of the die body was about 0.250 inch. The body portion **214** is projected into the opening in the forward extremity of the crimped tube **45**. At the forward extreme of the travel of the die **184**, a small gap **310** remains between the pointed tip **216** and the tip of the punch **160**. The front end of the tube **45** is opened slightly by the die **184**.

The succeeding die **186** enters the crimped end of the tube **45** and has the same action as the die **184** but, as a result of the larger diameter of the body portion **218**, about 0.375 inch in the aforementioned practical example, the die **186** opens the tube still further as may be seen in FIG. **21**. The die **188**, depicted in FIG. **22**, also has the same action but as a result of the fact that its body portion **222** has almost the same diameter, about 0.573 inch in the aforementioned example, as the original inside diameter of the tube **45**, it opens the crimped end of the tube still further. The tube **45** is thus almost completely back to its original form except, of course, that on retraction of the casting **140** and die **188**, weakened folds remain in the front end of the tube. Also, the forward end of the tube **45** has now been so weakened along the fold lines that the end of the tube **45** will easily refold back into the pleated configuration when engaged again by a folding die.

As noted, the purpose of the exercising operations is to weaken the conically shaped tube end to facilitate the discharge of a tampon from the final product with minimum effort. The number of exercising operations is thus dictated chiefly by the material used to form the tube. If a sufficiently weak tube paper is utilized, only one exercising operation, for example, may be required. In that case, of course, correspondingly fewer dies, punches and dwell stations are needed and, if desired, the turret wheel **110**, the casting **140** and the indexing mechanism, such as Geneva mechanism **114**, may be modified accordingly. Such modification will be apparent to those ordinarily skilled in the art and are deemed to fall within the purview of the present invention.

The tube **45** at the station *g* is treated by the die **190** as shown in FIG. **23**. The die **190** is moved toward the punch **160** dwelling at station *g*, the pin **230** enters the tip of the tube, and the side surfaces of the conical cavity **226** compresses the end of the tube **45** against the punch forming the end into a conical shape, with the pin **230** assuring that a small opening **18** (see FIGS. **2** and **3**) remains in the tip of the finished tube **45***a*. One purpose of the hole **18** is to lessen the amount of pressure required to open the forward end of the tube during use of the tampon applicator. It should be noted again that the conical cavity **226** has a rounded bottom **228** so that the end of the final tube **45***a* is not exactly a cone. The tube **45** readily refolds on its original fold lines and the pin **230** serves as a guide to assure that the fold pattern is symmetrical about the longitudinal axis of the tube, thereby preventing lopsided bunching of the folds which tends to increase the effort required to expel the tampon and providing a neat, concentric appearance. The action of the die **190** at the station *g* is substantially the same as the action of the die **182** at station *c* in that the die **190** squeezes the folded end of the tube **45** over the conical end of the punch **160**. Just prior to the time of impact by the die **190**, the end of the pin **230** contacts the tip of the punch **160** and is forced back against the bias of the spring **238**. On retraction of the die along with the casting **140**, the pin **230** returns to its initial position.

The finished tube **45***a*, positioned on the punch **160** at the station *h*, is unloaded from the punch **160** by means of the rotating paddle wheel **276**. As already mentioned, the paddles **278** contact the tube **45***a* on the punch **160** and propel it into the conveyor tube **48**.

In the specific example considered, in which eight stations are used, the Geneva mechanism **114** causes the turret wheel **110** to index 45° at a time so that each of the punches **160** dwells at each of the stations *a* to *h* for a predetermined length of time. The Geneva mechanism **114** may be designed, for example, so that the Geneva wheel **116**, and hence the turret **110**, dwells for about one-half revolution of the driver **122** and indexes during the remaining one-half revolution of the driver. The switches **290** and **292** are positioned relative to one another and the cam **294** so that the casting **140** is caused to reciprocate through one complete cycle, that is, forward and back, during the dwell period of the turret wheel **110**. Referring to FIG. **29**, the cam **294** rotates at a constant angular velocity and during its rotation it actuates the switch **290** substantially simultaneously with the beginning of the dwell period. The cam **294**, approximately one-half revolution later, actuates the switch **292** and this concurs with the end of dwell and the start of the indexing motion of the turret wheel **110**. The switch **290** is connected with the solenoid valve **300** and when the switch **290** is energized, air pressure from the line **304** is supplied through the valve **300** to the rear end of the cylinder **144** so as to propel the die plate assembly **104** toward the turret **110** so as to cause the previously described interaction between the dies and the tubes **45** carried by the various punches **160**. When the switch **292** is energized at the end of dwell, this causes energization of the solenoid valve **302** and air pressure is admitted to the forward end of the cylinder **144** to cause retraction of the die plate assembly **104** and the dies carried thereby.

