

[54] APPARATUS FOR FORMING A CYLINDER

[75] Inventor: **Donald R. Trask**, Bat Village, Ohio

[73] Assignee: **Union Carbide Corporation, New York, N.Y.**

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[51] **Int. Cl.**..... **B31c 3/02**

[58] **Field of Search**..... 93/81 R, 39.2, 44.1

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Primary Examiner—Donald R. Schran

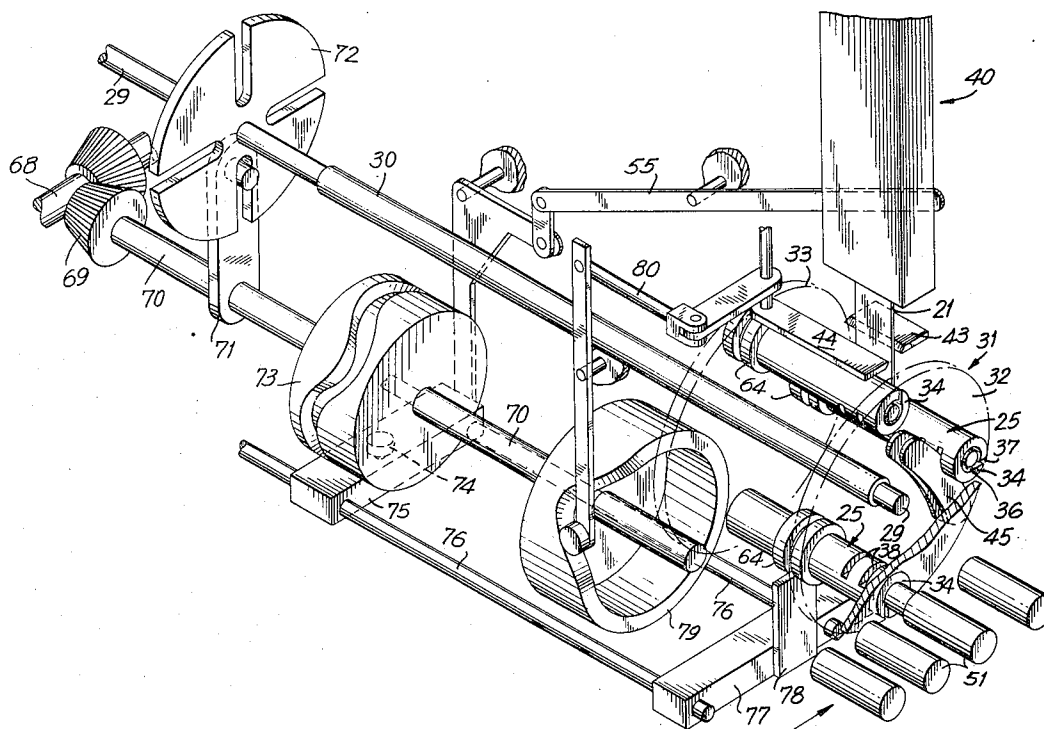
Attorney—James C. Arnantes, John F. Hohmann, John R. Doherty and Cornelius F. O'Brien

[57] **ABSTRACT**

An apparatus for forming a cylinder is disclosed. It is

useful, for example, for forming cylindrical battery can separator liners from a continuous strip of paper liner stock. The apparatus includes a forming tube having a receiving chamber that is defined by the inner surface of an outer tubular member and the outer surface of a central cylindrical member. The apparatus also includes means for sequentially positioning said forming tube at receiving and eject stations, and means for feeding the leading edge of a predetermined length of liner into said receiving chamber through a longitudinal slot in said outer tubular member. The outer tubular member has at least one transverse opening that is constructed to permit the extension therethrough of a friction element to engage the liner in the receiving chamber as said forming tube is moved from said receiving station toward the eject station to thereby wind the liner up into cylindrical configuration by catching the liner between the friction element and the central cylindrical member. After the liner has been wound up into a cylinder, ejection means ejects the liner from the forming tube, for instance, into a battery can.

11 Claims, 21 Drawing Figures



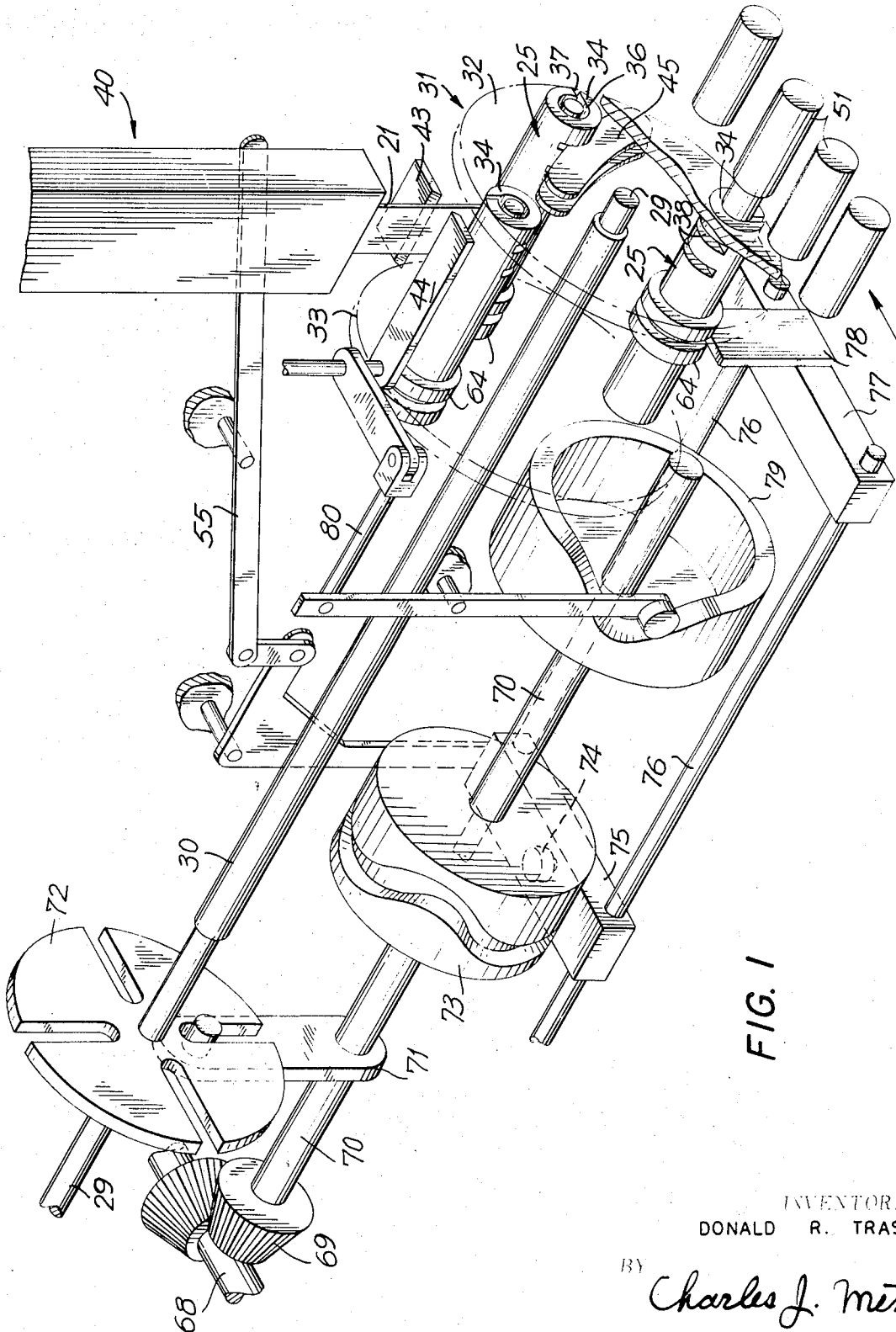
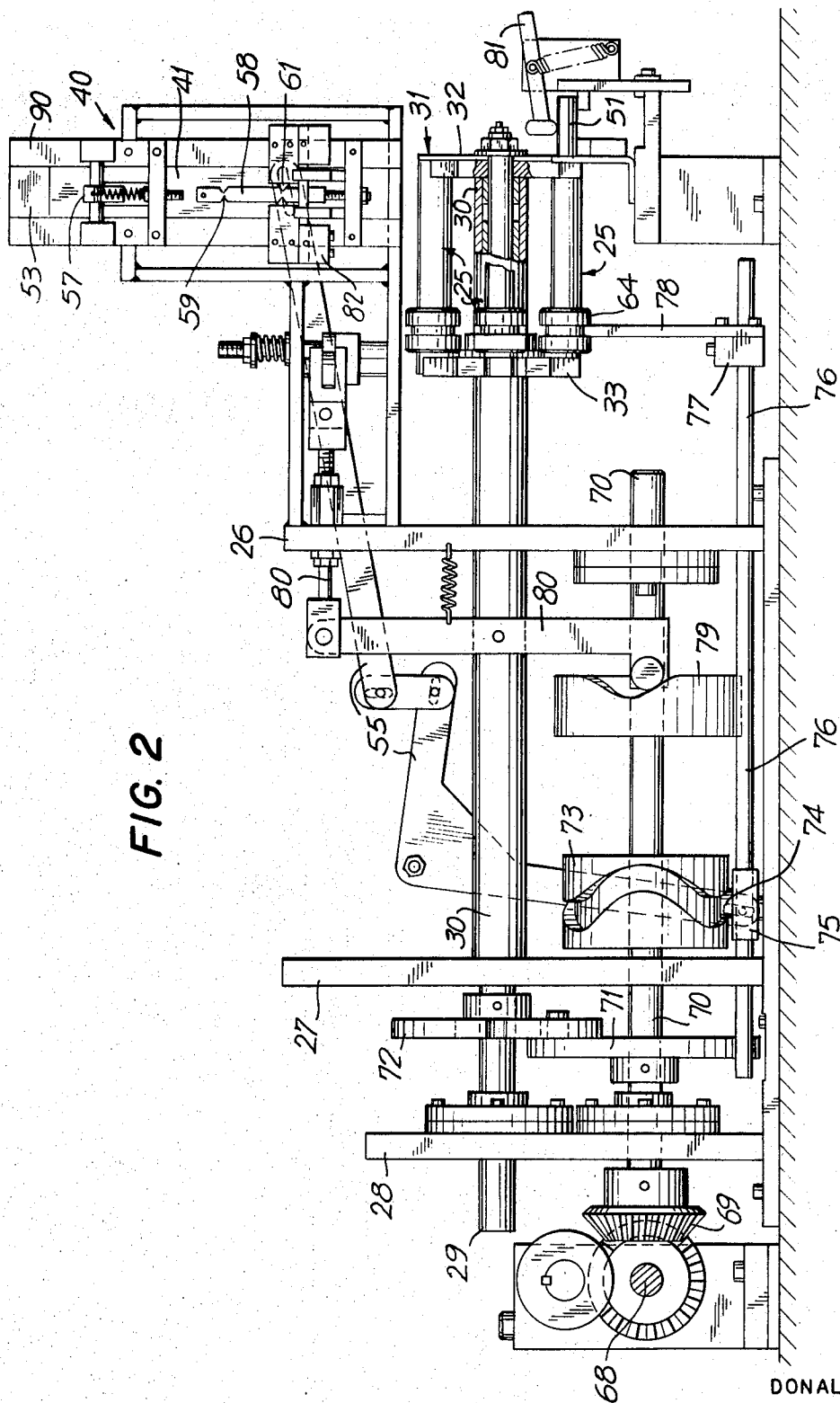


