

May 10, 1966

H. E. KASTING

3,250,187

BAG MAKING MACHINE

Filed June 26, 1963

28 Sheets-Sheet 1

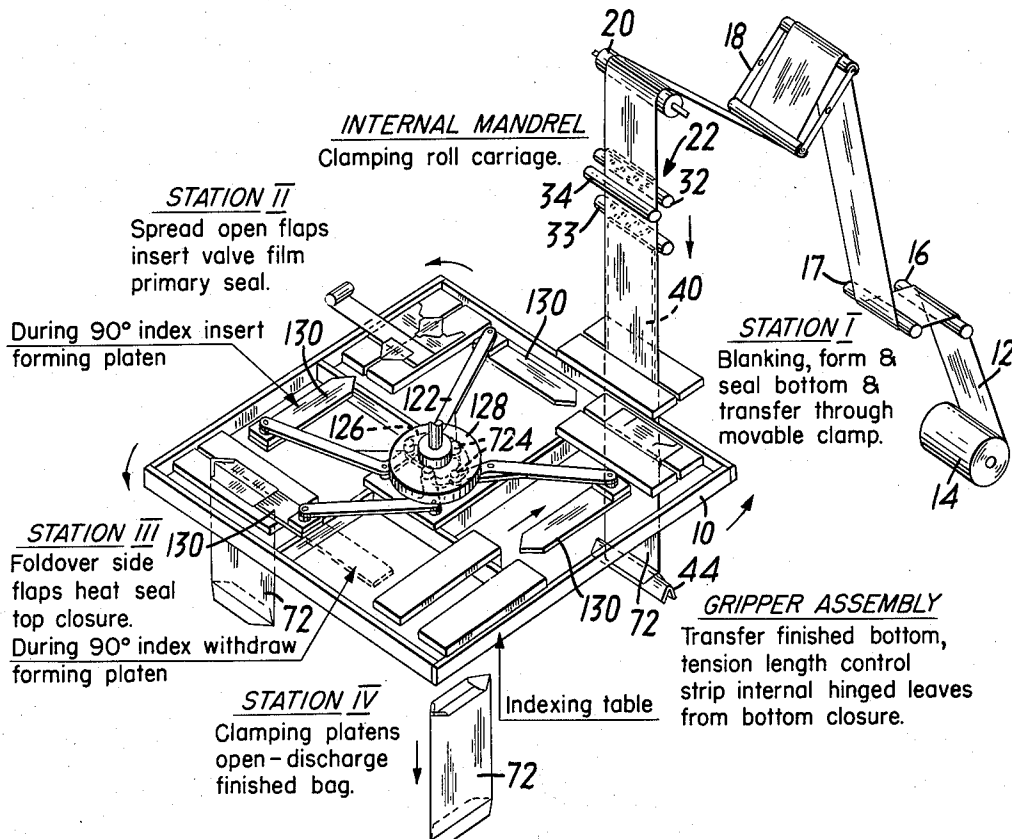


FIG. 1

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BY

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May 10, 1966

H. E. KASTING

3,250,187

BAG MAKING MACHINE

Filed June 26, 1963

28 Sheets-Sheet 2