The cylinder **266** of the vertical displacement mechanism **262** is connected to the solenoid valve **300**, which is actuated by the cylinder **266**, thus pushes an additional tube **45** down into the magazine channel **254** while a tube **45** is unloaded from the bottom of the magazine by the plate **258** during the forward stroke of the die plate assembly **104**.

The embodiment discussed above, utilizing punches **160** having a generally conical tip, and the various dies **180**, **182**, **184**, **186**, **188** and **190**, is particularly useful in the process for fabricating the outer tampon applicator tube **10**. The machine which has been described may also be employed for forming the forward, reduced diameter section **24** of the inner applicator tube **12**.

To this end, referring to FIGS. **30** and **31**, a plurality of punches **320**, having a necked down forward end **322**, and carrying a spring biased, flanged sleeve **324**, are affixed to the turret wheel **110** for slidably carrying tube blanks **47**. The casting **140** supports a crimping die **326**, generally similar to the die **180**, for forming initial folds in the front end of the tube blanks. As shown in FIG. **30**, the shape resulting from the action of the die **326** is generally that of a truncated cone. The projecting length of the crimping die **326** is such that the tube **47** is normally pushed back a short distance on the punch **320**. A stop means **328** is provided for engagement by the flanged portion of the sleeve **324** to limit the rearward movement of the tube blanks.

The final forming step is shown in FIG. **31**. A compression die **330** having an interior cavity **332**, with a necked down shape determinative of the shape of the finished tube end, is advanced to squeeze the tube end over the punch **320** to produce the final necked down, pleated configuration shown as inner tube section **24** in FIG. **3**. The action of the die **330** is similar to that of the die **190**, already discussed. No stop is provided at this station for engaging the flanged sleeve **324** thereby permitting the tube blank to slide rearwardly on the punch **320** until impact by the compression die **330**. No exercising stations are required, of course, in the formation of the inner tube so basically only four stations, tube blank loading, crimping, folding, and unloading, are necessary.

Turning now to FIGS. **32–43**, and particularly FIG. **32**, the ring applying unit **44** comprises, in general, a frame **340**, a rotating and indexing turret assembly **342**, a loading magazine assembly **344**, a tube removal assembly **346**, a glue applying unit **348**, a ring applying assembly **350** and a vibrating bowl feeder **352** for the rings.

Referring to FIGS. **32–34**, it will be seen that the turret assembly **342** comprises a plurality of punches **354** which are rotatably mounted within a turret wheel **356**. The punches **354** are disposed at equal intervals in a circular array. Each of the punches **354** has a pulley **358** affixed to its forward end and a plurality of belts **360** extend around the arrangement of pulleys **358**, so that the punches **354** are rotatable in unison. A drive motor **362** is provided for rotating the punches **354** and, as best shown in FIGS. **33** and **34**, a drive belt **364** extends around most of the pulleys **358** and also around a pulley **366** fixed to the drive shaft of the motor **362**.

The turret assembly **342**, as shown in FIG. **35**, includes also a Geneva mechanism **368** which is driven

by a jackshaft **370**. The Geneva mechanism **368** is similar to the Geneva mechanism **114** described in connection with the tube forming unit **42** and functions to intermittently rotate or index the turret wheel **356**. The jackshaft **370** is driven b a motor **372** via pulleys **374** and **376** mounted, respectively, on the jackshaft **370** and the shaft of motor **372** and a belt **378** extending about the pulleys **374** and **376**. The ring applying unit **44** is synchronized with the tube forming unit **42** and to this end the motor **372** is preferably energized from the same source of electrical supply as the motor **112**. Preferably, both of these motors are synchronous electric motors and will therefore operate at the same angular velocity as a result of being connected to the same alternating current source.

