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(54) Compact form-fill-seal machine for automatic production of sealed packages with improved transverse cutting mechanism.

(57) A compact form-fill-seal machine for producing sealed cups and other sealed package structures, including dispenser packages for flowable substances having a fault line extending over a stress concentrating protrusion member, and including a new and improved transverse cutting mechanism.

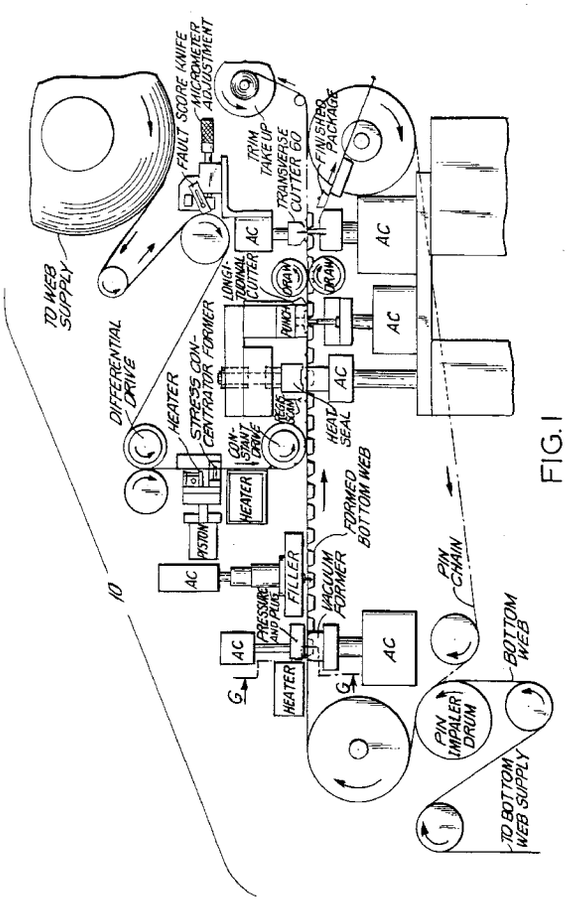

FIG. 1

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The form-fill-seal machine structures disclosed in this patent application represent improvements of or improved additions to the structures disclosed in Redmond U.S. Patent No. 4,819,406, issued April 11, 1989, the disclosure of which is hereby incorporated hereinto by reference.

The present invention relates generally to form-fill-seal machines and, more particularly, to certain new and useful improvements in the manufacture of such machines in an unusually compact size capable of producing sealed cups and other sealed package structures with increased efficiency.

"Form-fill-seal" is the generic name for a type of machine used to produce thermoformable plastic containers which hold a variety of products (i.e. condiments, epoxy mixes, shaving gels, dental products, nuts, bolts, bandages, tapes, machine parts, etc.). In operation, a first thermoformable plastic web is indexed (in most cases, intermittently) to a heating station where the web is brought to forming temperature and then indexed to a forming station where the heated web is drawn by vacuum or pressed by air pressure, or both, either over or into one or more forming dies to thereby form the web into the desired configuration, usually a cup-like cavity. Once the desired cup-like formations are made in the web, the web is advanced to a filling station where the cup formations are filled with a predetermined amount of product.

Simultaneous with the formation and filling of the cup-like formations in the first web, a second upper web, often containing a printed pattern which requires registration with the first web, will be brought into parallel proximity over the first web and then indexed simultaneously in printed register therewith to a sealing station. At the sealing station, retractable heated sealing dies clamp and seal the lower web to the upper web. The sealing dies then withdraw from the sealed web structure to permit further indexing of the sealed packages to a cutting station where the individual packages are cut from the web structure and delivered to a packing or loading station.

In general, previously known form-fill-seal machines for packages are large, unwieldy, and extremely expensive. For example, a widely used machine for producing plastic cups of butter, margarine and the like is approximately 25 ft. long, costs in the neighborhood of $800,000-$1,200,000, including collating apparatus, yet only produces on the order of 500 cups per minute of 5-gram size.

The Redmond U.S. Patent No. 4,819,406 (hereinafter the 406 patent) discloses a new and improved form-fill-seal machine for automatically producing filled and sealed cups or other package structures which is more compact in size, on the order of only 10 ft. long, including collating apparatus (which does not form a part of the present invention), and produces package structures more efficiently (on the order of about 2:1) and more economically (at least about 50% cost savings) than previously known machines.

While the machine described in the Redmond 406 patent was designed to handle a broad range of plastic web materials, co-extrusions, and laminations, it was found that the guillotine-type knife blades used to separate the individual packages had a high incidence of breakage when cutting packages made of particularly tough materials such as polyester having a sealed web thickness of about 15 mils and higher. The cost of replacing the cutting blades and the resultant machine downtime added a good deal of expense to the cost of producing the packages.

It is therefore an object of the present invention to provide a new and improved machine for automatically producing filled and sealed cups or other package structures.

It is another object of the invention to provide a new and improved machine for automatically producing filled and sealed cups or other package structures which is more compact in size and produces package structures more efficiently than previously known machines.

It is still another object of this invention to provide a new and improved machine for automatically producing filled and sealed cups or other package structures which is unexpectedly cheaper to manufacture than previously known machines and yet has approximately equal production capabilities.

It is yet a further object of the invention to provide a new and improved machine for automatically producing filled and sealed cups or other package containers employing a new cutting mechanism and method for separating the individual packages from the sealed web material which substantially increases the useful life of the cutting blades, and reduces the incidence of blade breakage and resultant machine downtime associated with the cutting of tough web materials such as polyester, and General Electric's heat resistant polystyrene marketed under the tradename "Noreal".

The foregoing specific objects and advantages of the invention are illustrative of those which can be achieved by the present invention and are not intended to be exhaustive or limiting of the possible advantages which can be realized. Thus, these and other objects and advantages of the invention will be apparent from the description herein or can be learned from practicing the invention, both as embodied herein or as modified in view of any variations which may be apparent to those skilled in the art. Accordingly, the present invention resides in the novel parts, constructions, arrangements, combinations and improvement herein shown and described.

Briefly described, the present invention relates to a form-fill-seal machine for producing sealed cups and other sealed package structures, including dispenser packages for flowable substances having a

fault line extending over a stress concentrating protrusion member.

According to one specific aspect of the invention, a bottom thermoformable plastic web continuously intermittently indexed by a pair of pin chains is indexed to a heating station where it is brought to forming temperature and thereafter indexed to a forming station which has one or more female forming dies each having a cup-like configuration. At the forming station, the heated bottom web member is continuously clamped about its periphery, and is drawn via vacuum or air pressure into the female dies to form cup-like pocket formations in the bottom web.

As here embodied, the forming dies and clamping mechanism are retractably mounted, and once the cup-like pocket formations are formed in the bottom web, the dies retract downwardly while the clamping mechanism rises, thereby enabling the formed web to advance to a filling station where a filler mechanism delivers a pre-determined amount of product into each cup-like pocket formation.

Simultaneous with the forming and filling of the bottom web, an upper web member is brought by means of a differential drive roller and a constant drive roller into parallel proximity with the formed bottom web. The top web is thereafter indexed simultaneously with the bottom web, in printed register, where necessary, to a sealing station. At the sealing station, retractable heated sealing dies and a clamping mechanism seal the lower formed and filled web to the upper web to form a sealed web structure. After the sealing step, the sealing dies withdraw to permit further indexing of the sealed web structure.

As the top web member is being simultaneously indexed, it will pass via draw rollers through a series of blade members which score fault lines in the web member down the center of each individual package to be formed. Next, a series of diamond-shaped contact heaters impress a series of horizontal diamond-shaped areas on the top web member. Thereafter, a series of pyramidal punch presses force these diamond-shaped areas into a series of female dies creating a horizontal line of small pyramidal-shaped stress concentrating protrusions, with the fault lines passing through their centers.

According to another specific aspect of the invention, the sealed web structure is thereafter indexed to a punch station, where a series of hard steel punches and dies advantageously punch a suitably shaped hole in the web structure at the locations of the corners of the individual packages to be made, so that, after the cutting process, the packages will have rounded or bevelled corners.

To create individual packages from the sealed web structure, the present invention provides sequential longitudinal and transverse cutting mechanisms located downstream of the punch station. As here embodied, the longitudinal cutting mechanism preferably comprises a series of sharpened tungsten carbide blades which cut the formed packages into a series of longitudinal package rows. A set of upper and lower draw rollers provided just downstream of the longitudinal cutting mechanism aid the pin chains in pulling the web structure through the cutting blades.

According to another specific aspect of the invention, the transverse cutting mechanism is located downstream of the longitudinal cutting mechanism, and generally comprises a horizontally movable series of single-edged cutting blades vertically mounted to a sliding bearing member, which in turn is housed within a clamping assembly positioned above the web structure. As here embodied, the bearing member is connected to a first piston member which in turn is connected to a first air cylinder which actuates to drive both the bearing member and clamping assembly downward toward the web structure with each cycle of the machine.

According to the invention, the vertical cutting blades are mounted to a bearing block located within the sliding bearing member. The bearing block is connected via a rod member to a second piston which in turn is connected to a second air cylinder. According to the invention, an anvil member having a slot formed thereinto is disposed below the bottom web material and runs the length of the clamping assembly such that the cutting blades align with the anvil slot.

As the web structure exits the longitudinal cutting mechanism, it will be indexed forward into position below the clamping assembly such that the first set of punch holes formed in the web structure align with the vertical cutting blades. This will actuate the first air cylinder causing the first piston to move the clamping assembly downward to clamp the packages preceding the first set of punch holes to the anvil. The first piston will then move the sliding bearing to the bottom of the clamping assembly causing the vertical cutting blades to pass through the corresponding punched holes and into the anvil slot.

Once the sliding bearing has moved to the bottom of the clamping assembly, the second air cylinder will actuate causing the second piston to push the bearing block across the web structure, thereby causing each blade to cut horizontally through the web structure and separate a set of individual packages from the longitudinal rows. After this cutting step, the clamping assembly, sliding bearing, and blade members will rise so that the next row of packages can be indexed in the place over the anvil for cutting. At the top of the machine cycle, the second piston will retract causing the blades to translate back to their original starting position.

According to another specific aspect of the invention, the single-edged blades can be replaced by double-edged blades having the same configuration, but being sharpened on two vertical edges. This will eliminate the step of having the blades return to their origi-

nal starting position after a cut has been made. Thus, according to the invention, each double-edged blade is lowered into the anvil slot through the corresponding punch hole as described above, and moved horizontally to cut through the web structure and thereby separate a set of packages from the longitudinal rows.

As here embodied, the clamping assembly, sliding bearing, and blade members are then raised to allow the next set of packages to move forward into cutting position with the blades remaining in their post-cut position. The clamping assembly is then lowered to clamp this next series of packages, and the blades are lowered into the next corresponding set of punch holes. The second piston will then retract causing the blades to move horizontally in the opposite direction and make the cut. At this point, the clamping assembly, sliding bearing, and blade members are raised to their original starting position to allow the next series of packages to index forward into cutting position, and the two-cycle cutting sequence is repeated.

After the transverse cutting process is complete, the individual packages are transferred via an incline ramp member to a packing, loading or collating station. As the individual packages are cut by the transverse cutting mechanism, a thin strip of plastic is left on each pin chain. These strips of plastic are then stripped from the pin chains and disposed of.

It will be appreciated by those skilled in the art that the foregoing brief description and the following detailed description are exemplary and explanatory of the present invention, but are not intended to be restrictive thereof or limiting of the advantages which can be achieved by the invention. Thus, the accompanying drawings, referred to herein and constituting a part thereof, illustrate preferred embodiments of the invention and, together with the detailed description, serve to explain the principles of the invention.

FIGURE 1 is a side elevation, partly schematic view of a form-fill-seal machine construction embodying the present invention capable of producing a sealed package structure having a fault line extending across a stress concentrating protrusion member formed in the top surface of the package.

FIGURE 2 is an enlarged fragmentary view in side elevation, partly sectional, illustrating the bottom web heating, vacuum and air pressure apparatus for forming cup-like cavities in the bottom web member.

FIGURE 2A is an end elevational view, partly sectional, through line G-G of FIGURE 1, illustrating the female forming dies and vacuum and air pressure platens for forming the double cup-like configurations in the bottom web.