ATTORNEY

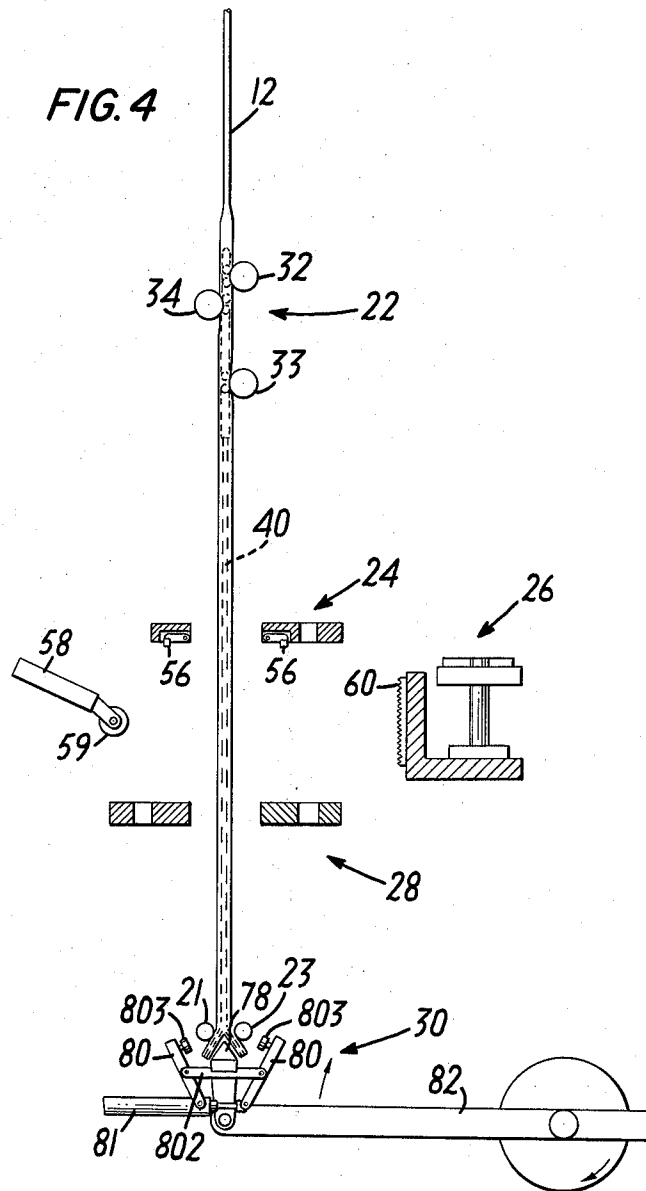
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H. E. KASTING
BAG MAKING MACHINE

3,250,187

Filed June 26, 1963

28 Sheets-Sheet 3



INVENTOR.
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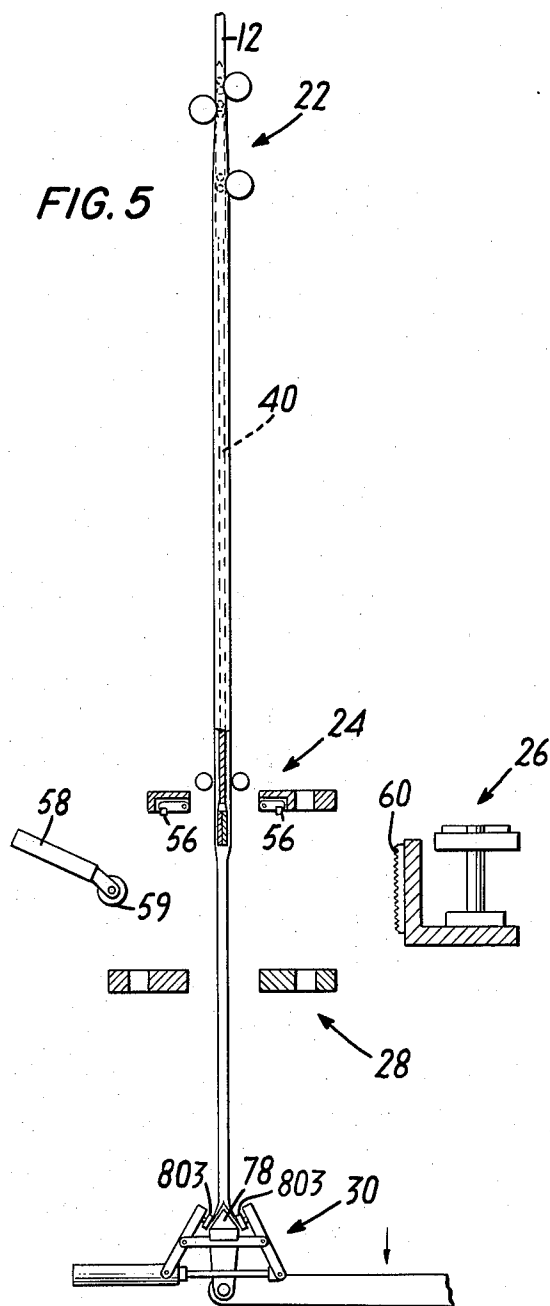
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3,250,187