FIG. 1

INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY

FIG. 2



INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY

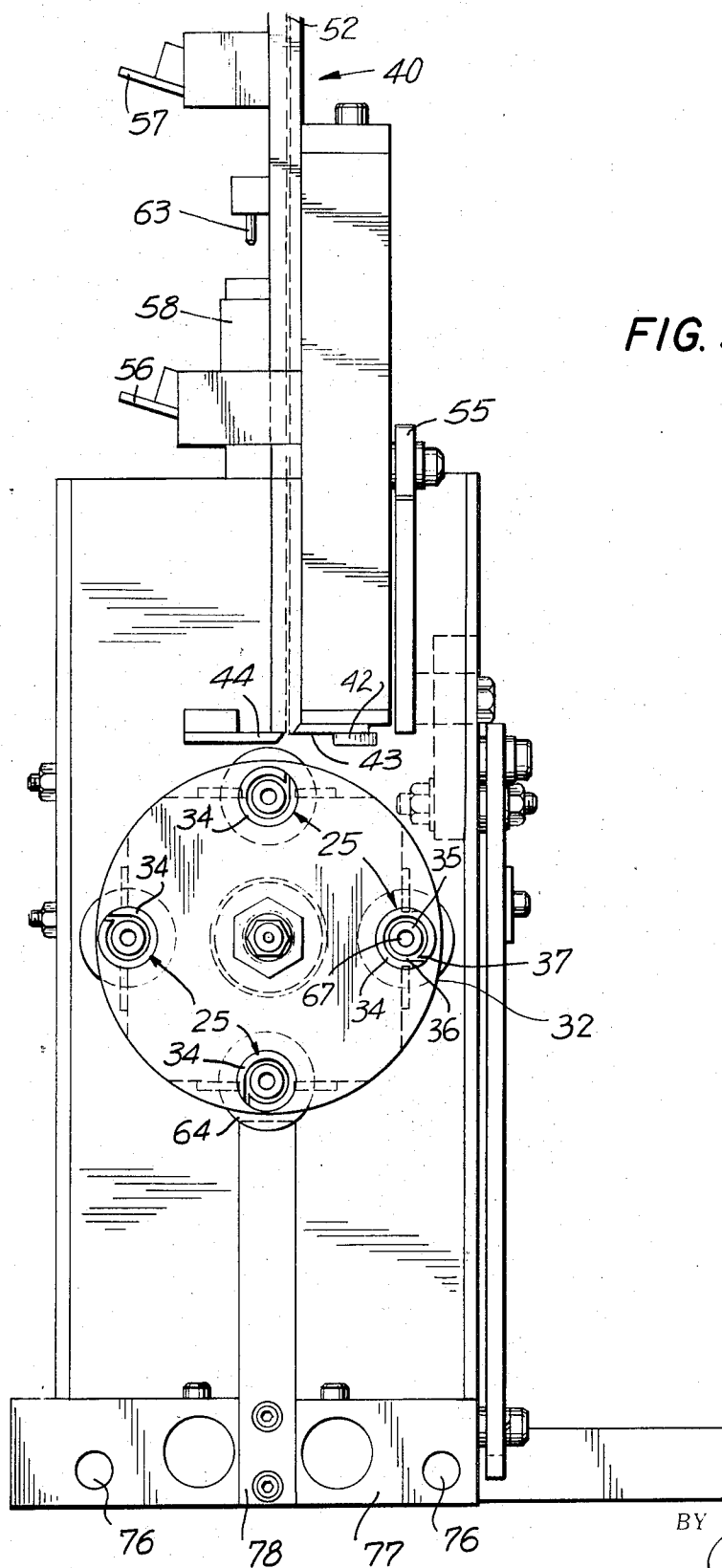


FIG. 3