FIGURE 3 is an enlarged view in side elevation, partly sectional, of the filler mechanism for depositing a desired flowable substance in equal amounts into each cup-like cavity formed in the bottom web.

FIGURE 4 is a top plan, partly sectional, taken along line A-A of FIGURE 3, illustrating the product entry ports of the filler bar.

FIGURE 5 is a sectional view taken along line B-B of FIGURE 3, illustrating the product exit ports of the filler bar.

FIGURE 6 is an enlarged fragmentary view in side elevation, illustrating the top web supply fault line scoring knife, and micrometer adjusting means for locating the depth of the knife score, shown in FIGURE 1.

FIGURE 7 is a fragmentary bottom plan taken along line C-C, illustrating a multiple of 4 scoring knives simultaneously forming a fault for each sealed package being produced.

FIGURE 8 is an enlarged fragmentary view and side elevation, partly sectional, illustrating the differential and constant drive rollers drawing the top web material passed the stress concentrator heating and forming means and into register with the formed and filled bottom web cup-like cavities, the top and bottom heat sealing unit sealing the top web onto the bottom web, the punch die which punches the web at the corner locations for the individual packages, and the photoelectric eye which scans registration of the top and bottom web and transmits a signal to the differential drive roller control for correcting register error.

FIGURE 9 is an enlarged fragmentary view taken along lines D-D of FIGURE 8, illustrating the punch openings, stress concentrator locations, and fault lines formed in the top web member.

FIGURE 10 is an enlarged fragmentary view in side elevation, partly sectional and partly schematic of the indexer drive of FIGURE 1, the view also showing the longitudinal and new transverse mechanisms according to the invention for separating the individual packages, the incline ramp for receiving the finished packages, and the take-up roller for the trim waste.

FIGURE 11 is an end elevation view taken along line E-E of FIGURE 10, illustrating the new transverse cutting blades according to the invention prior to being lowered into the corresponding punch holes in the sealed web material, and schematically illustrating the means for horizontally moving the blades through the web material.

FIGURE 12 is a top plan view taken along line F-F of FIGURE 10.

FIGURE 13 is an end elevation view of the new transverse cutting mechanism of the invention shown in FIGURES 10-12.

FIGURE 14 is a slide elevation view, partly in cross-section, illustrating the new transverse cutting mechanism of the invention shown in FIGURE 13.

FIGURE 15 is a schematic diagram showing the cutting sequence of a single-edged new transverse cutting blade according to the present invention.

FIGURE 16 is a schematic diagram showing the cutting sequence of a double-edged new transverse cutting blade according to the present invention.

Referring now to the accompanying drawings, wherein like reference numerals refer to like parts throughout the various views, there is illustrated in FIGURES 1-16 the preferred embodiments of the form-fill-seal machine (generally indicated at reference numeral 10) in accordance with the present invention. As preferably embodied, machine 10 is advantageously adapted for simultaneously forming, filling and sealing four sealed packages, here in the configuration of the dispenser package described in Redmond et al. U.S. Pat. Nos. 4,493,574 ("the 574 patent") and, 4,611,715 ("the 715 patent"), the disclosures of which are hereby incorporated hereinto by reference.

While the apparatus of the present invention as here embodied is particularly adapted to and was designed for use in the production of the dispenser package structures described in the 574 and 715 patents, the principles underlaying the operation of the invention are not limited to such usage. Since the invention is particularly adaptable to such usage, however, reference will be made hereinafter thereto in order to provide an example of a practical and useful embodiment of the invention.

It will also be understood that the invention is not limited to the simultaneous production of four packages, but may be readily adapted to the simultaneous production of more or less packages as desired. Moreover, while the invention is not limited to the production of any particular size package, it is particularly well suited for the production of relatively small packages, containing on the order of a few grams to on the order of 4 oz. of product.

Machine 10 as here embodied has been constructed on the order of 60" (5 feet) long, as compared to the previously mentioned approximately 25 foot long commercial machine, and yet has the same or a somewhat higher output and can be manufactured to sell for less than one-half the price of the aforesaid machine.

The key feature and reason behind the unexpected small size and efficient operation of machine 10 of the present invention is believed to be that a basic physics concept has been overlooked in the development of prior equipment, namely, the formula for inertia, MV^2 (Mass times Velocity squared). Thus, the aforesaid prior equipment takes 30 cups per cycle in a 5 x 6 configuration while machine 10 of the invention has a configuration of 10 x 2, or 20 cups per cycle. The essence of the cycling rates is the V^2 factor (velocity squared). Running the 10 x 2 configuration at 30 to 40 cycles per minute, 2 x 1-1/4 = 2-1/2" (2-1/2 inches per cycle) is much easier than moving 7-1/2" per cycle:

$$(7\text{-}1/2)^2 = 56.25$$

$$(2\text{-}1/2)^2 = 6.25$$

It becomes clear that the acceleration/deceleration forces for a 7-1/2" index is 9 times greater than for a 2-1/2" index. Much greater power input, much heavier construction, and much greater braking force all contribute to operating inefficiency.

If the portion of cycling movement time is 33% of the entire cycle, then 1/3 X 9 = 3. Thus, mechanical efficiency on this phase alone of the entire machine is 3:1. If 20 cups areproduced at 3 times the efficiency that 30 cups are produced, 60 cups are, in effect, produced on machine 10 of the invention for every 30 cups produced on the large machine, with the attendant savings. Add to this other similar savings throughout the machine and it will be seen that significant size and cost reductions can be made (certainly at least 50%).

Referring again to the drawings, and specifically to FIGS. 1-5, there is shown a bottom thermoformable plastic web 12 indexed intermittently to a heating station 14 where it is brought to forming temperature. Bottom web 12 is thereafter indexed to a forming station 16. At the forming station, the heated web 12 is clamped and, where necessary or desirable, plugged, while either air pressure or vacuum is applied to web 12 to force it into the configuration of one or more female forming dies 18 to achieve a cup-like structure 21. As a further alternative, a combination of pressure and vacuum may be used.

As here embodied, bottom web 12 is transported (indexed) to the various stations by a pair of "pin" chains 20, 20a (see Figure 5) which are simply roller chains with a series of sharp pins impaled thereon by an impaling drum along the selvege (edge) on both sides of the bottom web material 12. It will be understood by those skilled in the art that other alternative means for gripping web 12 may be used, such as clamping clips mounted on a roller chain. Such clips, however, are expensive and have not been found to hold any advantage over the use of simple pins.

During the forming operation, web 12 is normally clamped continuously about the periphery of each female die 18 via a clamping mechanism 19. Female dies 18 are kept cool by either air or liquid coolant. If desired, clamping mechanism 19 can also drive a preforming plug into the heated plastic to assis and control the web thickness after forming by a variety of means. For example, such a plug may be heated or cooled, and may be made of a variety of materials, ranging from aluminum to Teflon plastic to achieve a broad range of effects and results. The forming dies 18 and clamping mechanism 19 are retractably mounted, and once the cup-like pocket formations are formed in the bottom web 12, the dies retract downwardly while the clamping mechanism rises, enabling the formed web to advance to a filling station 22, where a filler mechanism (indicated generally at 24) delivers a predetermined amount of product into each cup-like pocket formation 21.

Referring now to Figures 1 and 6-8, as the bottom web 12 is being filled and formed, a top web 26 is drawn by a pair of draw rollers and indexed simul-

taneously by the same drive means that indexes web 12. As here embodied, upper web 26 is drawn from a supply roll 27 by a draw roller 28 after which it passes over a second draw roller 29. Positioned at roller 29 is a series of sharp hard blades 30, each independently mounted on a micrometer controlled member 30a. The purpose of blades 30 is to score the heavier top plastic web 26 so as to create a fault line down the center of each individual package to be formed. An alternate method of putting fault lines in web 26 and eliminating the sharp blades 30 is to have a controlled heated blade indent the fault line at the position where it traverses the stress concentrator protrusion 40 (described below).

Referring now to Figure 8, draw rollers 28, 29 are connected to the main drive through a differential drive system which can slow or increase the amount of top web movement (which is the printed web) in response to a signal from a photoelectric scanner eye which reads a printed spot on the top web to tell whether the print is in register. The upper drive rollers (31, 32) are located so as to draw the top web 26 from supply roll 27 through the fault line blades 30 and feed it vertically downwardly to a second, constant drive draw roller system (indicated by reference numeral 33) advantageously positioned approximately 12 inches below.

As here embodied, a radiant heater 34 and a horizontal series of diamond-shaped contact heaters (indicted generally by reference numeral 35), one for each longitudinal row of packages to be formed, are located between rollers 31, 32 and second draw roller system 33. The center of each diamond heater 35 is positioned in line with the fault lines scored in web material 26. Positioned one index below heaters 35 is a horizontal row of pyramidally-shaped punches and female dies (indicated generally by reference numerals 36 and 37, respectively). One punch and die is provided for each longitudinal row of packages to be formed. When web 26 is indexed by draw rollers 31, 32 and 33, diamond heaters 35, which have a properly preset temperature, are compressed against top web 26 causing a series of horizontal diamond-shaped areas to be formed thereon. At the next index, pyramidal punch presses 36 force these diamond-shaped areas into the series of female dies 37 creating a horizontal line of small pyramidal-shaped protrusions 40, with the fault line passing through their centers. According to the invention, the lower draw roller system 33 has relief areas so that protrusions 40 can pass through the rollers without being crushed. As web 26 passes through the roller system 33, it is transported horizontally above the lower web 12 such that each protrusion 40 is in registry with one of the cup-like formations 21.

According to the invention, the registered top and bottom webs are thereafter indexed to a sealing station 42. Located at sealing station 42 is a retractable heated lower sealing die 43 which moves vertically upward to compress the lower web 12 to the upper web 26. As sealing die 43 rises, an upper pressure pad 44 descends into contact with web 26 such that webs 12 and 26 are compressed, heated and sealed between die 43 and pad 44 to form a sealed web structure 27. The sealing die 43 then retracts to permit the now formed, filled and sealed stress concentrator packages 100 comprising web structure 27 to advance to a punch station 46.

At punch station 46, a series of hard steel punches and dies (one such punch and die are indicted generally in Figure 8 by reference numerals 48 and 49, respectively) advantageously punch a "star"-shaped hole 46a through web structure 27 at the locations of the corners of the individual packages (see Figure 9). As more fully discussed below, this will create rounded or beveled corners on the individual packages pursuant to the cutting operations. The star-shaped trim is removed by suitable vacuum means well within the skill of the art.

To create individual packages from the sealed web structure, machine 10 of the present invention provides sequential longitudinal and transverse cutting mechanisms 50 and 60, respectively, located downstream of the punch station. As shown in Figures 10 and 12, longitudinal cutting mechanism 50 preferably comprises a series of sharpened tungsten carbide blades 51 which cut the formed packages away from pin chains 20,20a and into a series of longitudinal package rows. A set of upper and lower draw rollers 52, 53 are provided just downstream of cutting mechanism 50 to aid pin chains 20,20a in pulling web structure 27 through cutting blades 51.

Referring now to Figures 10-16, there is shown transverse cutting mechanism 60 and the operation thereof in accordance with the present invention. As here embodied, transverse cutting mechanism 60 is located downstream of longitudinal cutting mechanism 50, and generally comprises a horizontally movable series of blades 62 vertically mounted to a sliding bearing member 64, which in turn is housed within a clamping assembly 66 positioned above web structure 27. In accordance with one preferred embodiment of the invention, each blade 62 is sharpened along one vertical edge 62a, and is formed with a tapered tip 62b. As here embodied, blades 62 may be fabricated from a variety of hard materials suitable for cutting tough plastic web structures, such as tungsten carbide and titanium carbide coated tool steel. Although tungsten carbide is a particularly hard material, the use of titanium carbide coated tool steel is preferred as it is corrosion resistant and less expensive than tungsten carbide.

As preferably embodied, each blade 62 is dimensioned to a full length of about 1-1/2 inches (measured from the end of the blade located inside clamping assembly 66 to the opposite end of the blade project-

ing outwardly thereof), with a projecting length ranging from about 1/16 to about 1/2 inch. In addition, each blade 62 is preferably dimensioned to a width of about 7/16 inch and a thickness ranging from about 15 to about 25 thousandths of an inch. This will permit each blade to easily pass through a star-shaped punch hole 46a formed in web structure 27 to initiate the transverse cutting process (described below). It will be understood by those skilled in the art that the foregoing configuration and dimensions of cutting blades 60 are merely illustrative of preferred embodiments of this aspect of the present invention, and are not intended to be limiting of the invention.