In the specific example shown in the drawings, the turret wheel **356** is rotated to eight different dwell stations by means of the Geneva mechanism **368**. Referring momentarily to FIG. **39**, these stations include a tube loading station *m*, an intermediate station *n*, a glue applying station *o*, an intermediate station *p*, a ring applying station *q*, two intermediate stations *r* and *s* and a tube unloading station *t*, and each of the punches **354** consecutively arrive at and dwell at these stations.

The tube magazine and loading assembly **344**, which slides the formed tubes **45**a one after the other onto the punches **354**, in sequence, at the station *m*, is shown in FIGS. **36–38** and comprises a magazine **380** having a vertical, elongated channel **382** therein adapted to receive the formed tubes **45***a* and hold them in a vertical stack with the individual tubes being horizontal and having their conical ends pointing rearwardly, that is, away from the turret wheel **356**. The upper end of the channel **382** communicates with the interior of the Plexiglass tube **48**, the tubes **45***a* being pneumatically transported through the tube **48** to the upper end of the magazine **380** by virtue of the action of the air ejector means **280**, **282**, **284**. A soft rubber cushion **384** is provided at the end of the tube **48** to absorb the impact of the tubes **45***a* and thereby prevent distortion of or damage to the conical tube ends.

The magazine **380** has a tube outlet opening **386** which is located in axial alignment and just rearwardly of a punch **354** in the tube loading station *m*. A plunger **388** is movable axially with respect to the opening **386** and is provided with a trough or seat **390** extending from its forward end for receiving the tubes **45***a* from the channel **382**. An air cylinder **392** having a piston **394** connected to the plunger **388** reciprocates the plunger **388**. The plunger **388** has a slot **389** cooperating with a fixed pin **391** to prevent rotation of the plunger.

The glue applying unit **348**, depicted in detail in FIG. **39**, and which operates basically as a glue droplet dispenser or extruder, includer a cylinder body **396** having a piston **398** slidably disposed therein. The piston **398** has an enlarged end portion **400** slidably disposed in and sealed with respect to the sides of a cylindrical bore **402** in the cylinder body **396**. A return spring **404** is disposed between the enlarged piston portion **400** and a shoulder **406** at the lower end of the bore **402**.

The piston **398** terminates at its lower end in a piston pin **408** which is slidably disposed in a relatively small diameter bore **410** terminating at a nozzle **412**. The cylinder body **396** is provided with a laterally extending glue inlet passage **414** which is in communication with the bore **410**. It should be noted that the bore **410** is of such a diameter, considering the relatively high viscosity of the glue used, that the glue will not drop from the lower end of the nozzle **412** without assistance from the piston **398**, downward movement of which causes dispensation or extrusion of a droplet of glue from the nozzle. The stroke of the piston **398** may be adjusted, so as to regulate the volume of glue dispensed in each droplet, by means of a stop **416** threadedly received in the upper wall of the cylinder body **396** and having a lower extremity **418** for engaging the upper face of the piston **398**.

A glue reservoir **420** connected to a source of air pressure by a hose **422** is connected by a tube **424** to the inlet passage **414** so as to supply glue under slight pressure to the passage **414**. Air pressure is intermittently supplied to the upper end of the bore **402**, to move the piston **398**, from a source of air pressure (not shown) through a tube **426**, an air switch or valve **428**, and a tube **430** connecting the air switch with the body **396**. The air switch **428** is actuated by a mechanism to be hereinafter described. It should be noted that the nozzle **412** is positioned to be immediately above the rear end of a tube **45**a dwelling at station *o* so that glue will be dropped on the portion of the tube which will carry the ring **26**.

With reference now to FIGS. **32** and **40—42**, the ring applying assembly **350** comprises a magazine **432** having a vertical, rectangular cross-section slot **434** therein which is just slightly larger in width than the diameter of the rings **26**. The slot **434** is connected to a chute **436** which in turn is connected to the vibrating bowl feeder assembly **352**. The vibrating bowl feeder assembly **352** is similar to, but smaller in size than, the vibrating bowl feeder assembly **54** described in connection with the tube blank feeder unit **40**, and ma also be a commercially available unit, such as that marketed by the aforementioned Syntron Company. The vibrating bowl feeder **352** includes a spiral track bowl **438** which has ring orienting means analogous to the wedges **82** and **84**, but this orienting means is so disposed with respect to the spiral track in the bowl **438** that the rings lie flat on the spiral track within the bowl **438** and travel into the upper end of the chute **436** with their axes vertical. The chute **436**, for its complete length, has substantially the same thickness as the length of the rings so that the rings, as they reach the bottom of the chute **436**, are stacked one on top of the other with their axes horizontal, as shown in FIG. **40**, and enter the slot **434** in this position.