Filed June 26, 1963

28 Sheets-Sheet 4



INVENTOR.
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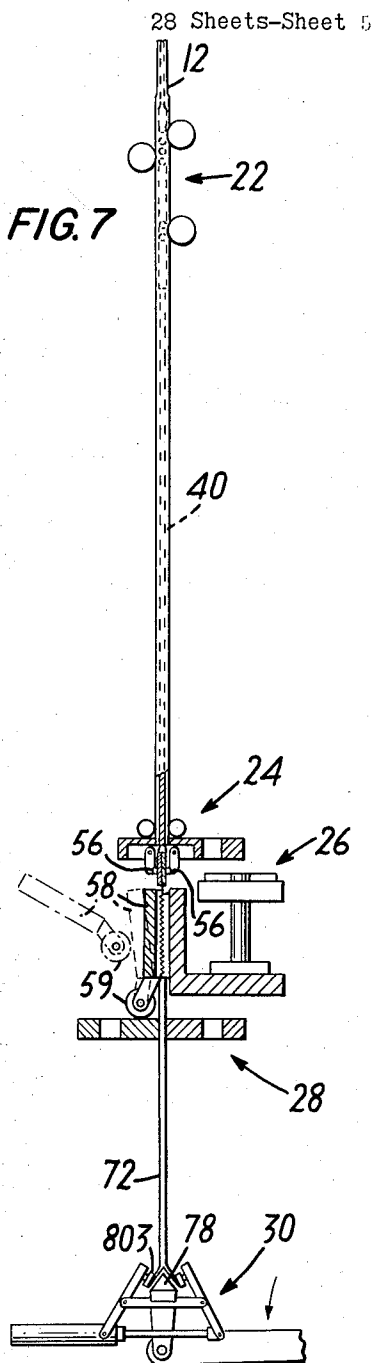
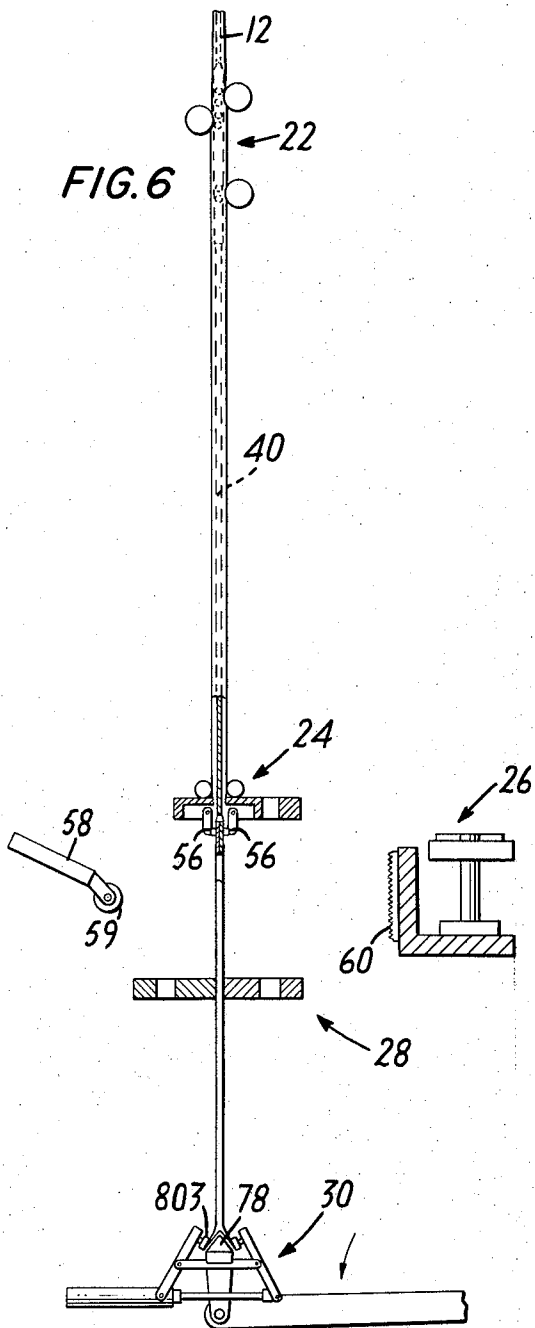
May 10, 1966