As here embodied, bearing member 64 is connected to an upper bar member 68 via a pair of shaft members 70, 71 which are slidably inserted through fixed bearing members 72 and 73, respectively. A spring member 74 encircles each shaft 70, 71 above bearing member 64 and sits upon the corresponding fixed bearing member 72, 73. Upper bar member 68 is in turn connected to a piston member 76 which is actuated by an air cylinder 78 to drive both bearing member 64 and clamping assembly 66 downward toward web structure 27 with each cycle of machine 10.

According to the invention, cutting blades 62 are mounted via screw members 63 to a bearing block 86 located within sliding bearing member 64. Bearing block 86 is pressed into a bearing block holder 88 and rides on a pair of parallel rods 90, 92. Bearing block 86 is also connected to a rod 94 which in turn is connected to piston 96 of an air cylinder 98. As here embodied, an anvil member 80 having a slot 80a formed thereinto is disposed below web material 12 and runs the length of clamping assembly 66 such that blades 62 align with slot 80a. Slotted anvil 80 is fixedly mounted to a bar member 82 which also runs the length of clamping assembly 66 and helps bear the weight of the clamping assembly at the bottom of its downward cycle. In addition, anvil 80 is bolted to a block member 84 which sits upon bar 82 and helps support anvil 80 in an upright position.

Operation of cutting mechanism 60 in accordance with the present invention is relatively straightforward. As here embodied, web structure 27 is indexed forward from cutting mechanism 50 into position below clamping assembly 66 such that the first set of punch holes 46a formed in web structure 27 align with cutting blades 62. This will actuate air cylinder 78, which in turn will cause piston 76 to move clamping assembly 66 downwardly to clamp the longitudinal row of packages 45 preceding the first set of punch holes 46a to anvil 80. At this point, piston 76 will continue to move downward causing bar 68 to compress spring members 74. This in turn will cause shaft members 70 and 71 to translate downward through bearing members 72 and 73, thereby causing sliding bearing 64 to move to the bottom of clamping assembly 66, and blades 62 to pass through the corresponding punch holes 46a into slot 80a formed in anvil 80.

Once bearing 64 has moved to the bottom of clamping assembly 66, air cylinder 98 will actuate causing piston 96 to push bearing block 86 across web structure 27, thereby causing each blade 62 to cut horizontally through the web structure to the next adjacent punch hole 46a, and thereby separate a set of individual packages 100 from the longitudinal rows. After this cutting step, clamping assembly 66, bearing 64 and blades 62 will raise so that the next row of packages can be indexed into place over anvil 80 for cutting. At the top of the machine cycle, piston 96 will retract causing blades 62 to translate back to their original starting position (see Figure 15). As shown in Figure 12, the configuration of star-shaped holes 46a, in combination with the longitudinal and transverse cutting operations, result in each individual package 100 being formed with rounded corners 100a.

In a particularly preferred embodiment of the invention, the single-edge blades 62 can be replaced by double-edge blades 102 having the same preferred configuration and dimensions as blades 62 (although again not limited to such configuration or dimensions), but being sharpened on two vertical edges (one such blade is shown in Figure 16 with cutting edges 102a and 102b). This will eliminate the step of having the blades return to their original starting position after a cut has been made. Thus, as illustrated in Figure 16, each double-edge blade 102 is lowered into anvil slot 80a through the corresponding punch hole 46a as described above and moved horizontally to cut through web structure 27 to the next adjacent hole 46a, and thereby separate a set of packages from the longitudinal rows. Clamping assembly 66, bearing 64 and blades 102 are then raised to allow the next series of packages to move forward into cutting position with blades 102 maintained in their post-cut position. Clamping assembly 66 is then lowered to clamp this next series of packages, blades 102 are lowered into the next corresponding set of punch holes, and piston 96 retracts causing blades 102 to move horizontally in the opposite direction to make the cut. At this point, clamping assembly 66, bearing 64 and blades 102 are then raised to the original starting position to allow the next series of packages to index forward into cutting position, and the two-cycle cutting sequence is repeated.

Those skilled in the art will readily recognize that the use of a double-edge cutting blade making a horizontal cut first in one direction, and then back in the opposite direction, facilitates both extended blade life and a reduction in bearing wear. Moreover, it will be recognized by those skilled in the art that cutting blades 62 and 102 may be actuated to perform the transverse cutting process by a variety of conventional means in addition to the pneumatic means described above.

In accordance with the invention, because warm blades heated to about 150° Fahrenheit will function better and last longer when cutting tough materials such as polyester, cutting mechanism 60 may be provided with a heating cartridge 104 mounted within bearing 64 with suitable temperature controls. Moreover, blades 62 and 102 may be adjustably mounted vertically within bearing 64 so that when the portion of the blade edge(s) that is doing the cutting wears out, it may be raised or lowered slightly to provide a fresh cutting edge.

As shown in Figures 10 and 12, the individual packages formed as a result of the transverse cutting process are transferred to a remote packing or loading station via a downwardly inclined ramp 110. As the individual packages are cut by cutting mechanism 60, a thin strip of plastic 112 is left on each pin chain 20 and 20a. These strips of plastic are rolled up on reels (indicated generally by reference numeral 114) via a trim takeup roller (indicated generally by reference numeral 116). As here embodied, reels 114 are driven by an air motor (not shown) which slips when pin chains 20, 20a are at rest or being drawn through rollers.

As here embodied, machine 10 provides a number of other features which give it extreme flexibility, small size, and economical but high precision construction. For example, machine 10 may be completely controlled by a commercially available programmable controller, which is effectively a small computer, such as manufactured by the Allen-Bradley company. Because it is basically a pneumatic machine, wide range of motions and timings may be accomplished by controlling air valves, air pressure, etc. with the programmable controller.

Also, as here embodied, the filler mechanism 24 is unique in that it loads diaphragms which in turn are depressed by pistons loosely fitted into cylinders which are attached to a bar which is driven up and down by an air piston compressing the diaphragms. These diaphragms are attached or clamped to a filler bar on which the air cylinders also are mounted, one for each diaphragm.

The filler bar is bored across its full width to relatively large bores. For ketchup, as an example, the holes are about 1" diameter. One bore is the product entry port and the product is delivered to it under pressure. When the diaphragms are fully filled with product, a valve is actuated by the programmable computer, shutting off the pressure. A rotating valve shaft, traversing the other bore, is then pivoted approximately 30 degrees, aligning cross-drilled holes in it with the outlet nozzles and with holes drilled in the filler bar. The pistons thereupon collapse and press against the filled diaphragms, forcing the product out of the outlet nozzles and into the cup-like pockets formed in the bottom web. Retraction of the piston thereafter creates suction on the nozzles to prevent drip. The valve shaft which traverses the filler bar is suitably sealed at each end with "O" rings or the like to prevent product leak. The entire filler assembly is mounted in such a manner that it may be flushed in place for cleaning by raising it and placing a special cleaning cap on the bottom of it to direct flushing water and detergent into an outlet hose and not all over the machine.

It will be appreciated by those skilled in the art that the present invention in its broader aspects is not limited to the particular embodiments shown and described herein, and that variations may be made which are within the scope of the accompanying claims without departing from the principles of the invention and without sacrificing its chief advantages. For example, the present invention may be adapted to cut packages from formed, filled, and sealed single row web structures, as well as discrete sections from single row or strip web structures comprising sealed top and bottom layers or just a single layer, without package formations formed thereinto. For such embodiments, the single row or strip web structure is carried on a single pin chain assembly, the longitudinal cutting apparatus is eliminated, and a single line of punch holes are formed along the pin chain carrying edge of the web material to accomodate one single-edged transverse cutting blade. The cutting blade can be operated as described above to cut packages or discrete sections from the single row web structure.

Claims

1.

A machine for automatically simultaneously producing a predetermined number of filled and sealed finished packages, comprising:

a pneumatically driven adjustable indexing drive mechanism driving a main shaft member;

a sprocket assembly mounted to said main shaft engaging and adapted to intermittently advance and rest a pair of web transporting roller chains in response to movement of said main shaft, said web transporting roller chains including a series of upstanding pin members;

a rotary impaler cylinder driven by said roller chains;

roller means transporting a bottom thermoformable web material from a supply roll to said impaler cylinder, said impaler cylinder impaling each of the opposed lateral edges of said bottom web onto said roller chain pin members;

means intermittently indexing said bottom web material to a heating station where said bottom web material is heated to thermoformability;

means intermittently indexing said heated web to a forming station, said forming station including retractable forming die means forming a series of cup-

like pockets in said bottom web material;

means intermittently indexing the formed bottom web to a filler station, said filler station including means for filling each of said cup-like pockets with a discrete amount of a product supplied to said filler station;

driven roller means simultaneously advancing a thermoformable top web material in timed sequence with the intermittent advance, forming and filling of said bottom web member;

said top web driven roller means transporting said top web into substantially parallel closely adjacent proximity to said bottom web material after said cup-like pockets formed therein are filled;

means intermittently indexing both said bottom web material and said top web material together to a sealing station, said sealing station including retractable heat sealing die and clamping means for heat sealing said top web material and said bottom web material together to form a sealed web structure;

means intermittently indexing said sealed web structure to a punch station, said punch station including a series of punch dies which punch openings in said web structure at the location of the corners of the individual packages to be formed;

means intermittently indexing and pulling said sealed web structure through a longitudinal cutting station wherein slitting means slit said web structure along first opposed sides of said cup-like pockets and adjacent the pin engaging edge portions of said bottom web material to form longitudinal rows of packages;

means intermittently indexing said web structure from said longitudinal cutting station to a transverse cutting station, said transverse cutting station including a plurality of cutting blade members disposed above said web structure, said cutting blades being aligned with a corresponding set of said punch openings upon each intermittent index of said web structure to said transverse cutting station, said cutting blades thereupon being actuated to descend through said corresponding punch openings, thence move laterally so as to slit said web structure along second opposed sides of said cup-like pockets and thereby separate an individual finished package from each said longitudinal row thereof, whereupon said cutting blades move upwardly away from said web structure so as to allow the next set of packages to be indexed into cutting position;

means transporting said finished packages away from said machine; and

take up roller means removing the bottom web trim from said roller
chain pins.

2. A machine as claimed in claim 1, further comprising clamping means to hold said sealed web structure in position at said transverse cutting station with each intermittent index thereof prior to said cutting blades descending into a corresponding set of said punch holes.

3. A machine as claimed in claim 1, including solid state programmable controller means controlling said indexing drive means.

4. A machine as claimed in claim 1, wherein said forming means includes vacuum means drawing said bottom web material into a female forming die and air pressure means simultaneously pressing said web into said forming die.

5. A machine as claimed in claim 1, wherein said top web driven rollers include

a differential drive roller, and

a constant index drive roller, and including scoring means adapted to indent said top web with a fault line extending partially through the thickness of said web material;

said differential drive and constant index rollers transporting said scored top web past heat means and stress concentrator former means,

said stress concentrator former means adapted to form a protrusion in said top web member at said fault line to thereby displace said fault line from the surface of said web; and

registration scanner means adapted to detect lack of register between said top web and said cup-like pockets formed in said bottom web, said scanner means including means for sending a control signal to said differential drive means to correct improper register.

6. A machine as claimed in claim 1, wherein said filler station is adapted to fill a flowable product into cup-like pockets formed in said bottom web, said filler station including

a filler bar comprising

a series of product exit ports located in registry with each cup-like pocket formed in said bottom web, each product exit port communicating with an expandable diaphragm chamber and including valve means for closing said communication,

a product entry port communicating with each of said expandable diaphragm chambers,

means introducing product to each of said chambers under pressure,

means shutting off pressure to said product when each of said chambers is full, and

means closing communication between each of said chambers and said exit port when product is being filled into said chamber; and

piston means adapted to depress said diaphragm when full to force the product in each of said chambers out said product exit port.