INVENTOR.
DONALD R. TRASK

BY

Charles J. Metz
ATTORNEY

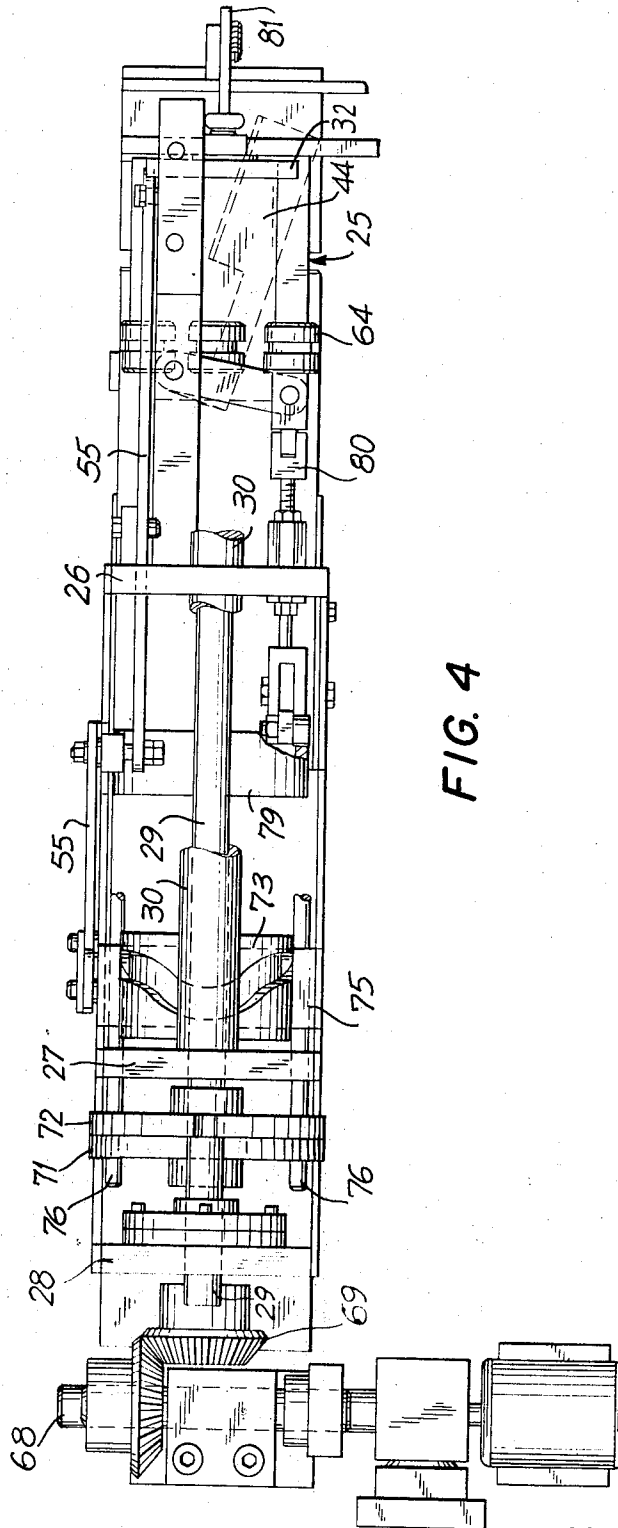
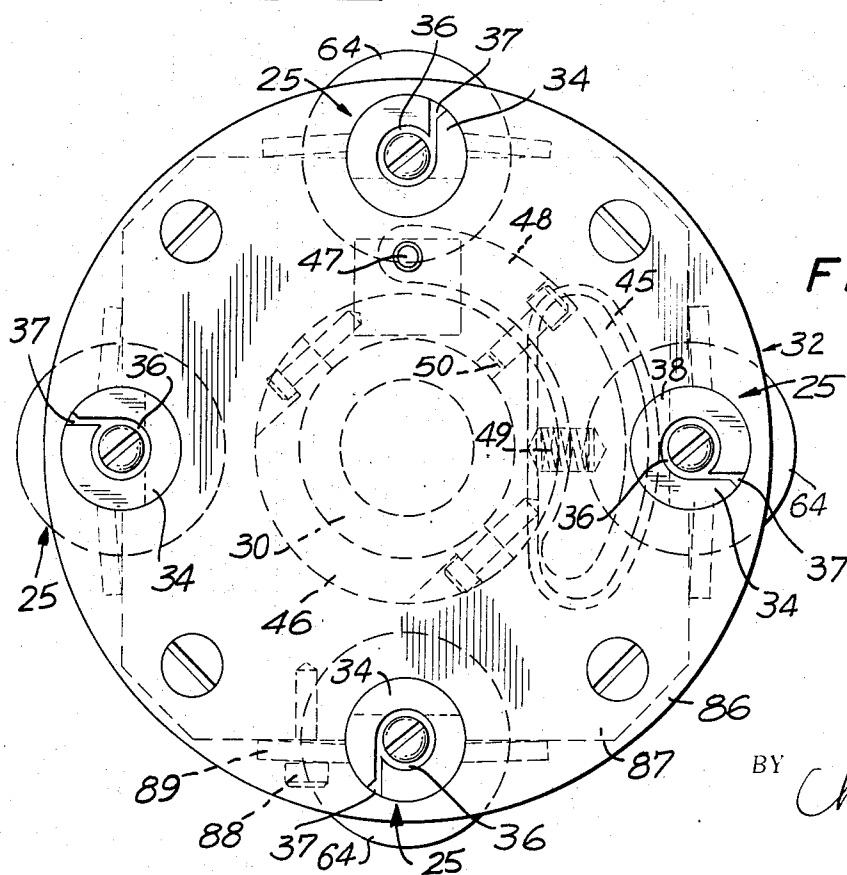
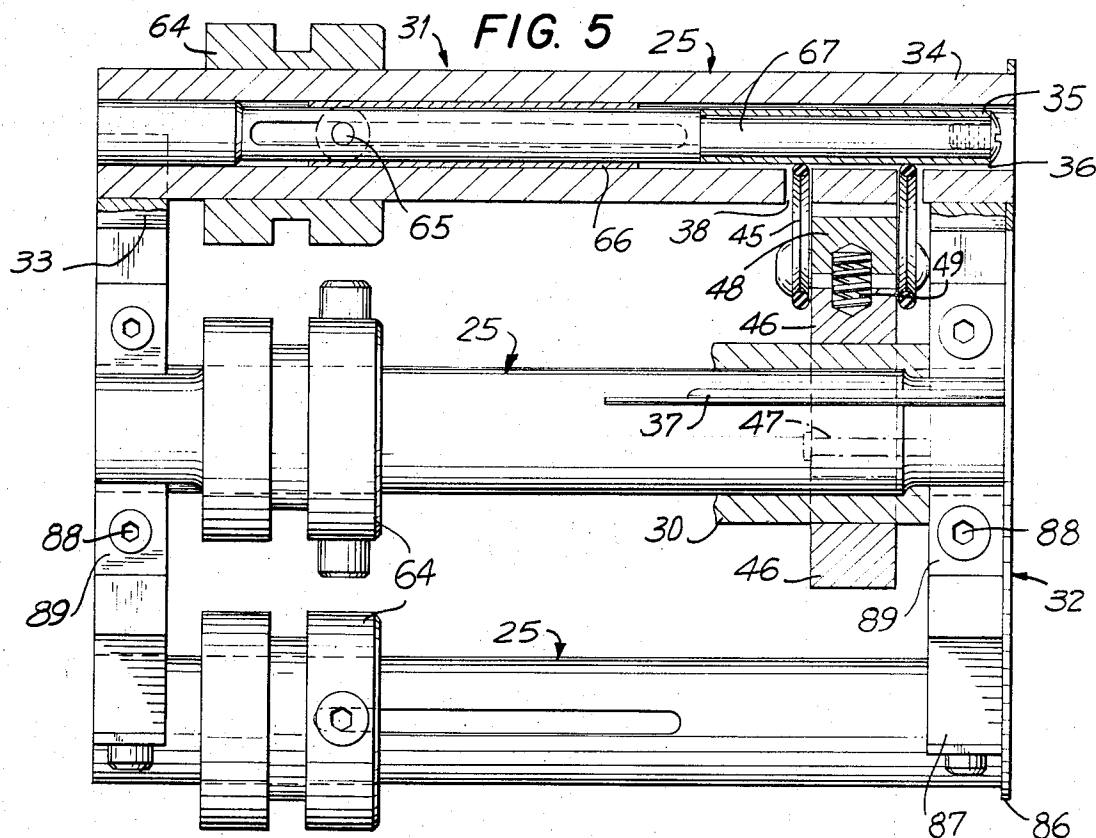