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BAG MAKING MACHINE

Filed June 26, 1963



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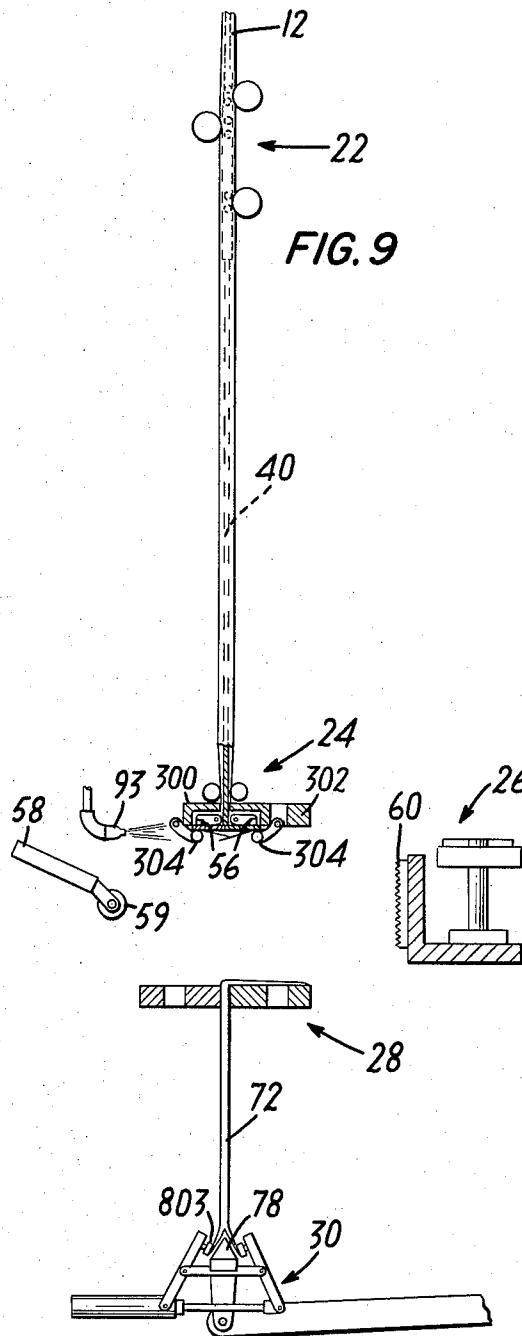
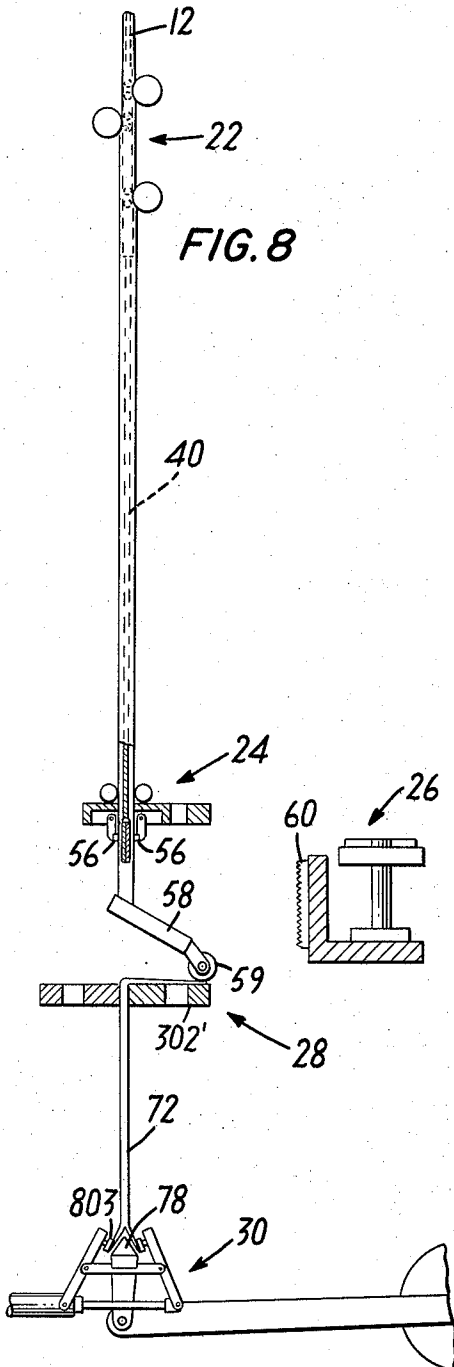
May 10, 1966