7. An apparatus for cutting a web structure into discrete sections, comprising:

means indexing said web structure to a punch station, said punch station including at least one punch die which punches an opening into said web structure at at least one predetermined location;

means indexing and pulling said web structure to a longitudinal cutting station, said longitudinal cutting station including slitting means which slit said web structure along first opposed sides to form longitudinal strips;

means indexing said web structure strips from said longitudinal cutting station to a transverse cutting station, said transverse cutting station comprising,

(1) a clamping assembly disposed above said web structure and housing a bearing member vertically slidably translatable therewithin, said clamping assembly being actuated to move downwardly and clamp a predetermined section of each of said longitudinal strips to a support member upon each index of said web structure to said transverse cutting station;

(2) at least one vertically oriented cutting blade connected to said bearing member, said cutting blade being aligned with a corresponding punch opening upon each index of said web structure to said transverse cutting station, said cutting blade being actuated to descend through said corresponding punch opening upon said clamping assembly coming into clamping contact with said longitutinal strips, said cutting blade thence being further actuated to move laterally so as to slit said web structure along a second side of said longitutinal strips and thereby separate an individual finished section from each of said longitudinal strips, whereupon said clamping assembly is actuated to move upwardly away from said web structure so as to allow the longitutinal strips to be indexed into the next cutting position.

8. An apparatus according to claim 7, wherein said web structure is fabricated from polyester.

9. An apparatus according to claim 7, wherein said web structure is fabricated from polystyrene.

10. A method for cutting finished filled packages from a thermoformable web structure including a top web member sealed to a bottom web member having a series of cup-like pockets formed thereinto, said method comprising the steps of:

intermittently indexing said sealed web structure to a punch station;

punching openings in said sealed web structure at the location of the corners of the individual packages to be formed;

intermittently indexing the said web structure to a longitudinal cutting station;

slitting said web structure along first opposed sides of said cup-like pockets with knife means located at said longitudinal cutting station to form longitudinal rows of packages;

intermittently indexing said web structure from said longitudinal cutting station to a transverse cutting station;

clamping a package from each said longitudinal row of packages to a support member with each intermittent index of said sealed web structure to said transverse cutting station;

actuating a plurality of cutting blades disposed above said web structure in a first position to descend into a corresponding set of said punch openings upon each intermittent index of said web structure to said transverse cutting station;

further actuating said cutting blades upon their descent into said corresponding set of punch openings to move laterally across said longitudinal rows of packages so as to slit said web structure along second opposed sides of said cup-like pockets, thereby separating an individual finished package from each said longitudinal row;

further actuating said cutting blades to move upwardly away from said web structure so as to allow the next package within each of said longitudinal rows to be indexed into cutting position; and

further actuating said cutting blades to thereupon move laterally across said web structure back to said first position.

11. A method according to claim 10, further comprising the step of heating said cutting blade prior to its descent into said corresponding punch opening.

12. A method for cutting finished filled packages from a thermoformable web structure including a top web member sealed to a bottom web member having a series of cup-like pockets formed thereinto, said method comprising the steps of:

intermittently indexing said sealed web structure to a punch station;

punching openings in said sealed web structure at the location of the corners of the individual packages to be formed;

intermittently indexing the said web structure to a longitudinal cutting station;

slitting said web structure along first opposed sides , of said cup-like pockets with knife means located at said longitudinal cutting station to form longitudinal rows of packages;

intermittently indexing said web structure

from said longitudinal cutting station to a transverse cutting station;

clamping a package from each said longitudinal row of packages to a support member with each intermittent index of said web structure to said transverse cutting station;

actuating a plurality of cutting blades disposed above said web structure in a first position to descend into a corresponding set of said punch openings upon each intermittent index of said sealed web structure to said transverse cutting station;

further actuating said cutting blades upon their descent into said corresponding set of punch openings to move " laterally across said longitudinal rows of packages so as to slit said web structure along second opposed sides of said cup-like pockets, thereby separating an individual finished package from each said longitudinal row;

further actuating said cutting blades to move upwardly away from said web structure so as to allow the next package within each of said longitutinal rows to be indexed into cutting position;

further actuating said cutting blades to move back downwardly into the next corresponding set of said punch openings;

further actuating said cutting blades to move laterally back across said web structure to separate a next set of individual packages from said longitudinal rows; and

further actuating said cutting blades to move upwardly away from said web structure back to said first position.

13. A method according to claim 12, further comprising the step of heating said cutting blade prior to its descent into said corresponding punch opening.

14. A method for cutting a web structure into discrete sections, comprising the steps of:

indexing said web structure to a punch station;

punching at least one opening in said web structure at at least one predetermined location;

indexing the said web structure to a longitudinal cutting station;

slitting said web structure along first opposed sides to form longitudinal strips;

indexing said web structure from said longitudinal cutting station to a transverse cutting station;

clamping a predetermined section of each of said longitudinal strips to a support member upon each index of said web structure to said transverse cutting station;

actuating at least one tranverse cutting blade disposed above said web structure in a first position to descend into a corresponding punch opening upon each index of said web structure to said transverse cutting station;

further actuating said cutting blade to move laterally so as to slit said longitutinal strips along second opposed sides of said web structure to separate an individual finished section from each of said longitudinal strips;

further actuating said cutting blade to move upwardly away from said web structure so as to allow the longitutinal strips to be indexed into the next cutting position.

15. A method according to claim 14, further comprising the step of heating said cutting blade prior to its descent into said corresponding punch opening.

16. A method according to claim 14, wherein said web structure is fabricated from polyester.

17. A method according to claim 14, wherein said web structure is fabricated from polystyrene.

18. A method for cutting a web structure into discrete sections, comprising the steps of:

indexing said web structure to a punch station;

punching at least one opening in said web structure at at least one predetermined location;

indexing said web structure to a transverse cutting station;

clamping a predetermined section of said web structure to a support member upon each index of said web structure to said transverse cutting station;

actuating at least one tranverse cutting blade disposed above said web structure in a first position to descend into a corresponding punch opening upon each index of said web structure to said transverse cutting station;

further actuating said cutting blade to move laterally so as to slit said web structure and thereby separate an individual section therefrom;

further actuating said cutting blade to move upwardly away from said web structure so as to allow said web structure to be indexed into the next cutting position.

19. A method according to claim 18, wherein said web structure is fabricated from polyester.

20. A method according to claim 18, wherein said web structure is fabricated from polystyrene.

21. A method according to claim 18, further comprising the step of heating said cutting blade prior to

its descent into said corresponding punch opening.

22. An apparatus for cutting a web structure into discrete sections, comprising:

means indexing said web structure to a punch station, said punch station including at least one punch die which punchs an opening into said web structure at at least one predetermined location;

means indexing said web structure to a transverse cutting station, said transverse cutting station comprising,

(1) a clamping assembly disposed above said web structure and housing a bearing member vertically slidably translatable therewithin, said clamping assembly being actuated to move downwardly and clamp a predetermined section of said web structure to a support member upon each index of said web structure to said transverse cutting station;

(2) at least one vertically oriented cutting blade connected to said bearing member, said cutting blade being aligned with a corresponding punch opening upon each index of said web structure to said transverse cutting station, said cutting blade being actuated to descend through said corresponding punch opening upon said clamping assembly coming into clamping contact with said web structure, said cutting blade thence being further actuated to move laterally across said web structure so as to cut a discrete section therefrom, whereupon said clamping assembly is actuated to move upwardly away from said web structure so as to allow said web structure to be indexed into the next cutting position.

23. An apparatus according to claim 22, wherein said web structure is fabricated from polyester.

24. An apparatus according to claim 22, wherein said web structure is fabricated from polystyrene.

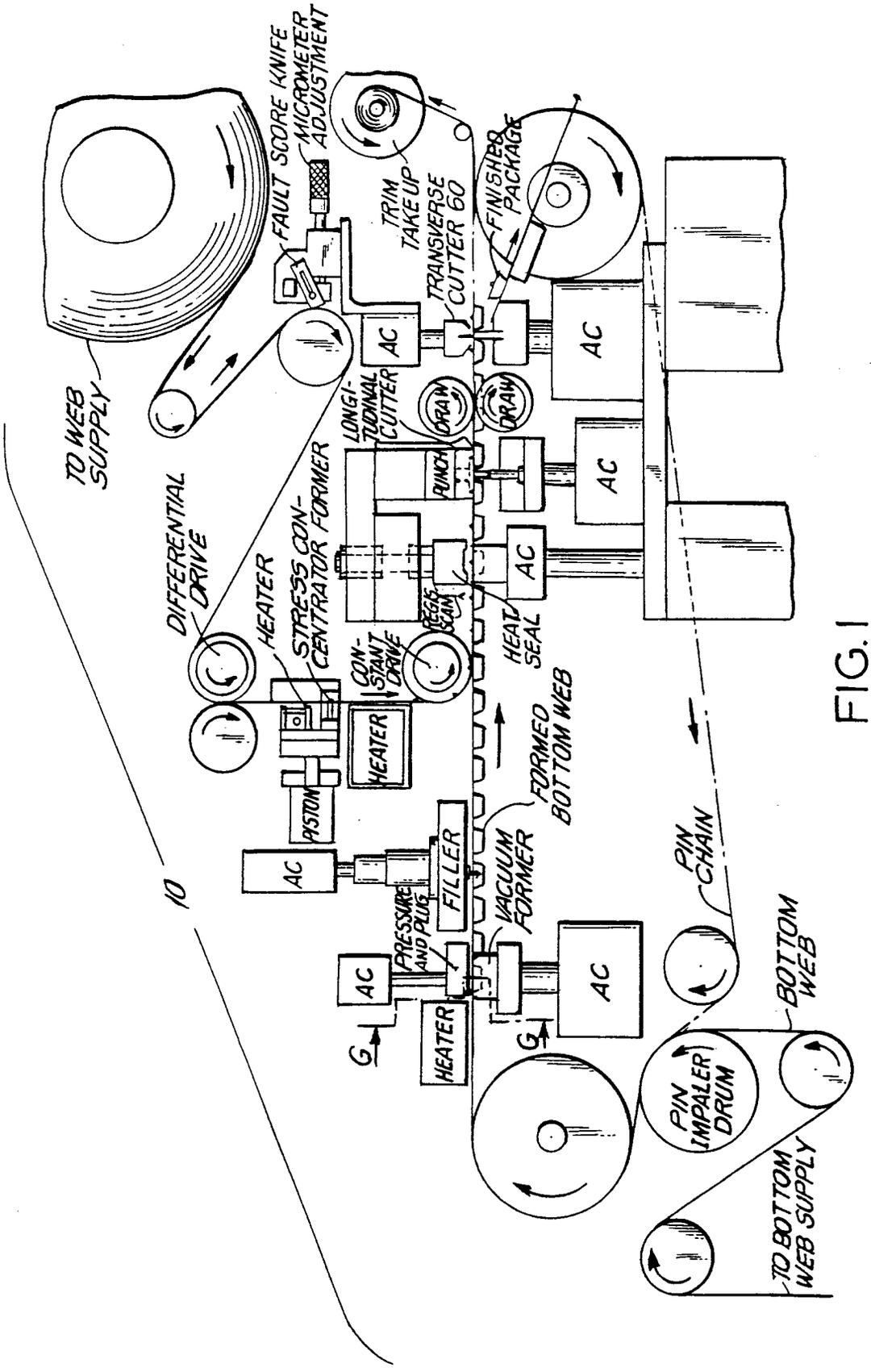
10
TO WEB SUPPLY
DIFFERENTIAL DRIVE
HEATER
STRESS CONCENTRATOR FORMER
CONSTANT DRIVE
HEATER
PISTON
AC
FILLER
PRESSURE AND PLUG
HEATER
AC
G
VACUUM FORMER
AC
G
FORMED BOTTOM WEB
HEAT SEAL
AC
REGISTRATION
PUNCH
DRAW
DRAW
LONGITUDINAL CUTTER
AC
TRANSVERSE CUTTER 60
TRIM TAKE UP
FAULT SCORE KNIFE
MICROMETER ADJUSTMENT
AC
AC
FINISHED PACKAGE
PIN CHAIN
PIN IMPALER DRUM
BOTTOM WEB
TO BOTTOM WEB SUPPLY