The ring applying assembly **350** comprises also a piston sleeve **440** reciprocable in a horizontal cylinder bore **442** formed in the magazine **432**. The piston sleeve **440** has a longitudinal slot **441** cooperating with a pin **443** to prevent rotation of the piston sleeve. The internal diameter of the bore **444** in the sleeve **440** is just slightly greater than the external diameter of the tubes **45***a*. The sleeve **440** is provided with a counter bore **446** on its extreme tip which counter bore has a diameter just slightly greater than the outer diameter of the rings **26** and a length slightly greater than the outer diameter of the rings **26** and a length slightly less than the length of the rings **26**. The top half of the counter

bored portion of the piston sleeve **440** is cut away to provide an open portion **448** through which the rings **26** drop into the remaining lower half of the counter bored section. A forwardly tapering flat **450** is provided in the upper surface of the piston sleeve **440** at the forward extremity thereof to prevent the front, upper edge of the sleeve **440** from jamming against the next to last ring **26'** (see FIG. **40**).

A piston **452**, slidably disposed within the sleeve **440**, has a relatively small diameter, rearwardly projecting shaft **454**. A compression spring **456** within a small diameter, elongated cavity in the sleeve **440** biases the piston **452**. As shown in FIG. **40**, the piston **452** is limited in its axial movement by a transverse pin **456** affixed to the shaft **454** and slidably received in a longitudinal slot **458** found in the wall of the sleeve **440**. The purpose of the piston **452** will be hereinafter described. An air cylinder means **460** is provided for reciprocating the piston sleeve **440**.

The tube removal assembly **346** (FIGS. **32** and **43**) is substantially the same as the tube removal assembly **108** and comprises a motor **462** driving a paddle wheel **464**, the periphery of which is tangent to the finished tubes **10** and in frictional engagement therewith during rotation to propel the tubes **10** off of the punches **354** at station *t*.

Referring to FIG. **34**, the air cylinders **392** and **460** are controlled by a switch **464** and a cam **466** fixed on the pulley **374**. The switch **464** has a depending actuating arm **468** riding in contact with the profiled surface of the cam **466** whereby the cam actuates the switch **464** as the pulley rotates. A solenoid air valve **470** is connected through the switch **464** with an electrical source **472**. The solenoid air valve **470** is supplied with air pressure from an air line **474** and has two output pressure lines **476** and **478** connected, respectively, with the propulsion and retraction ends of the air cylinders **392** and **460**.

Referring now also to FIG. **39**, the air switch **428** is controlled by a cam **480** having three lobes **482**, **484** and **486**. The cam **480** is connected to the pulley **374** and the switch **428** is thus actuated in timed relation with the rotation of the pulley.

In the operation of the ring applying unit **44**, the punches **354** are rotated constantly by the motor **362**, and the punch **354**, in the tube loading station *m*, has a tube **45***a* applied thereto from the magazine assembly **344**. During each cycle, which corresponds to a revolution of the pulley **374**, the switch **464** is closed by the cam **466**, and the solenoid air valve **470** is thus actuated. The air valve **470** is of such construction that when so actuated air pressure is supplied to the pressure line **476** and air pressure is thus supplied to the air cylinder **392**. A supply of formed tubes **45***a* is in the magazine channel **382**, and the air cylinder **392** when energized advances the piston **394** forwardly and thus ejects the bottommost tube **45***a* onto the awaiting punch **354** which, in its loading station *m*, is in axial alignment with the opening **386** and the plunger **388**. The plunger **388** is of substantially the same diameter as the tubes **45***a* and therefore the upper tubes **45**a in the channel **382** are retained in their original positions until the plunger **388** retracts, at which time the next lowermost tube in the channel **382** drops into the seat **390**. Retraction occurs when the cam rotates to return switch **464** to its original condition and the solenoid air valve **470** recycles to provide air pressure in the pressure line **478** connected with the forward ends of the air cylinders **392** and **460**.