H. E. KASTING
BAG MAKING MACHINE

3,250,187

Filed June 26, 1963

28 Sheets-Sheet 6



INVENTOR.
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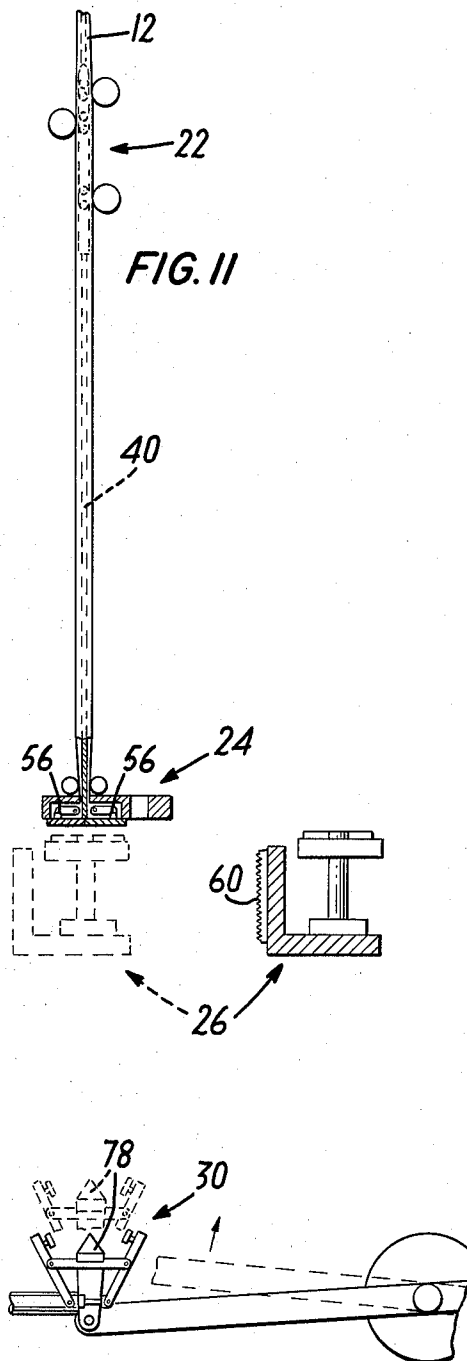
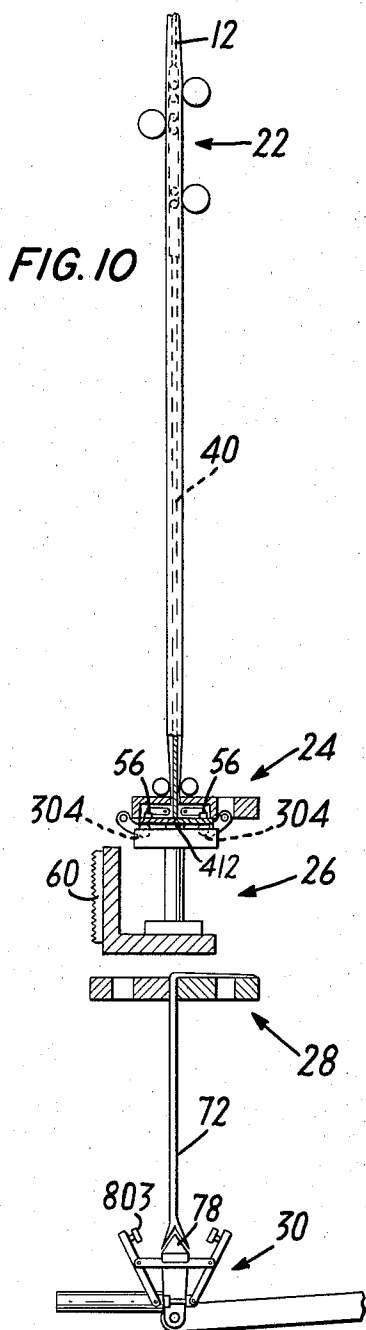
H. E. KASTING