FIG. 1

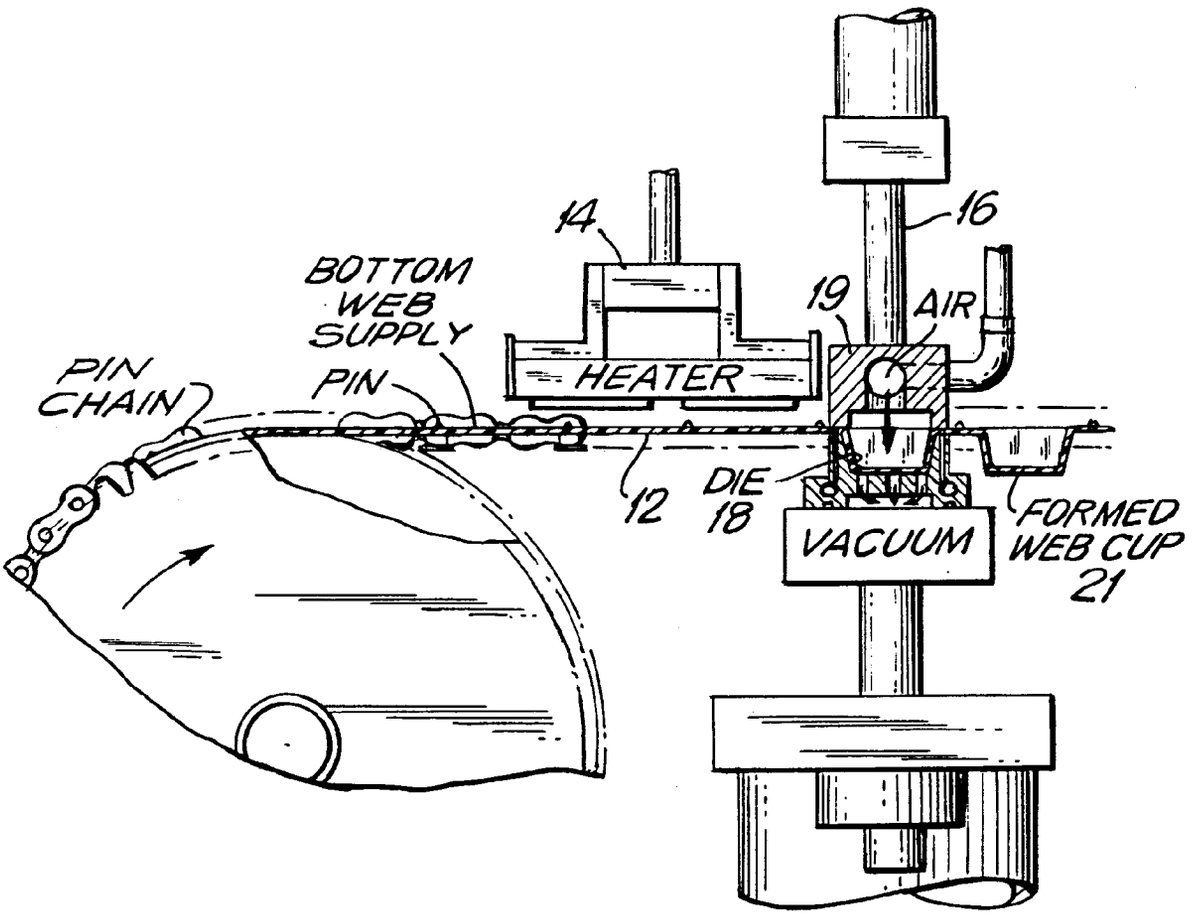
14
16
BOTTOM
WEB
SUPPLY
19
AIR
PIN
CHAIN
PIN
HEATER
12
DIE
18
VACUUM
FORMED
WEB CUP
21