FIG. 4

INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY

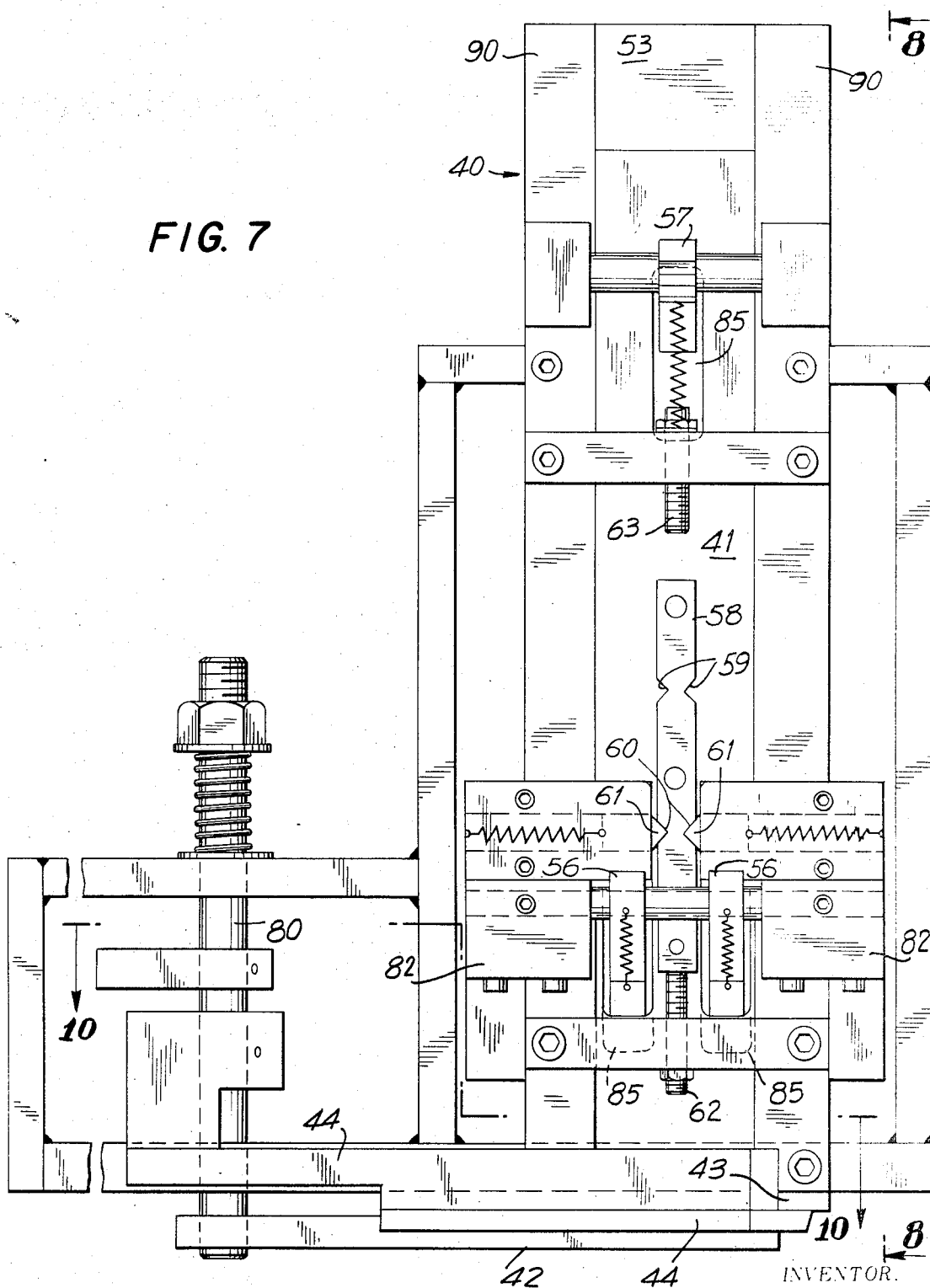


INVENTOR.
DONALD R. TRASK

BY

Charles J. Metz
ATTORNEY

FIG. 7



INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY

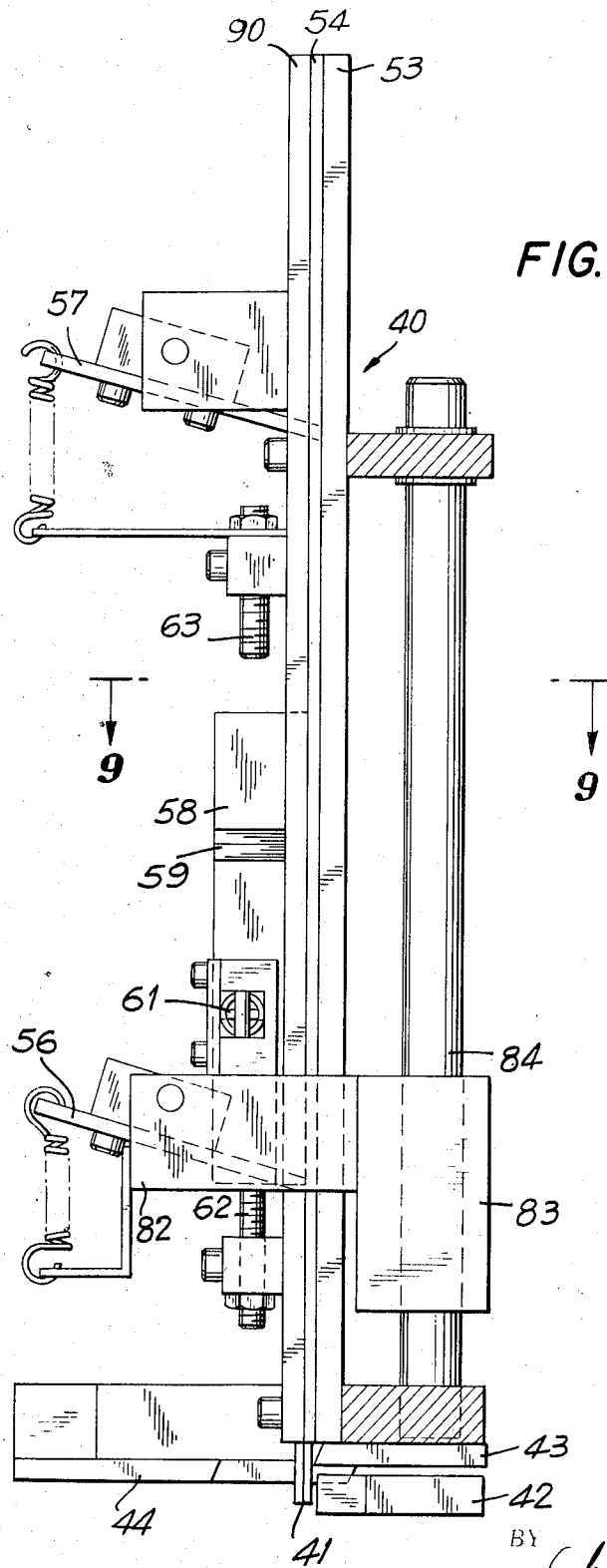


FIG. 8

INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY

FIG. 9

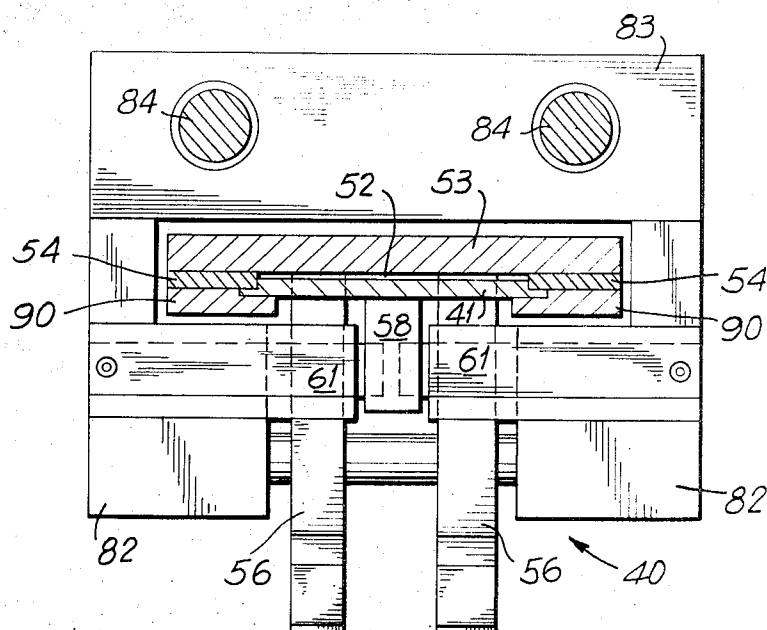
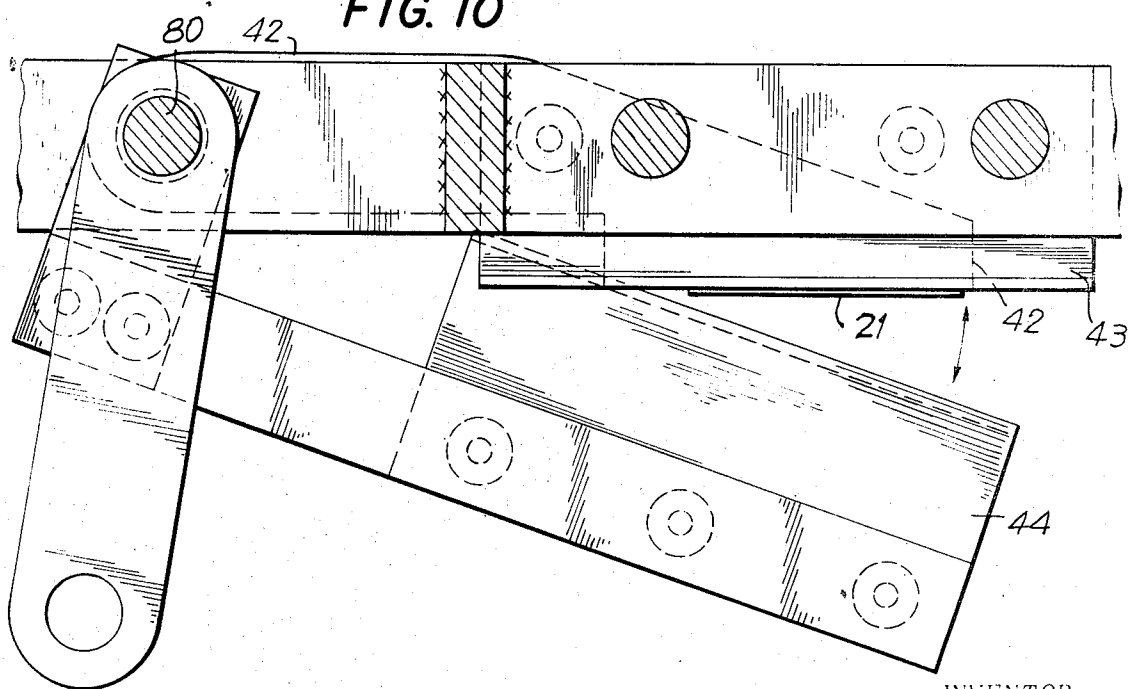