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BAG MAKING MACHINE

Filed June 26, 1963

28 Sheets-Sheet 7



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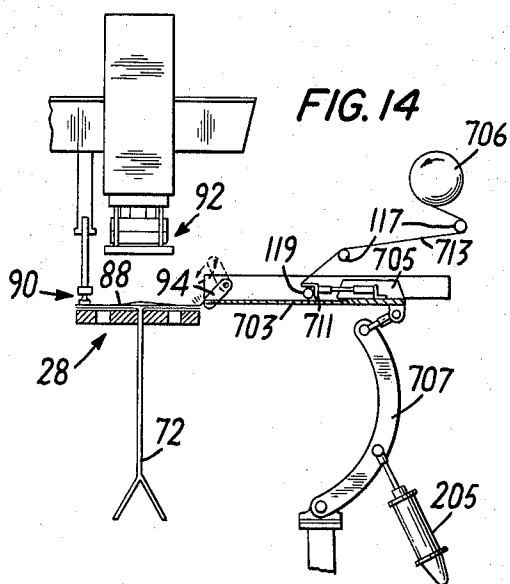
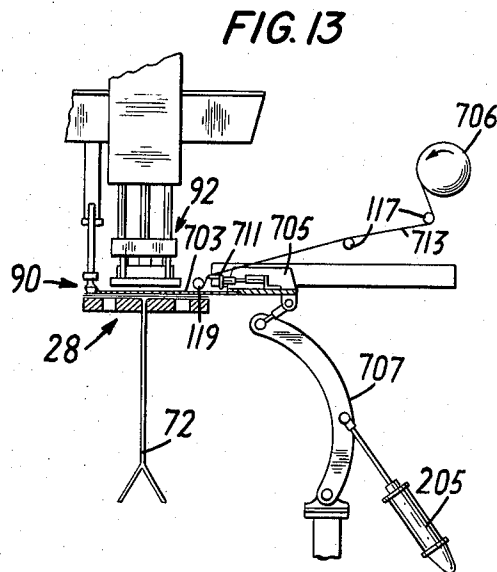
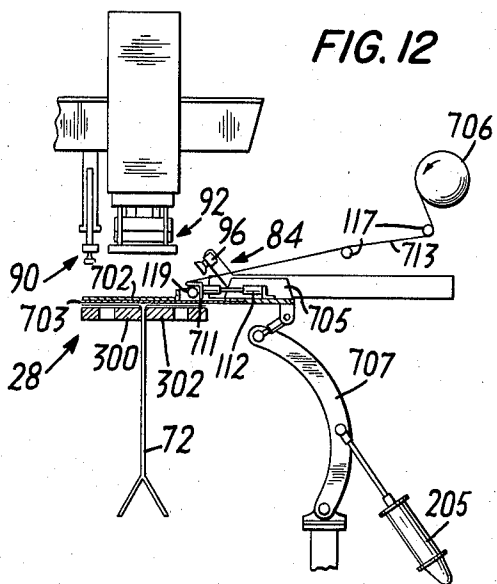
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H. E. KASTING
BAG MAKING MACHINE

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STATION II

INVENTOR.
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BAG MAKING MACHINE