FIG. 2

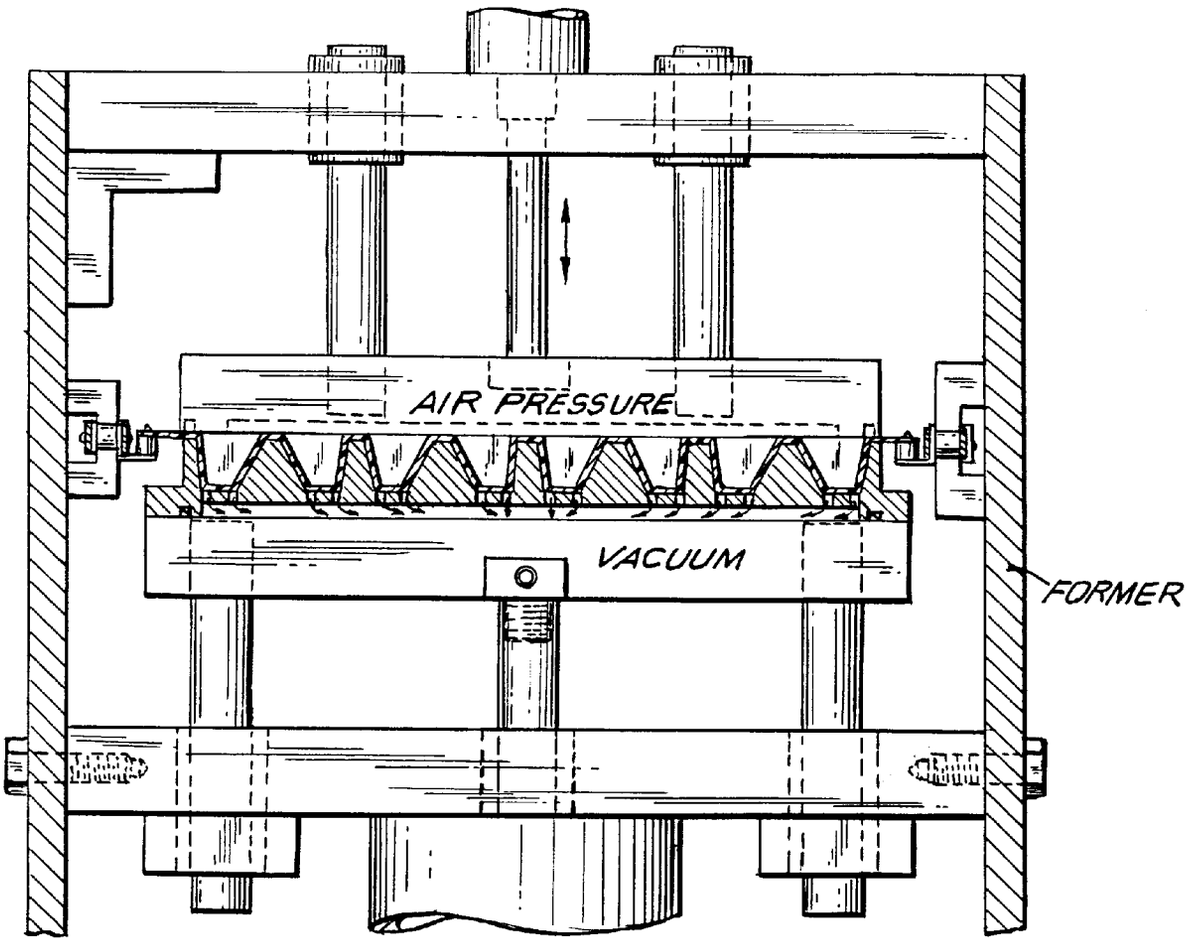

FIG. 2A

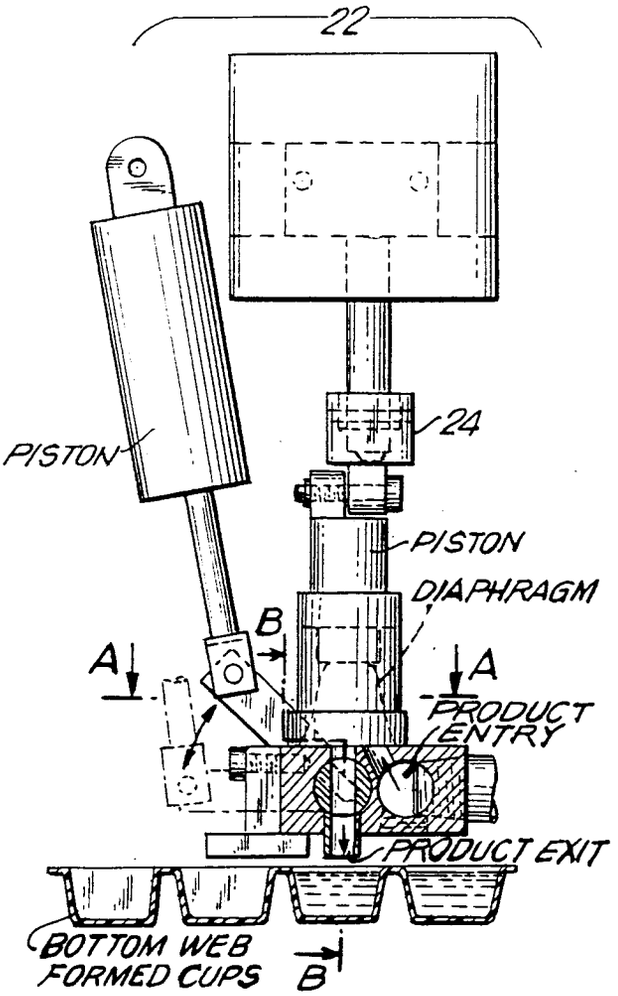

FIG. 3

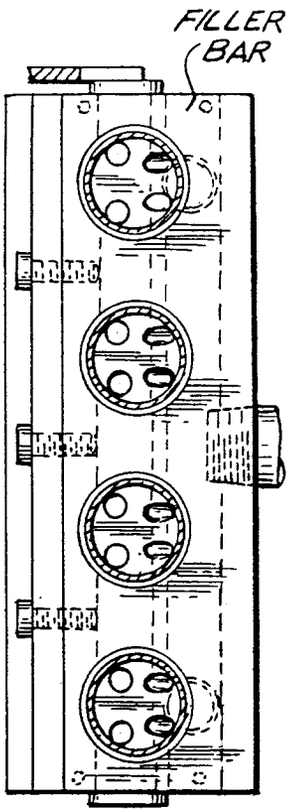

FIG. 4

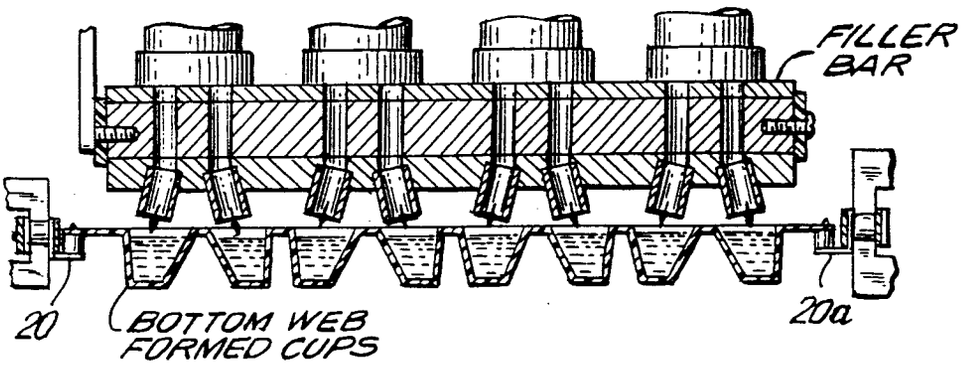

FIG. 5

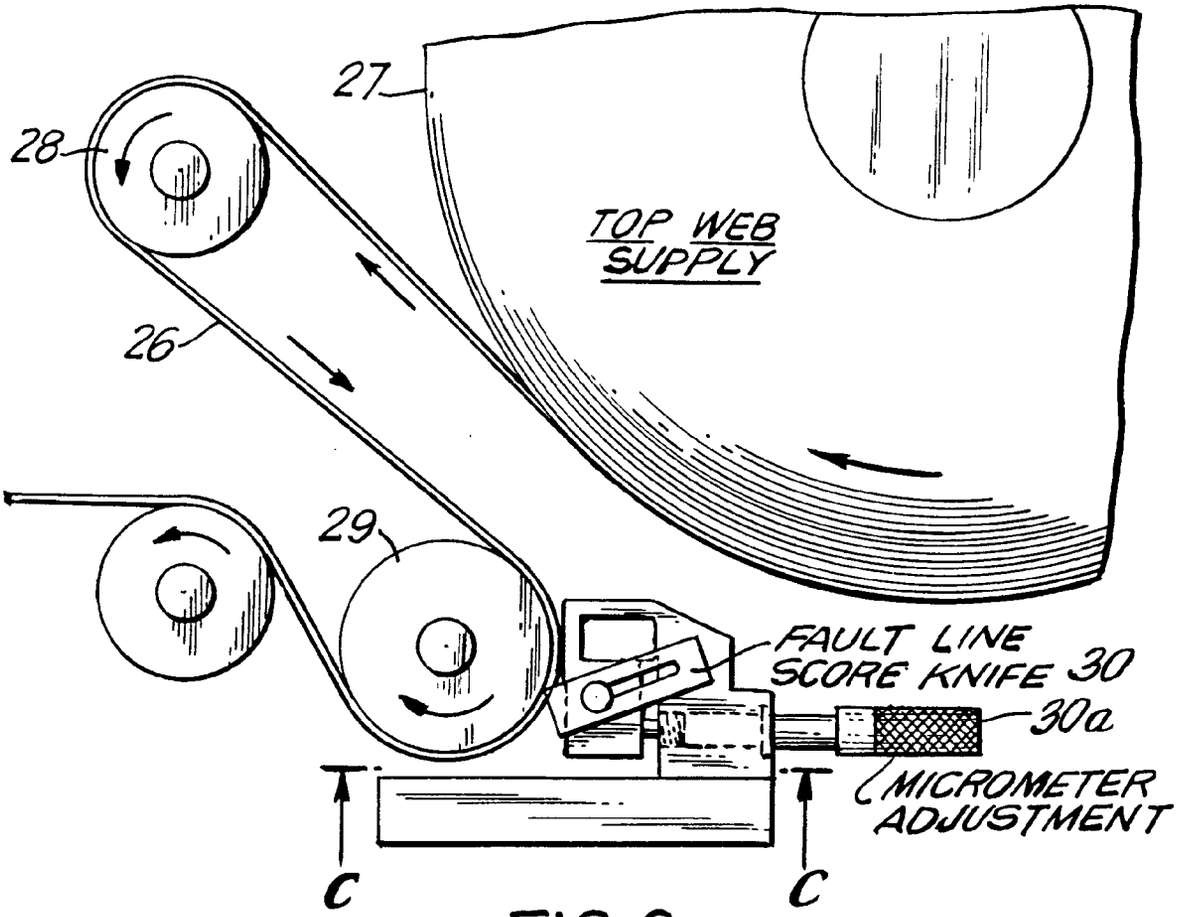
27
28
TOP WEB SUPPLY
26
29
FAULT LINE SCORE KNIFE 30
30a
MICROMETER ADJUSTMENT
C
C

FIG. 6

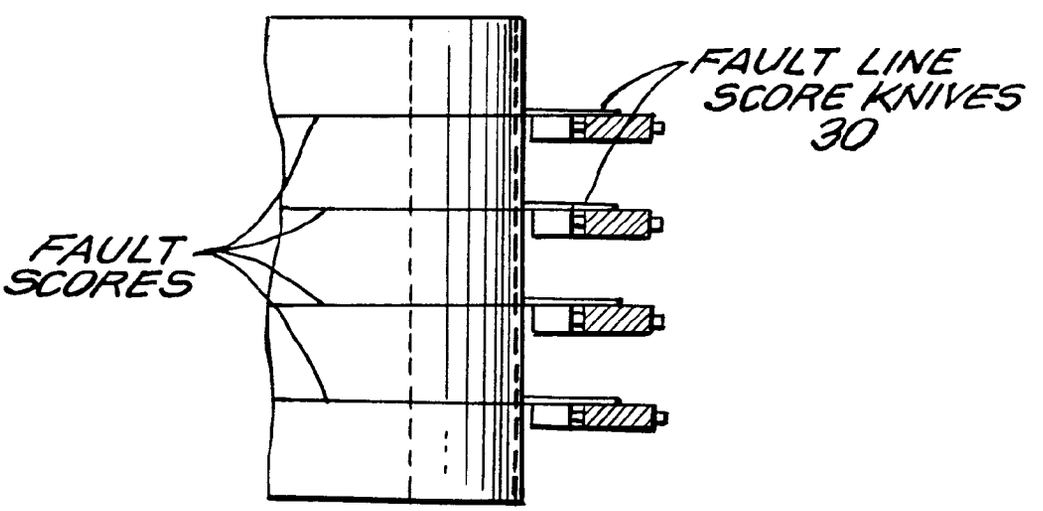
FAULT LINE SCORE KNIVES 30
FAULT SCORES

FIG. 7

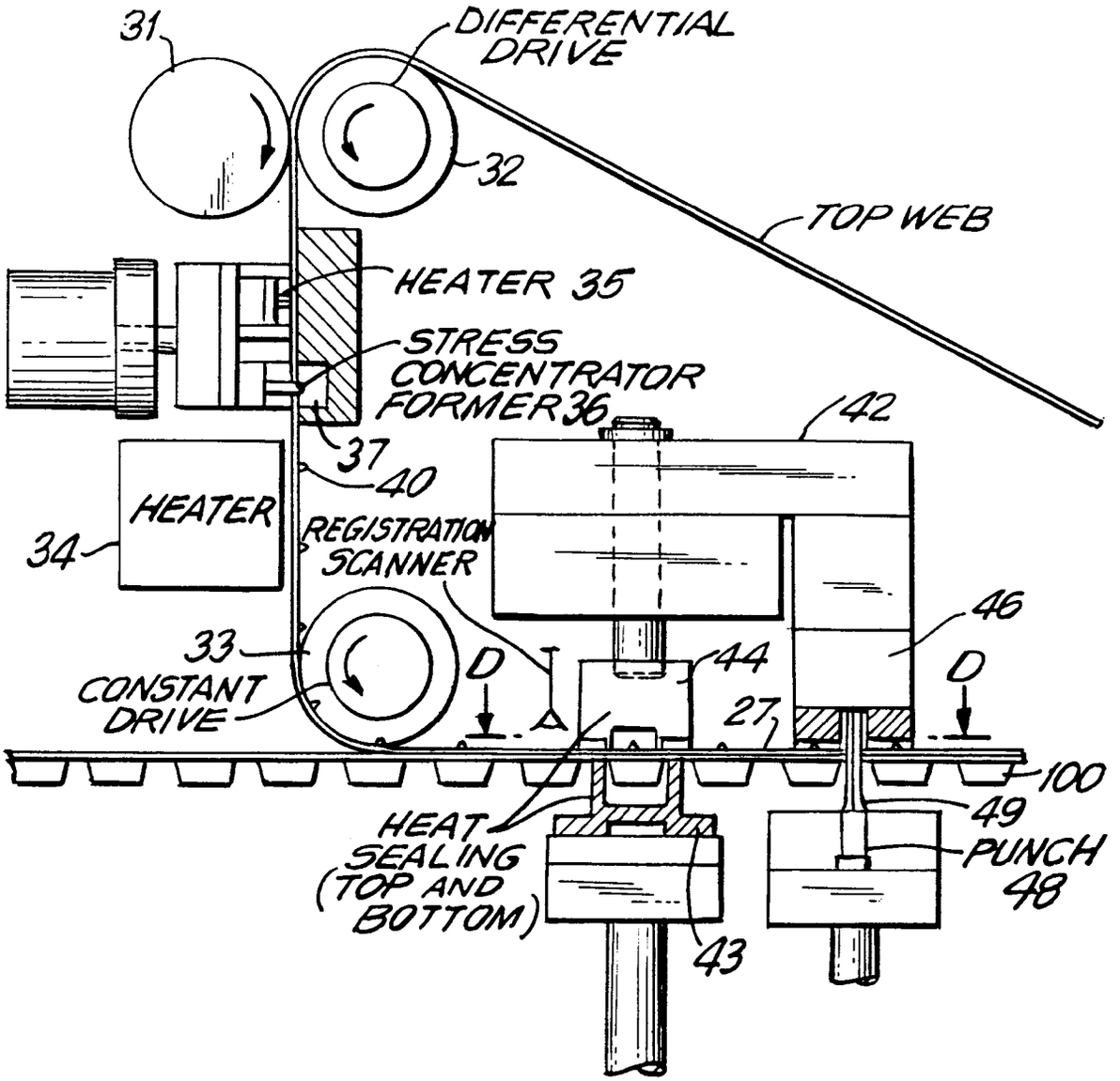
31
DIFFERENTIAL DRIVE
32
TOP WEB
HEATER 35
STRESS CONCENTRATOR FORMER 36
37
40
42
HEATER
34
REGISTRATION SCANNER
46
33
CONSTANT DRIVE
D
44
27
D
100
49
HEAT SEALING (TOP AND BOTTOM)
PUNCH 48
43

FIG. 8

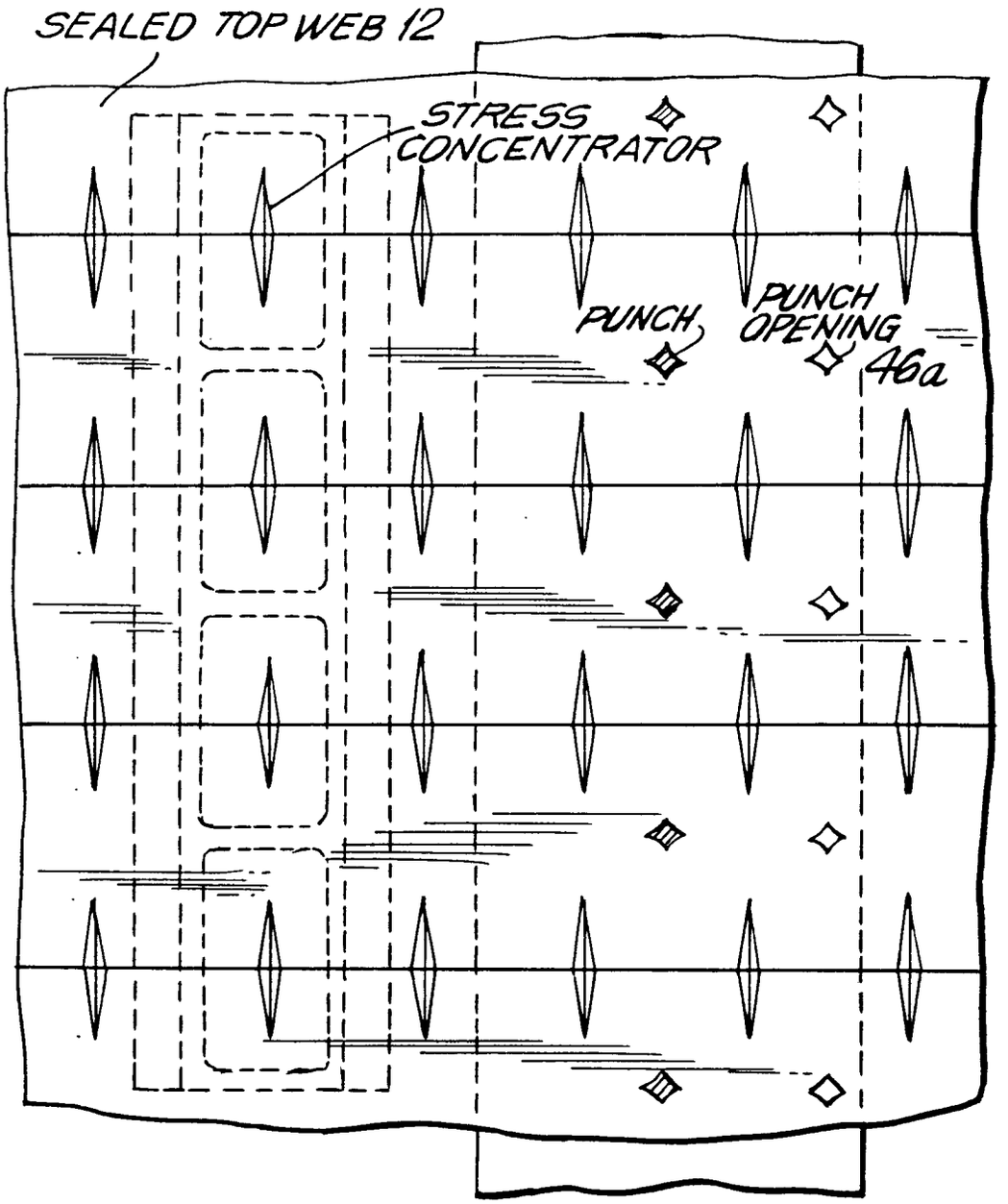
SEALED TOP WEB 12
STRESS CONCENTRATOR
PUNCH
PUNCH OPENING
46a