FIG. 10



INVENTOR.
DONALD R. TRASK

BY
Charles J. Metz
ATTORNEY

FIG. 11

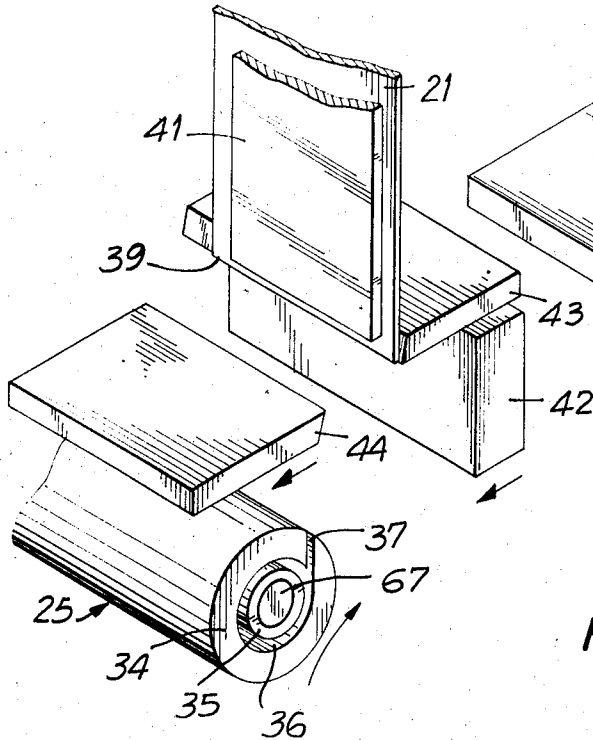


FIG. 12

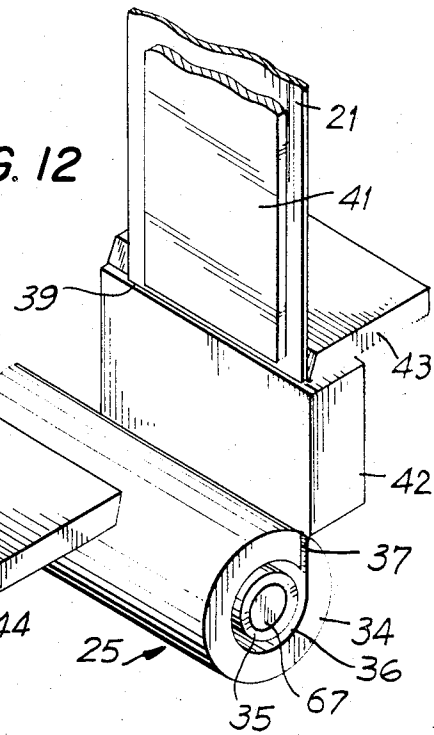


FIG. 14

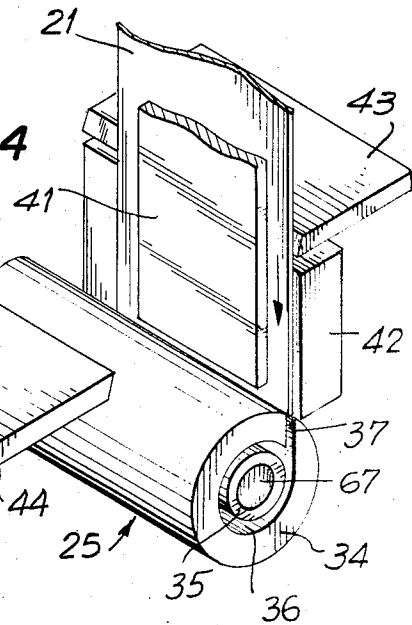
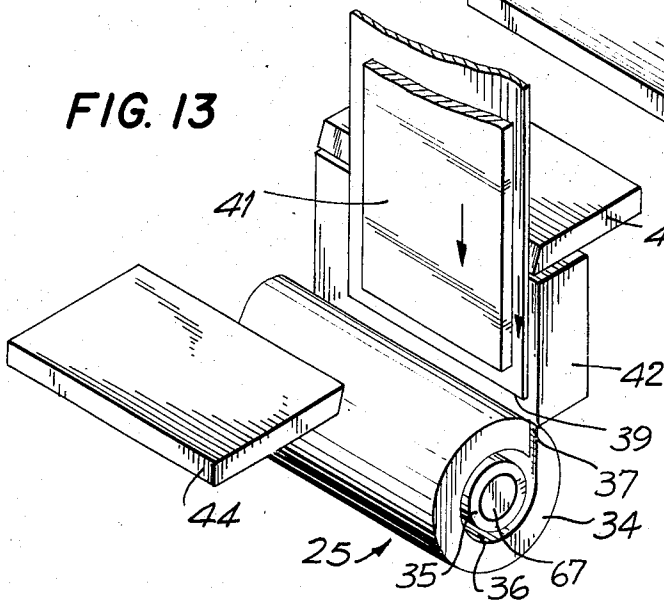
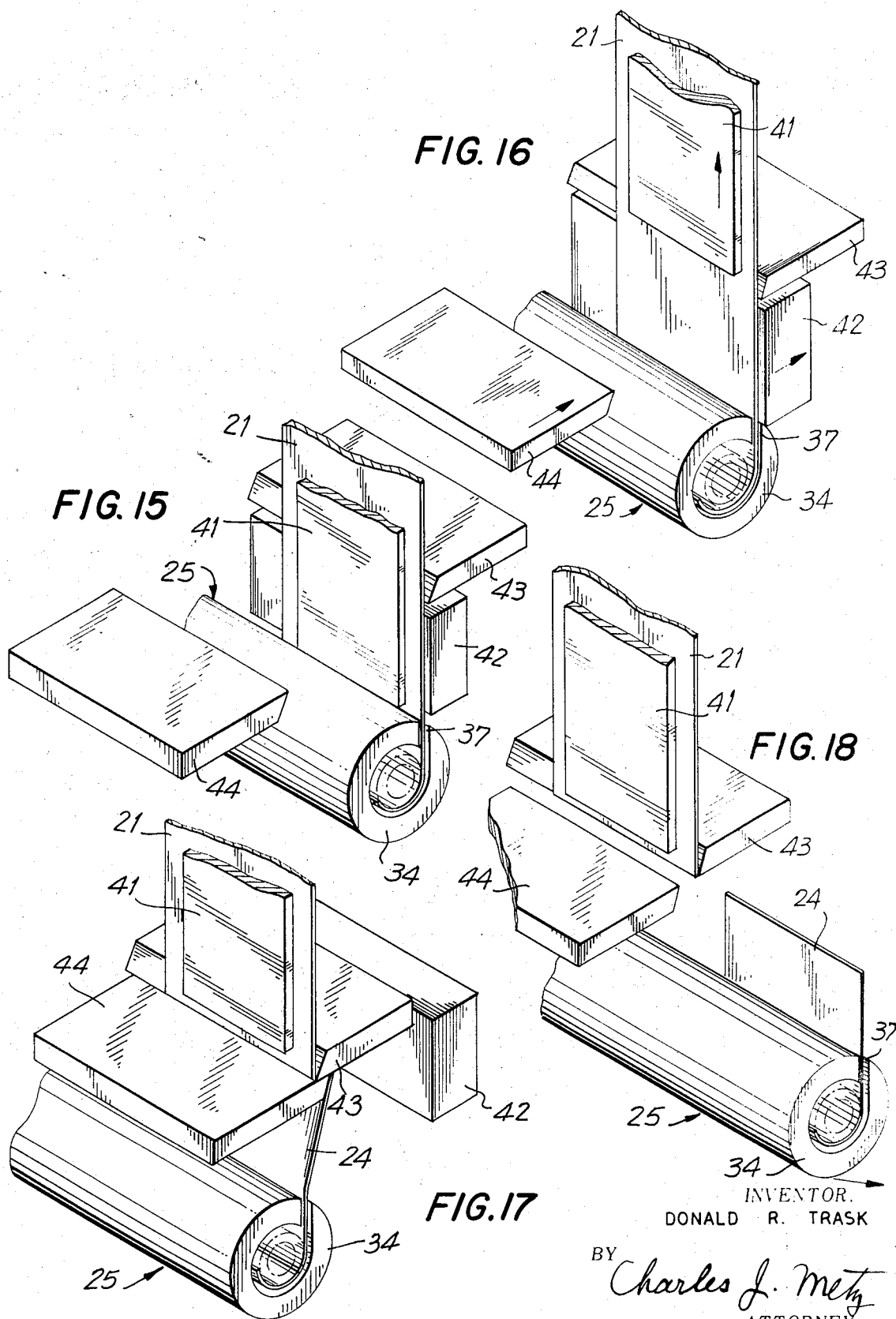