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FIG. 15

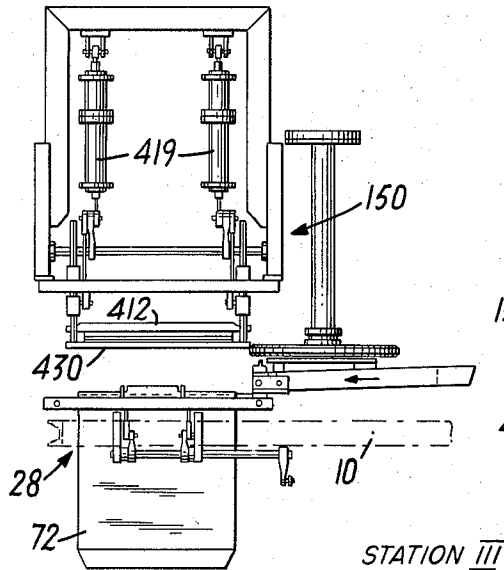


FIG. 16

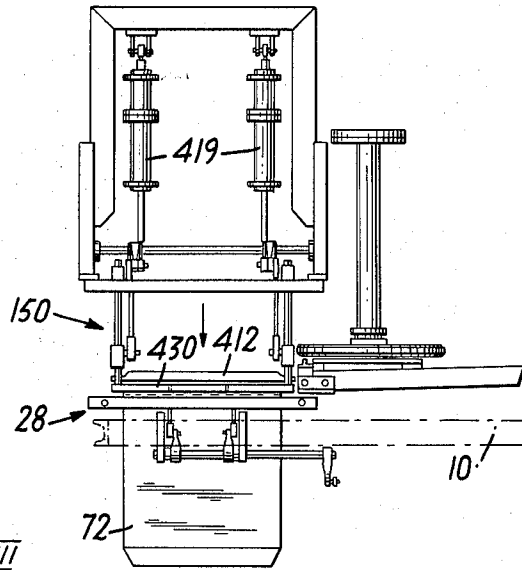


FIG. 17

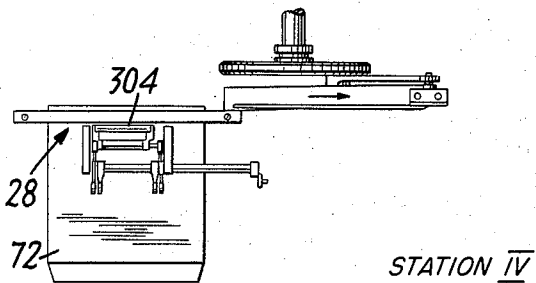
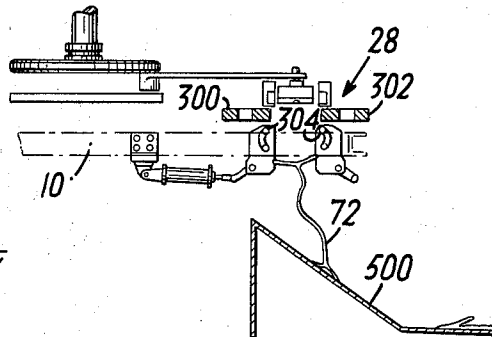


FIG. 18



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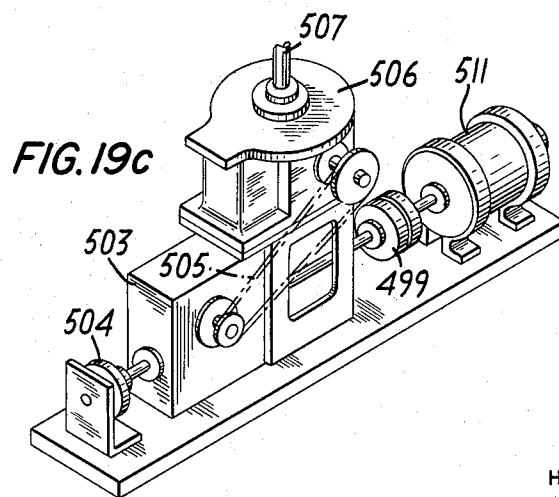
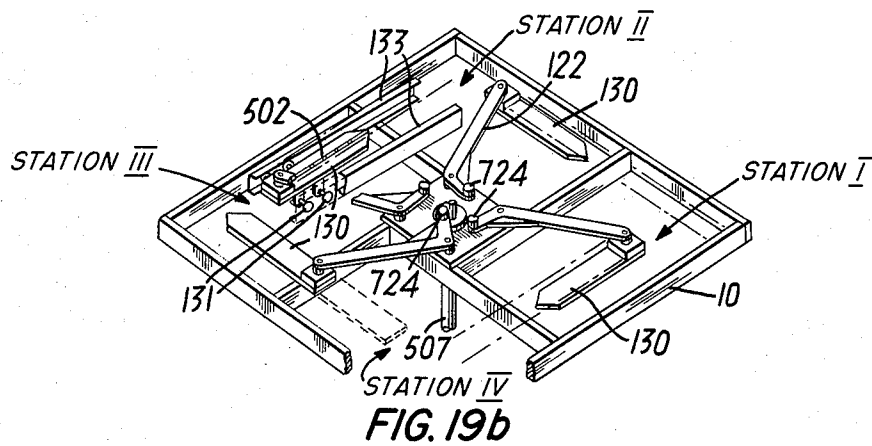
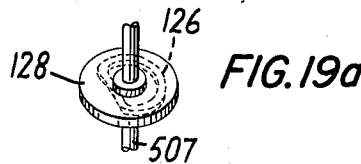
May 10, 1966