FIG.9

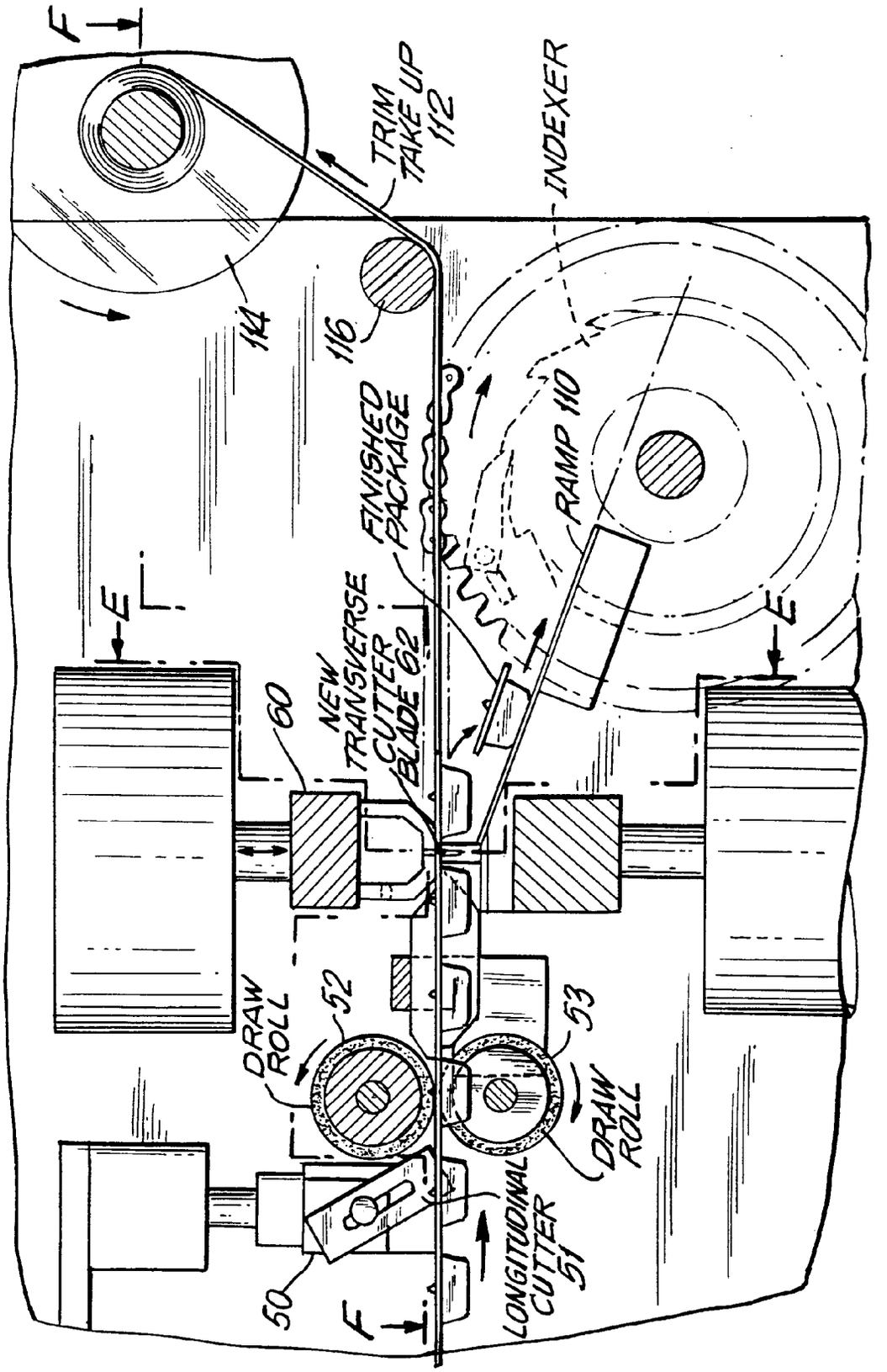
F
TRIM TAKE UP 112
INDEXER
114
116
FINISHED PACKAGE
RAMP 110
E
NEW TRANSVERSE CUTTER BLADE 62
60
DRAW ROLL
52
53
DRAW ROLL
LONGITUDINAL CUTTER 51
50
F

FIG.10

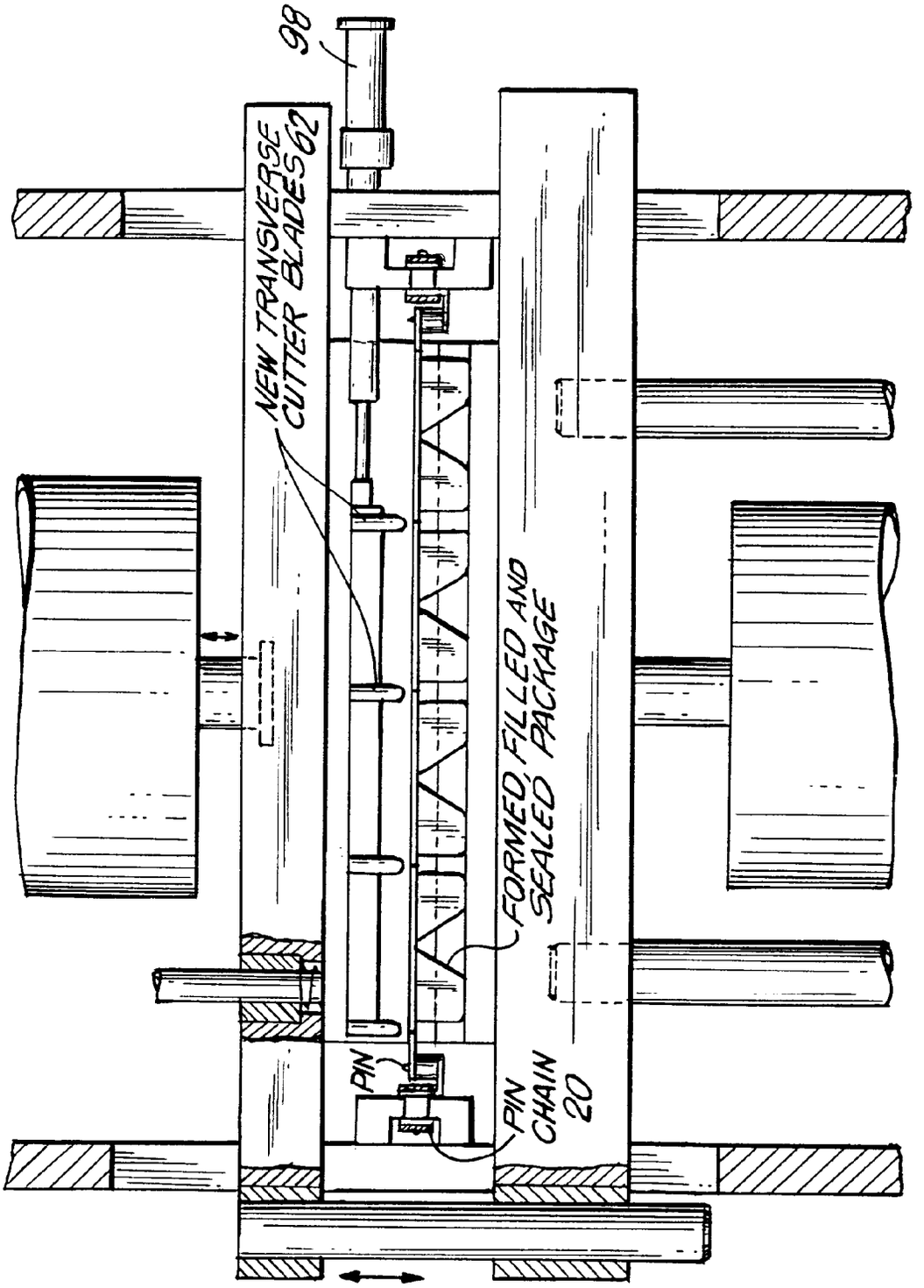
98
NEW TRANSVERSE CUTTER BLADES 62
FORMED, FILLED AND SEALED PACKAGE
PIN
PIN CHAIN 20

FIG.11

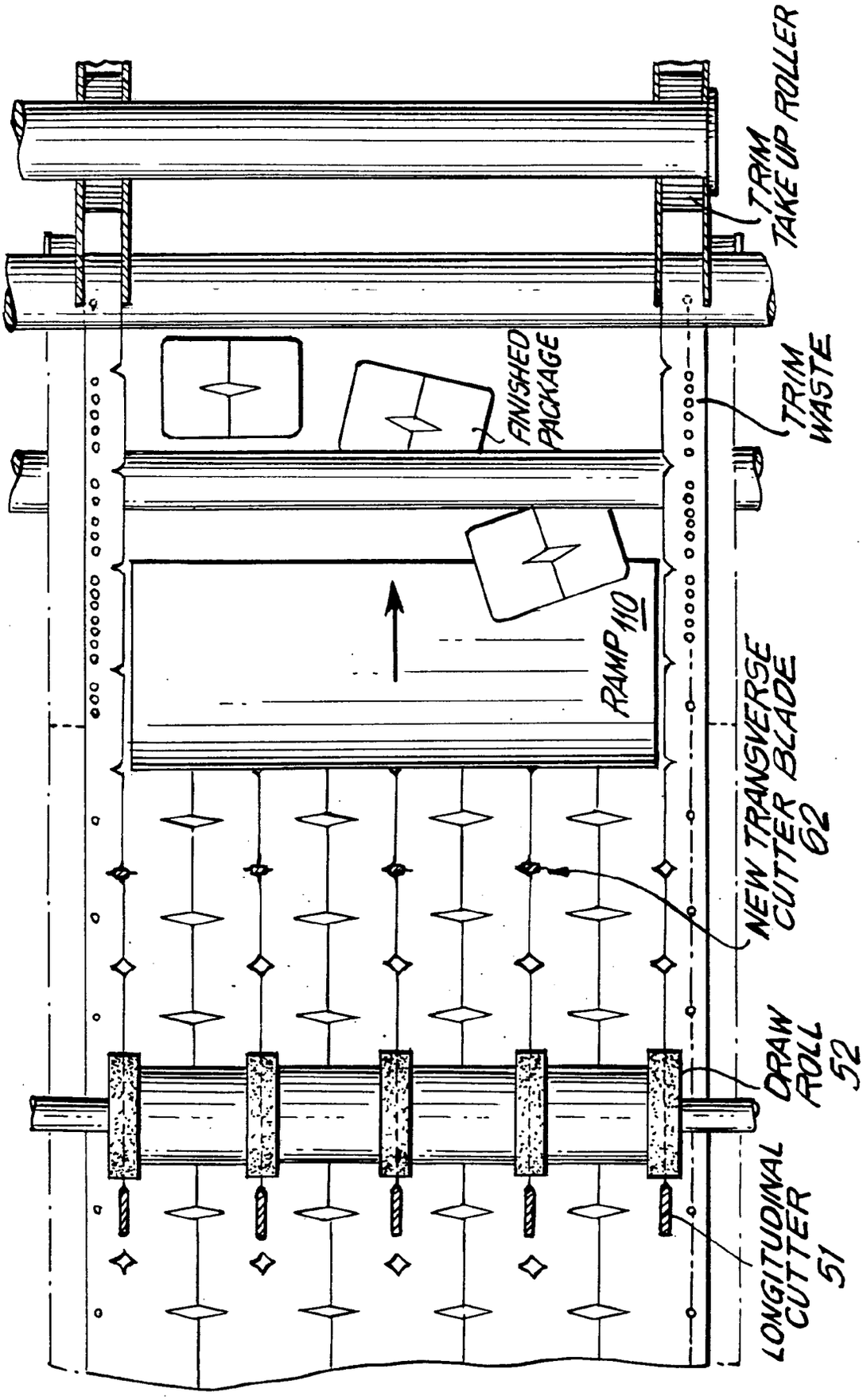
TRIM TAKE UP ROLLER
FINISHED PACKAGE
TRIM WASTE
RAMP 110
NEW TRANSVERSE CUTTER BLADE 62
DRAW ROLL 52
LONGITUDINAL CUTTER 51