FIG. 13



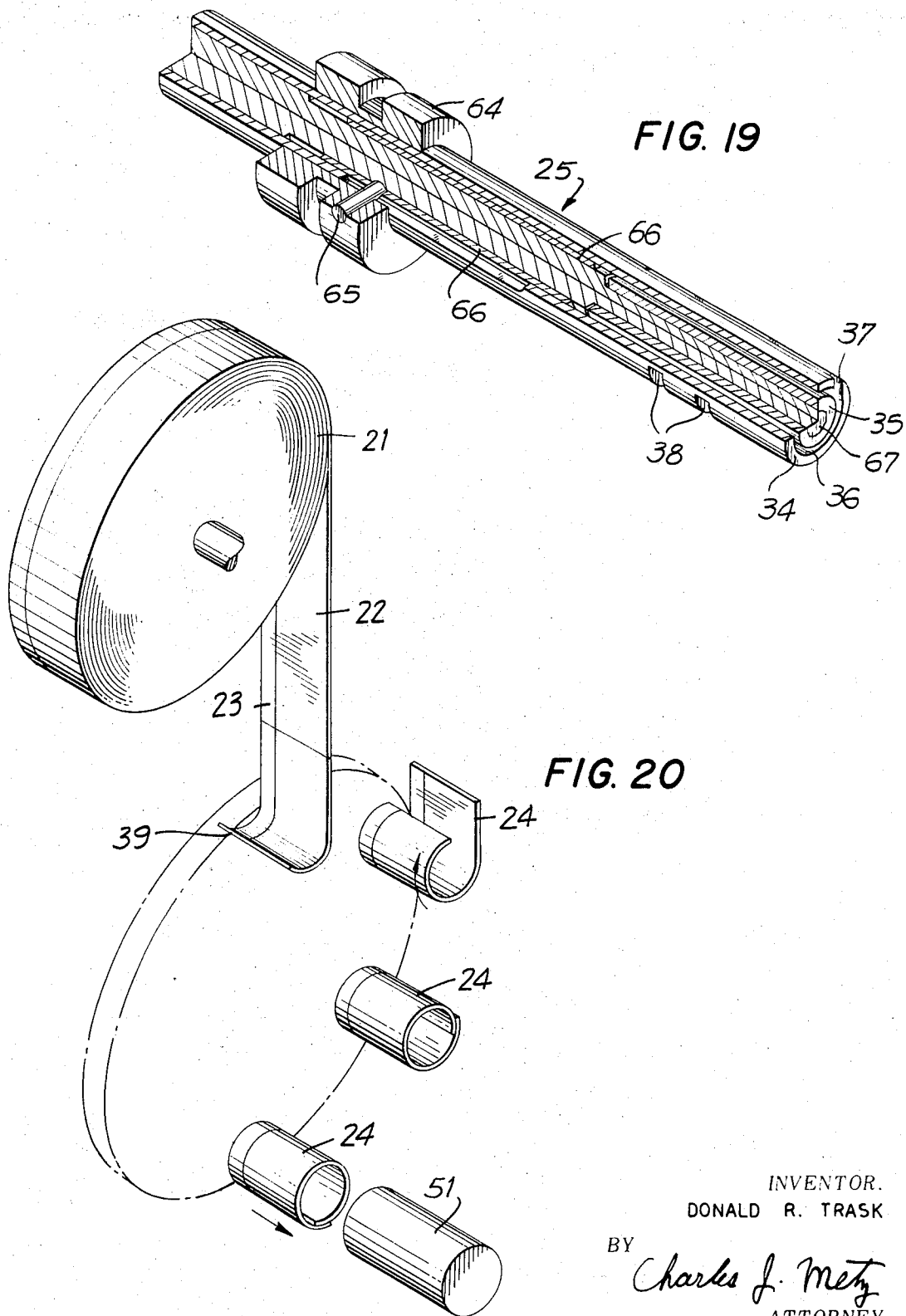
INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY



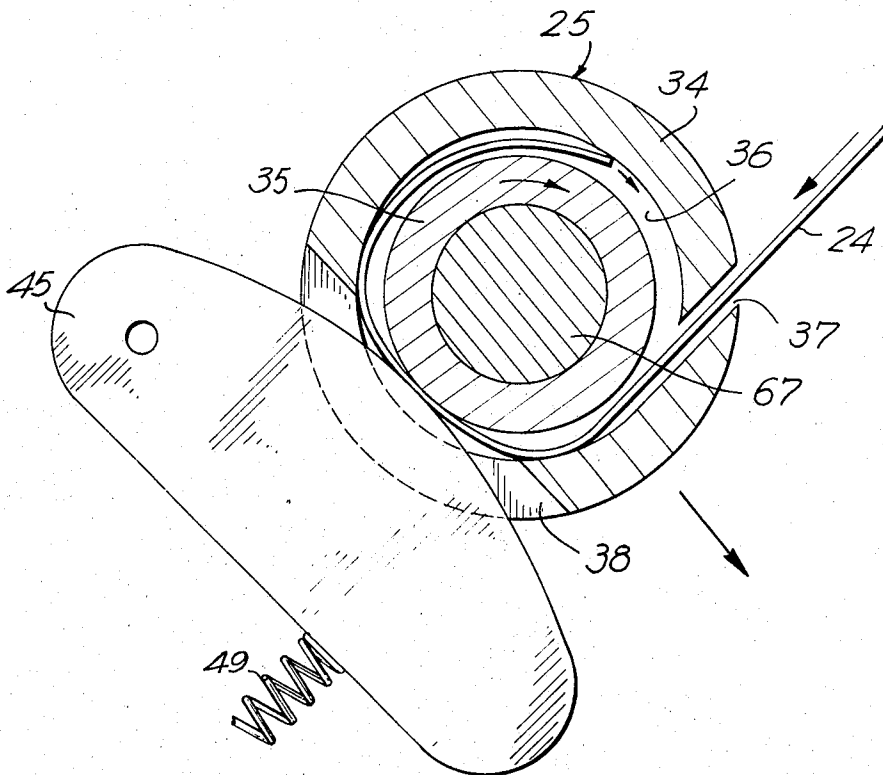
INVENTOR.
DONALD R. TRASK

BY *Charles J. Metz*
ATTORNEY



INVENTOR.
DONALD R. TRASK
BY
Charles J. Metz
ATTORNEY

FIG. 21



INVENTOR.
DONALD R. TRASK

BY

Charles J. Metz
ATTORNEY

APPARATUS FOR FORMING A CYLINDER

The invention relates to an apparatus for forming a cylinder, and more particularly, for forming a cylinder suitable for use as a separator liner in a battery can from strips of liner stock.

One known method and apparatus for forming cylindrical battery can separator liners out of flat strips of paper, and then inserting them into battery cans, are described by M. Orlando in U.S. Pat. No. 2,973,698. Briefly, the method of Orlando involves forming a continuous strip of liner paper into a cylindrical shape by curving the sides about the longitudinal axis of the strip of liner, inserting this cylinder into the battery can, and cutting the paper cylinder to the desired length. The method and apparatus of Orlando are useful if the liner is uniform from top to bottom in the cell. However, they are not suitable for the production and insertion of liners of the composite type in which a plastic film strip is joined to the upper portion of a paper liner — a type described in the application filed concurrently herewith in the name of Vicente S. Alberto and assigned to the same assignee as this application ("Galvanic Cell Having Improved Construction"; D-8573).

The present invention provides an improved apparatus for forming cylindrical paper separator liners which can then be inserted in battery cans. The cylindrical liners can have strips of plastic film extending circumferentially around the top and/or bottom thereof. The apparatus of this invention enables cylindrical battery can liners to be formed from a continuous length or roll of paper having a continuous strip of plastic film on at least one longitudinal edge.

It is an object of the invention to provide an improved apparatus for forming cylinders for continuous strips of flat liner stock.

It is another object of the invention to provide an improved apparatus for inserting cylindrical liners in battery cans.

It is a further object of the invention to provide an apparatus for forming cylindrical paper liners from continuous strips of liner stock having a continuous strip of plastic on at least one longitudinal edge, to form thereby cylindrical liners having a strip of plastic film extending circumferentially around the top and/or bottom.

In one embodiment, the apparatus of the invention includes a plurality of forming tubes mounted on a rotatable turret such that the forming tubes can be moved to position them sequentially at receiving and ejecting stations by rotating the turret. The forming tube includes a receiving chamber having an annular cross section. The receiving chamber is defined by the inner surface of an outer tubular member, and the outer surface of a central cylindrical member. At the receiving station a predetermined length of liner is partially inserted into said receiving chamber through a longitudinal slot in the outer tubular member. After the liner has been partially inserted in the receiving chamber, and thereby partially coiled or wound up, the turret is rotated to move the forming tube past at least one stationary friction member, such as a friction cam, which is arranged and constructed to extend through a transverse opening in the outer tubular member. The liner in the receiving chamber is caught between the stationary friction member and the central cylindrical member, and is wound up into cylindrical configuration as

the forming tube passes the stationary friction member. After the liner has been wound up into cylindrical configuration, it is ejected from the forming tube into a battery can.

The understanding of the invention is facilitated by reference to the drawings, in which:

FIG. 1 is a schematic, perspective view of an apparatus constructed in accordance with the principles of the invention;

FIG. 2 is a side elevational view of the apparatus of FIG. 1;

FIG. 3 is a front elevational view of the same apparatus;

FIG. 4 is a top plan view of the same apparatus;

FIG. 5 is a partially sectioned, top plan view of the turret assembly, showing the forming tube in greater detail;

FIG. 6 is a front view of the turret assembly;

FIG. 7 is a side elevational view of the paper liner feed assembly;

FIG. 8 is a partly sectional view taken along the line 8—8 in FIG. 7;

FIG. 9 is a partially cross-sectional view taken along the line 9—9 in FIG. 8;

FIG. 10 is a partially cross-sectional view taken along the line 10—10 in FIG. 7;

FIGS. 11 through 18 are fragmentary views of the same portion of the apparatus showing the forming tube, liner cutter, and lower part of the liner feed assembly at various stages in their cycle of operation;

FIG. 19 is a perspective view of the forming tube with part being broken away and shown in cross section to illustrate its construction in greater detail;

FIG. 20 is a schematic view showing the liner at various stages in the operation of the apparatus; and

FIG. 21 is a cross-sectional, partially schematic view of the forming tube and friction cam, illustrating the operation of winding the liner into cylindrical configuration.