The air switch **428** is actuated by each of the cam lobes **482**, **484**, **486** in sequence to apply drops of glue onto the base end of a tube **45**a at the glue applying station *o*. On each actuation of the switch **428**, air pressure is supplied to the upper end of the piston **398**, and the piston thus moves downwardly in the body **396** against the action of the spring **404** so as to move the piston pin **408** downwardly past the end of the inlet passage **414** and into the nozzle **412**, thus ejecting a drop of glue. The cam **480** is so located on the pulley **374** and the lobes **482**, **484** and **486** so spaced that the air switch **428** is actuated to eject drops of glue from the nozzle **412** onto a tube **45***a* while the turret wheel **356** is in its dwell condition. The cam lobes **482**, **484** and **486** ma be so spaced that drops of glue are applied approximately 120° apart on the tube **45***a* while the tube rotates.

The ring applying assembly **350** is actuated once each cycle, along with the loading magazine assembly **344** when the solenoid air valve **470** is actuated. Air pressure is supplied both to the rear end of the air cylinder **460** and to the rear end of the cylinder **392** of the tube loading assembly **344**, and the air pressure so applied to the air cylinder **460** of the ring applying assembly **350** advances the sleeve **440**. The sleeve **440** carries a ring **26** within its counter bore **446** forwardly and slides it onto the tube **45***a* dwelling at the ring applying station *q*. The ring **26** is pushed over the complete length of the tube **45***a* onto the glue previously applied by the unit **348**. Air pressure is then applied to the forward end of the cylinder **460** the pressure line **478** to retract the sleeve **440** to its original position. A ring **26** above the ring just applied then drops downwardly into the counter bored portion **446** of the sleeve **440**.

The piston **452** has the function of assuring that the tube **45**a is not retracted from its supporting punch **354** by frictional contact with the interior surface of the sleeve **440**. As a result of the biasing action of spring **456**, the piston **452** remains in contact with the tip of the tube **45***a* during most of the retracting movement of the sleeve **440**, thus firmly holding the tube **45***a* on the punch.

The unloading assembly **346** functions to unload the finalized tubes **10** at the station *t* in a manner already described. An suitable receptacle may be provided for receiving the tubes **10** so unloaded from the punches **354**. A pneumatic tube **488**, similar to the tube **48** can, for example, be utilized.

The intermediate dwell station *n* has no particular function; however, the station *p* is provided so that the glue may dry slightly on the base ends of the tubes **45***a* after being applied thereon by the glue applying unit **348** and prior to receiving a ring **26**. The rings **26** are applied at the station *q*, as described above, and the intermediate dwell stations *r* and *s* serve to allow still further drying of the glue after the rings **26** have been applied onto the tubes prior to unloading at the station *t*.

An an alternative to using the exercising dies as exemplified by one or more of the dies **184**, **186** and **188**,

a single station exercise system may be substituted in which each of the punches **160** is replaced by a punch assembly **490**, as shown in FIGS. **44** and **45**. With this embodiment, the outer tubes **45** are exercised after crimping by opening or expanding the crimped forward end from the inside rather than by insertion of one or more dies from the outside.

Each of the punch assemblies **490** comprises a tube **492** with a threaded portion extending through and fixed to the turret wheel **110** by nut **494**. The tube **492** has a boss **496** drawn into contact with the front face of the turret wheel **110** by tightening the nut **494**. The outer diameter of the portion of tube **492** extending forwardly of boss **496** is the same as the outer diameter of the punches **160** for receiving tube blanks **45**. A stem **498** is reciprocably disposed in the tube **492** and has an enlarged, generally conically shaped head **500** on its front end which has essentially the same outer diameter as that of the tube **492**. The head **500** matches in profile the front end of each of the punches **160** and is adapted to fit against the forward edge of the tube **492**. A spring **502** is provided between the rear end of the tube **492** and a snap ring **504** disposed in a slot adjacent the rear end of the stem **498** to bias the head **500** against the front edge of the tube **492**.