FIG. 12

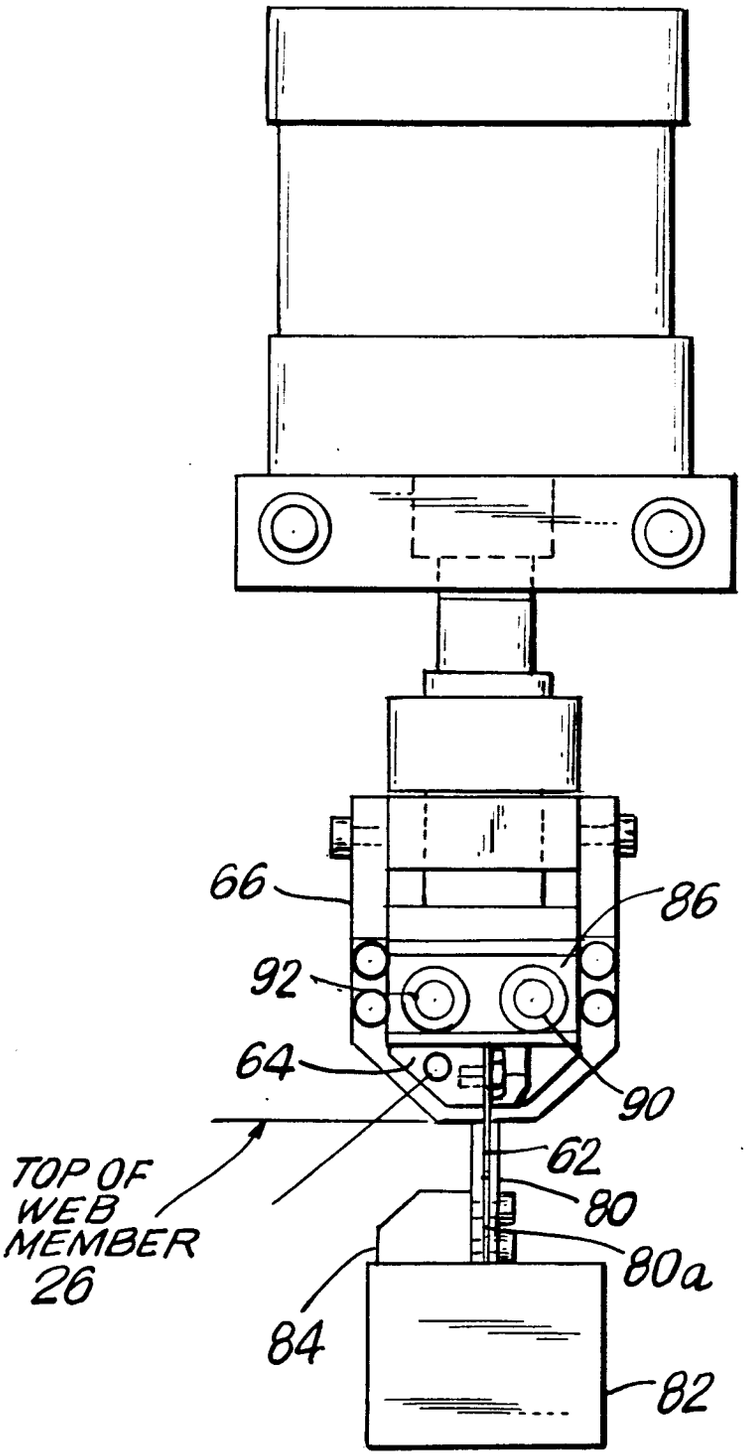

FIG.13

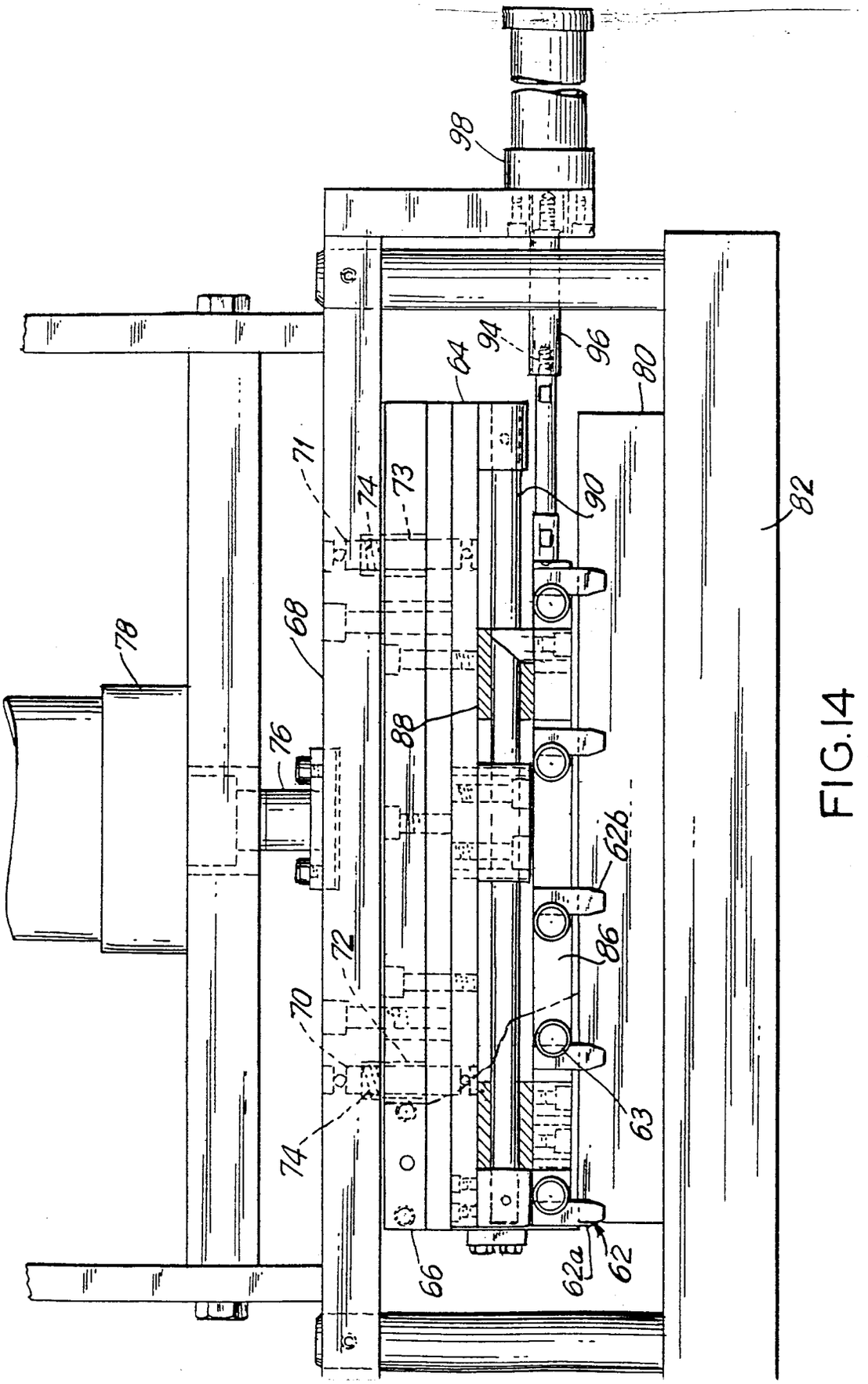

FIG.14

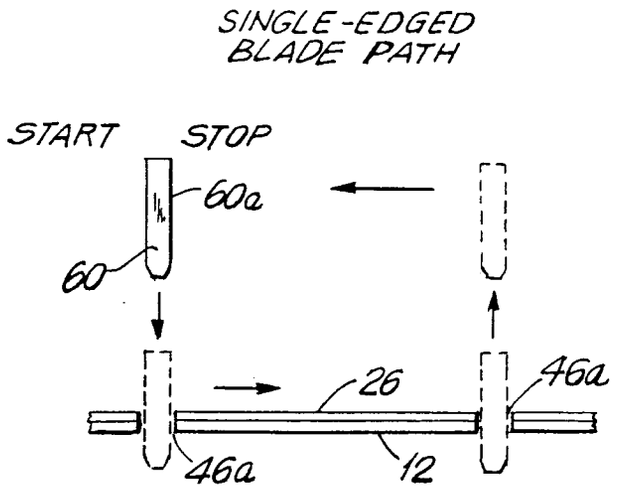
SINGLE-EDGED
BLADE PATH
START
STOP
60a
60
26
46a
46a
12

FIG. 15

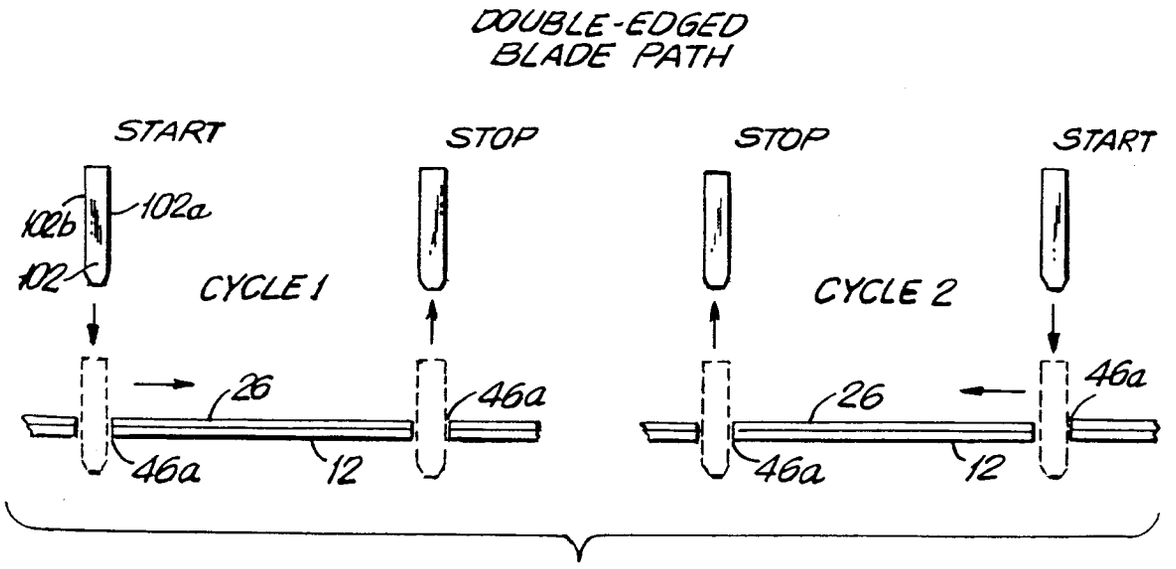
DOUBLE-EDGED
BLADE PATH
START
STOP
STOP
START
102b
102a
102
CYCLE 1
CYCLE 2
26
46a
46a
12
26
46a
46a
12

FIG. 16

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 91 31 0295

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,Y	EP-A-0 310 306 (SANFORD REDMOND) * column 10, line 1 - column 12, line 4; figures * ---	1-7,9, 10,12, 14,17, 18,20, 22,24	B65B61/06 B65B9/04 B26D1/10 B26D1/11 B26D9/00
Y	WO-A-8 801 220 (A. SZOGI) * page 1, line 4 - line 7 * * page 16, line 18 - page 21, line 27; figures * ---	1-7,9, 10,12, 14,17, 18,20, 22,24	
A	GB-A-2 184 086 (F. JEFFERIES) * page 5, line 81 - page 6, line 69 * ---	1,2,7, 10,12, 14,18,22	
A	US-A-3 958 051 (T. SMITH) * column 3, line 40 - column 4, line 25; figure 1 * -----	7,14,18, 22	TECHNICAL FIELDS SEARCHED (Int. Cl.5) B65B B26D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	26 FEBRUARY 1992	JAGUSIAK A.H.G.

CATEGORY OF CITED DOCUMENTS

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

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

& : member of the same patent family, corresponding document

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