Referring first to FIG. 20, the various stages in the formation of the paper liner using the apparatus of the invention are shown. A coil of liner stock 21 is provided as the source from which liner is fed into the apparatus. The liner stock 21 is composed of a continuous strip of paper 22 bonded, as by heat sealing, to a continuous strip of plastic film 23. At a receiving station, the liner stock 21 is partially fed into a forming tube (FIG. 19), and is cut to the proper length. The cut liner 24 is then rolled up into a cylinder as the forming tube is moved away from the receiving station. Subsequently, at an eject station the rolled up cylindrical liner 24 is ejected from the forming tube into a battery can 51.

In FIGS. 1 through 4, an apparatus constructed in accordance with the principles of the invention is shown. The apparatus includes front, middle, and rear vertical frame members 26, 27 and 28, respectively (see FIG. 2). A turret shaft 29 extends from the rear of the apparatus through the rear, middle, and front vertical frame members 28, 27, and 26 to the front of the apparatus. The turret shaft 29 is enclosed in a stationary sleeve 30 mounted between the middle and front vertical frame members 27 and 26, and extends to the front of the apparatus. At the front of the turret shaft 29, there is mounted a rotatable turret, which is indicated generally as 31. The turret 31 is shown in greater detail in FIGS. 5 and 6. The rotatable turret 31 includes a front turret

plate 32 which is operatively connected to the turret shaft 29, and a rear turret plate 33, which is rotatably mounted on the stationary sleeve 30. As is shown in FIGS. 5 and 6, the front turret plate 32 is composed of a face plate 86 and a mounting plate 87. Four cylindrical forming tubes, shown generally as 25, are mounted on the turret 31, and extend from the rear turret plate 33 to the front mandrel plate 32. The forming tubes 25 are attached to the turret plates 32 and 33 by conventional means, as by bolts 88 and hold down plates 89.

As is best shown in the view of FIG. 19, the forming tubes 25 have an outer tubular member 34 having an annular cross section. Included within the outer tubular member 34 is a sleeve 35, which is rotatably mounted on a central mandrel 67 that extends the entire length of the forming tube 25. The inner surface of the outer tubular member 34 is spaced apart from the outer surface of the sleeve 35, so as to define a receiving chamber 36 having an annular cross section between the outer tubular member 34 and the sleeve 35. The mandrel 67, sleeve 35, receiving chamber 36, and outer tubular member 34 are preferably, but not necessarily, concentric with each other and with the longitudinal axis of the forming tube 25. It is not necessary that the mandrel 67 have a rotatable sleeve around it as long as the mandrel 67 has a low friction surface such that the friction cams will be able to catch the liner and wind it up around the mandrel 67 into cylindrical configuration, as is more fully discussed hereinafter. The outer tubular member 34 has a longitudinal slot 37 extending through said member 34 and communicating with the receiving chamber 36. The longitudinal slot 37 is preferably tangential to said receiving chamber 36 as shown in the drawings so that the liner stock 21 being fed through said slot 37 into the receiving chamber 36 will extend down into the receiving chamber 36 on the desired side of the sleeve 35. The outer tubular member 34 also has a pair of spaced transverse openings 38 which extend through said outer tubular member 34 and communicate with the receiving chamber 36.

In FIGS. 11 through 18, the several stages in the liner feeding operation are shown. The alignment of the various parts prior to the feeding operation is shown in FIG. 11. In FIG. 11, the forming tube 25 is moving into receiving position at a receiving station such that the longitudinal slot 37 is directly below the leading edge 39 of a continuous strip of liner stock 21, as is shown in FIG. 12. The liner stock 21 extends downwardly through a liner feed assembly 40. The other principal parts involved in the liner feeding operation include a guide plate 41, a guide bar 42, a stationary cutter blade 43, and a movable cutter blade 44. As the forming tube 25 is indexed into receiving position below the leading edge 39 of the liner stock 21, the guide bar 42 is advanced into the position shown in FIG. 12, and the movable cutter blade 44 is retracted. The guide plate 41 and liner stock 21 then begin to descend, as is shown in FIG. 13. The leading edge 39 of the liner stock 21 is guided into the longitudinal slot 37 by passing between the guide plate 41 and the guide bar 42. The guide plate 41 stops descending when it reaches the position shown in FIG. 14. The liner 21 continues its descent until the liner 21 has been inserted at least to an extent (FIG. 15) such that the cut liner 24 will be engaged by the friction cams (discussed below) when the forming tube 25 is moved past them. Then, as is shown in FIG. 16, the guide plate 41 ascends to its uppermost

position and the movable cutter blade 44 begins its stroke. As the movable cutter blade 44 begins its stroke, the guide bar 42 retracts and is fully retracted by the time the movable cutter blade 44 engages the stationary cutter blade 43 and shears the liner stock 21 into a liner 24 of a predetermined length (FIG. 17). After the liner 24 has been cut to the desired length, the forming tube 25 indexes away from the receiving station (FIG. 18).

After the forming tube 25 has received the lead portion of the predetermined length of liner 24 at the receiving station, the turret 31 is rotated in a clockwise direction (looking at FIGS. 1 and 6) such that two friction cams 45 reach through the spaced transverse openings 38 in the outer tubular member 34 of the forming tube 27. As the forming tube 25 moves past the friction cams 45, the liner 24 in the receiving chamber 36 is caught between the friction cams 45 and the sleeve 35, and is thereby rolled up into a cylinder. This operation is shown schematically in FIG. 21.

As is more particularly shown in FIGS. 1, 5 and 6, the friction cams 45 are mounted on the stationary sleeve 30 behind the front turret plate 32 in such a position that they line up with the spaced transverse openings 38 in the outer tubular member 34 of the forming tube 25. The friction cams 45 are attached to the stationary sleeve 30 by a pair of split collars 46. The cams 45 are pivotally attached to the split collars 46 at a pivot point 47 by a pivot mounting arm 48. The cams 45 are spring loaded outwardly by a spring 49 to press against the liner 24 and sleeve 35 in the forming tube 25. A stop 50 is provided to prevent the friction cams 45 from pivoting outwardly too far when they are not engaging a liner 24 in one of the forming tubes 25.

After the forming tube 25 has been moved past the friction cams 45, the liner 24 in the receiving chamber 36 is completely rolled up into a cylinder. The turret 31 is then rotated clockwise so that the forming tube 25 is indexed to an eject station where the cylindrical liner 24 is ejected from the forming tube 25 into a cylindrical battery can 51 (having a diameter larger than the liner 24), as is shown in FIGS. 1 and 20. The method of ejection of the liner 24 will be discussed in more detail below. Battery cans 51, into which the liners 24 are inserted, are indexed into receiving position at said eject station by conventional conveying means. The battery cans 51 are held in receiving position at the eject station by the spring loaded clamp 81 shown in FIG. 2.

The liner stock 21 is fed through the liner feed assembly 40 into the forming tube 25. The operation of the liner feed assembly 40 is shown most clearly in FIGS. 7, 8, and 9. The liner stock 21 is fed into the paper feed assembly 40 through a feed channel 52 (FIG. 9). The feed channel 52 is described by a back plate 53, the guide plate 41, and a pair of side guide strips 54. The side guide strips 54 and front guide plate 41 are held in position by a pair of retaining strips 90. A portion of the liner feed assembly 40 is adapted to reciprocate vertically in response to the motion of the paper feed assembly linkage 55 (see FIGS. 1-4). The operation of which is explained below. This vertically reciprocating portion includes feed gripping fingers 56 which are spring loaded to pull the liner stock 21 downwardly when the feed gripping fingers 56 descend, but which are constructed so as to slide over the liner stock 21 when the fingers 56 ascend. A stationary upper gripping finger 57, is spring loaded so as to permit the liner stock 21

to slide downwardly when the liner stock 21 is pulled downwardly by the feed gripping fingers 56, but to prevent the liner stock 21 from moving upwardly when the feed gripping fingers 56 are ascending. The feed gripping fingers 56 and the upper gripping finger 57 extend through vertical slots 85 (FIG. 7) in the guide plate 41 to gain access to the feed channel 52 and engage the liner stock 21.

The guide plate 41 is constructed so as to reciprocate vertically during the same cycle as the feed gripping fingers 56, but through a shorter stroke. The guide plate 41 has a vertically oriented slide bar 58 integrally fastened on the front of the guide plate 41. There are a pair of opposed upper notches 59 and a pair of opposed lower notches 60 in the sides of the slide bar 58. The two pairs of notches 59 and 60 engage a pair of opposed spring loaded drive teeth 61, which are arranged and constructed to reciprocate vertically with the same cycle and stroke as the feed gripping fingers 56. At the beginning of the downward stroke of the feed gripping fingers 56, the drive teeth 61 are meshed with the upper notches 59, and drive the slide bar 58 (and hence the guide plate 41) downwardly with the feed gripping fingers 56. The downward motion of all of these parts continues until the slide bar 58 strikes a lower stop 62, which prevents the slide bar 58 and guide plate 41 from descending further. At this point, the guide plate 41 is in its fully descended position as shown in FIG. 14. The feed gripping fingers 56, however, continue to descend to continue feeding the liner stock 21 until the liner stock 21 is inserted in the forming tube 25 to the extent shown in FIG. 15. The spring loaded drive teeth 61 disengage from the upper notches 59 and slide down the sides of the slide bar 58, until the teeth 61 engage the lower notches 60, at the bottom of the stroke of the feed gripping fingers 56. The feed gripping fingers 56 and the drive teeth 61 then begin their upward motion, and the slide bar 58 and guide plate 41 are carried upward until the slide bar 58 strikes an upper stop 63. The feed gripping fingers 56 and drive teeth 61 continue their upward motion, as the drive teeth 61 disengage from the lower notches 60 and slide over the sides of the slide bar to the upper notches 59, at which point the uppermost part of the cycle is reached. The cycle then repeats itself, as the next length of liner stock 21 is feed into the next forming tube 25.