A sleeve **506**, like the sleeve **162**, having a forwardly positioned, radially extending flange **508**, is slidably disposed on the tube, and a spring **510** is provided between the flange **508** and the boss **496**. The sleeve **506** and the spring **510** have the same function as the sleeve **162** and spring **170**, in the first embodiment, already discussed, and the sleeve has preferably the same limited movement on the tube **492** by virtue of a pin **512** held transversely by the tube **492** and riding in an axially oriented slot **514** (shown in broken lines) provided in the sleeve **506**.

A turret indexing mechanism providing six dwell stations may be used with the single exercise station under discussion but the eight station device already described can also be employed. In that case, each of the punch assemblies **490** is adapted to be operative in the station *e* of the turret wheel **110**, and at this station the roller **244** is adapted to contact the tube **45** and hold it in place on the tube **492**.

An air cylinder **516** having a plunger **518** is fixed to the base of the machine and disposed behind the turret wheel **110**. The plunger **518** is in axial alignment with the stem **498** of the punch assembly **490** positioned at the station *e*. One end of the air cylinder **516** is connected to the solenoid valve **302** and the other end of the air cylinder **516** is connected to the solenoid valve **300**, it being understood that the cylinders **144** and **266** remain connected to the solenoid valves **300** and **302** as shown in FIG. **18**.

In operation, the punch assemblies **490** have the same function as the punches **160** and cooperate in the same manner with the dies **180**, **182** and **190**, respectively, at the stations *b*, *c* and *g*, as has been previously described.

The forward stroke of the stem **498** for opening the crimped forward end of the tube **45** is accomplished by the air cylinder **516** which is energized by the valve **300** to advance the stem to the position shown in FIG. **45** in which the enlarged head **500** is disposed within the crimped portion of the tube **45** to penetrate and unfold that portion. At the same time, the valve **300** energizes the cylinder **144** for the purpose of advancing the die plate casting **140** and the cylinder **266** for the purpose of displacing a tube blank **45** downwardly into the magazine channel **254**. As previously described, the foregoing occurs at the beginning of the dwell portion of the cycle. At the completion of the dwell period, the switch **292** is actuated so as to energize the solenoid valve **302**, to admit air under pressure to the other ends of the cylinders **144**, **266** and **516** to simultaneously retract the casting **140**, the tube blank displacement assembly **262** and the plunger **518**, respectively, the retraction of the last element permitting the return of the stem **498** to its initial position (FIG. **44**) by the action of the spring **502**.

Although particular apparatus and methods have been described to illustrate various manners in which tampon applicator tubes can be fabricated, it will be appreciated that the present invention is not limited to such particular illustrations and descriptions, and modifications, alterations, and equivalent arrangements will suggest themselves to persons skilled in the art. For example, it will be obvious that, with the adoption of appropriate tube feeding and removal mechanisms, a tube forming unit such as the unit **42** may be oriented vertically with the reciprocating casting **140** positioned above the turret wheel **110**, or vice versa.

Further, it will be obvious that the tube forming unit and the ring applying and bonding unit may be combined into a single apparatus. To this end, the turret wheels **110** and **356** may be replaced by turret means having a sufficient number of stations to perform the tube shaping, ring applying and bonding operations. These stations would include tube blank loading, glue applying, ring applying, tube end crimping, folding, exercising, refolding and unloading. If three successive exercising operations are necessary, a total of 10 dwell stations would be provided.

Accordingly, any and all modifications, alterations, and equivalent arrangements which fall within the scope of the following claims should be considered to be part of the present invention.

What is claimed is:

1. A method for shaping the end portion of a tube comprising:

crimping said end portion to provide a plurality of longitudinally disposed folds;

folding and compressing said crimped end portion into a plurality of pleats, thereby forming said tube end into a generally conical shape;

penetrating said folded forward end of said tube with male die means to at least partially unfold said forward end; and,

refolding and compressing said forward end portion into said pleated, generally conical shape.

2. A method, as defined in claim **1**, in which:

said forward end portion is unfolded progressively in successive stages.

3. A method, as defined in claim **1**, in which:

said tube end is substantially fully unfolded in a single operation by positioning said male die means within said tube and moving said die means forwardly to penetrate said forward end.

4. A method, as defined in claim **1**, which includes:

forming a small, centrally oriented aperture in said forward end portion of said tube during the refolding step.

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