The feed gripping fingers 56 and the spring loaded drive teeth 61 are both attached to a pair of side blocks 82, as shown in FIGS. 7 and 8. The side blocks 82 are attached to a back block 83, which (as is shown in FIG. 8) slides up and down on a pair of guide rods 84. Thus, this whole assembly reciprocates vertically as a unit in response to the motion of the liner feed assembly linkage 55 (discussed below).

To summarize the operation of the liner feed assembly 40, when the feed gripping fingers 56 move downwardly, they pull the liner stock 21 with it, and also the guide plate 41 is moved into place to guide the leading edge 39 of the liner stock 21 through the longitudinal opening 37 into the receiving chamber 36.

The means for ejecting the rolled up liner 24 from the receiving chamber 36 into the battery can 51 at the eject station is shown most clearly in FIGS. 1, 2, 5 and 19. The forming tube 25 includes an eject bushing 64, eject drive pin 65, and an eject sleeve 66, which are normally positioned behind the receiving chamber 36, as shown in FIG. 19. The liner 24 is ejected by a forward

movement of the eject sleeve 66, which slides into the receiving chamber 36 all the way to the front of the forming tube 25. The eject sleeve 66 is driven by the eject bushing 64 through the eject drive pin 65. The eject bushing 64 is driven by means that will be explained below. After the liner 24 has been ejected into the battery can 51, the eject sleeve 66 is retracted into the position shown in FIG. 19.

The several operations that are described above can be driven and synchronized by conventional means. For instance, as is shown in FIGS. 1 and 4, the apparatus of the invention can be driven from the main drive shaft 68 of a conventional cell assembly machine. Such conventional machines are described, for instance, by M. Orlando et al, in U.S. Pat. No. 2,962,844. The power for driving the apparatus of the invention can be taken from the main drive shaft 68 through a bevel gear set 69. The bevel gear set 69 drives an input shaft 70. The input shaft 70 turns a Geneva driver 71, which in turn drives a conventional Geneva driven member 72. Alternatively, any other conventional type of indexing mechanism can be used in place of the Geneva gear set. The Geneva driven member 72 revolves the turret shaft 29, which in turn revolves the rotatable turret 31.

The input shaft 70 also revolves a slide cam 73. The slide cam 73 engages a cam follower 74 on a cam block 75 which, through an appropriate linkage 55, operates the paper feed assembly 40. The cam block 75 is also operatively connected by a pair of rods 76 to an ejector block 77, which has a vertical engaging member 78 for engaging the eject bushing 64 on the forming tube 25 to move the eject bushing 64 back and forth to effect the liner eject operation, as explained above.

The input shaft 70 also rotates a cutter cam 79. The cutter cam 79 operates the movable cutter blade 44 and the guide bar 42 through a suitable cutter linkage 80.

To briefly summarize, the power to drive the apparatus can come from the main cam shaft of a cell assembly machine. This main drive shaft, through appropriate gears, drives an input shaft, which powers all of the operations of the apparatus. First, the interrupted rotation of the turret is driven from the input shaft by way of a Geneva drive or other similar indexing mechanism. The input shaft also drives cam shafts to operate the liner feed, liner cutting, and liner ejecting operations.

An apparatus embodying the principles of the invention has been described. The apparatus is an assembly that can be attached to a conventional assembly machine at the liner loading station. The apparatus includes means for feeding predetermined lengths of liner into a forming tube. The forming tube is mounted on a rotatable turret that is adapted to index the forming tube to a receiving station, to move it from the receiving station to a second station, and to index the tube to a liner eject station. The forming tube includes an outer tubular member and a central mandrel inside of and concentric with the outer tubular member. In the front portion of the forming tube, the mandrel has a sleeve rotatably mounted thereon. There is a space having an annular cross section between the outer surface of the sleeve and the inner surface of the outer tubular member. This space is the receiving chamber. The outer tubular member has a longitudinal slot communicating with the receiving chamber and tangential therewith. The outer tubular member also has a pair of

spaced transverse openings communicating with the receiving chamber.

While the forming tube is positioned at the receiving station, a predetermined length of liner is partially inserted in the receiving chamber through the longitudinal slot in the outer tubular member. After the front portion of the liner is inserted in the receiving chamber, the turret is rotated to move the forming tube past a pair of friction cams that line up with the said transverse openings. The friction cams extend through the transverse openings and engage the liner and sleeve. The liner is caught between the friction cams and the sleeve, and is rolled up into a cylinder as the forming tube moves past the friction cams.

In the next step, the forming tube is indexed to an eject station, and the liner is ejected from the forming tube into a battery can that has been indexed into a receiving position at the eject station. The forming tube is then indexed back to the receiving station to start the cycle again.

While the apparatus has been described as being used to form a cylinder out of flat paper battery liner stock, it could be used to form cylinders from other materials such as metal foil, plastic films, sheeting, fabric, or other cylinder forming material. Other changes can be made without departing from the spirit and scope of the invention, as defined by the following claims:

What is claimed is:

1. An apparatus for forming a cylinder, which includes:

a forming tube having a longitudinal axis and a receiving chamber having an annular cross section, said receiving chamber being defined by the inner surface of an outer tubular member and the outer surface of a central cylindrical member, wherein said outer tubular member has a longitudinal slot substantially parallel to said longitudinal axis and communicating with said receiving chamber, and wherein said outer tubular member has at least one transverse opening communicating with said receiving chamber, said transverse opening being substantially perpendicular to said longitudinal axis;

means for indexing said forming tube to a receiving station, and means for inserting the leading edge of a predetermined length of cylinder forming material through said longitudinal slot into said receiving chamber while said forming tube is in receiving position at said receiving station;

means for moving said forming tube past at least one friction element which is constructed to extend through said transverse opening to engage said material whereby said material is caught between said friction element and said central cylindrical member and is rolled up into cylindrical configuration as said forming tube is moved past said friction element; and

means for moving said forming tube to an eject station where said material that has been rolled up into cylindrical configuration is ejected from said forming tube.

2. The apparatus of claim 1 wherein said forming tube is mounted on a rotatable turret.

3. The apparatus of claim 2 wherein said rotatable turret has a plurality of forming tubes mounted thereon.

4. The apparatus of claim 1 wherein said central cylindrical member has a rotatable surface.

5. The apparatus of claim 1 wherein said outer tubular member, said receiving chamber, and said central cylindrical member are concentric.

6. The apparatus of claim 1 wherein said means for inserting the leading edge of said predetermined length of cylinder forming material through said longitudinal slot into said receiving chamber includes:

a feed channel having a front, back, two sides, and an outlet;

means for feeding said material through said feed channel in increments equal to said predetermined length;

means for guiding the leading edge of said material into said longitudinal slot as said leading edge emerges from said outlet; and

means for cutting said material into lengths equal to said predetermined length.

7. The apparatus of claim 6 wherein said means for guiding said leading edge of said cylinder forming material into said longitudinal slot includes:

a guide plate comprising the front of said feed channel and adapted to reciprocate between a first position and a second position, wherein said guide plate moves from said first position to said second position during at least part of the time that said material is moving through said feed channel, and wherein said guide plate guides the leading edge of said material into said longitudinal slot when said guide plate is in the second position.

8. The apparatus of claim 7 wherein the means for cutting said material into lengths equal to said predetermined length comprises a movable cutter blade and a stationary cutter blade, the stationary cutter blade being adjacent to said outlet, wherein the movable cutter blade is adapted to reciprocate in a direction transverse to the direction of movement of said material through said feed channel, and to cut said material by engaging said stationary cutter blade.

9. The apparatus of claim 8 wherein said means for guiding said leading edge of said material into said longitudinal slot includes a guide member having a guiding surface, said guide member being positioned at a guiding position adjacent to said longitudinal slot when said forming tube is in receiving position at said receiving station, whereby said leading edge of said material is guided into said longitudinal slot by passing between said guide plate and said guiding surface of said guide member.

10. The apparatus of claim 9 wherein said guide member is adapted to retract from said guiding position when said movable cutter blade engages said stationary cutter blade to cut said material.

11. The apparatus of claim 10 wherein said apparatus contains a plurality of forming tubes mounted on a rotatable turret, and wherein said central cylindrical member has a rotatable surface.

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