H. E. KASTING
BAG MAKING MACHINE

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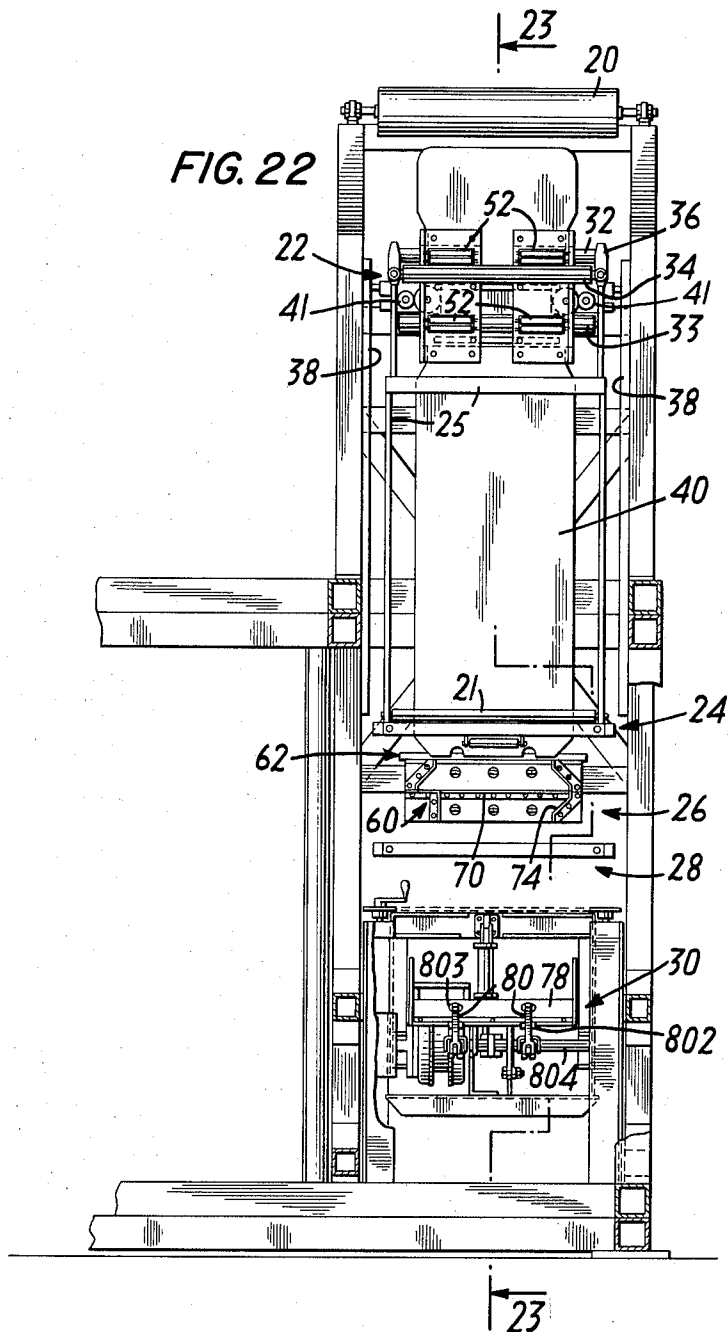
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H. E. KASTING
BAG MAKING MACHINE

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3,250,187

BAG MAKING MACHINE

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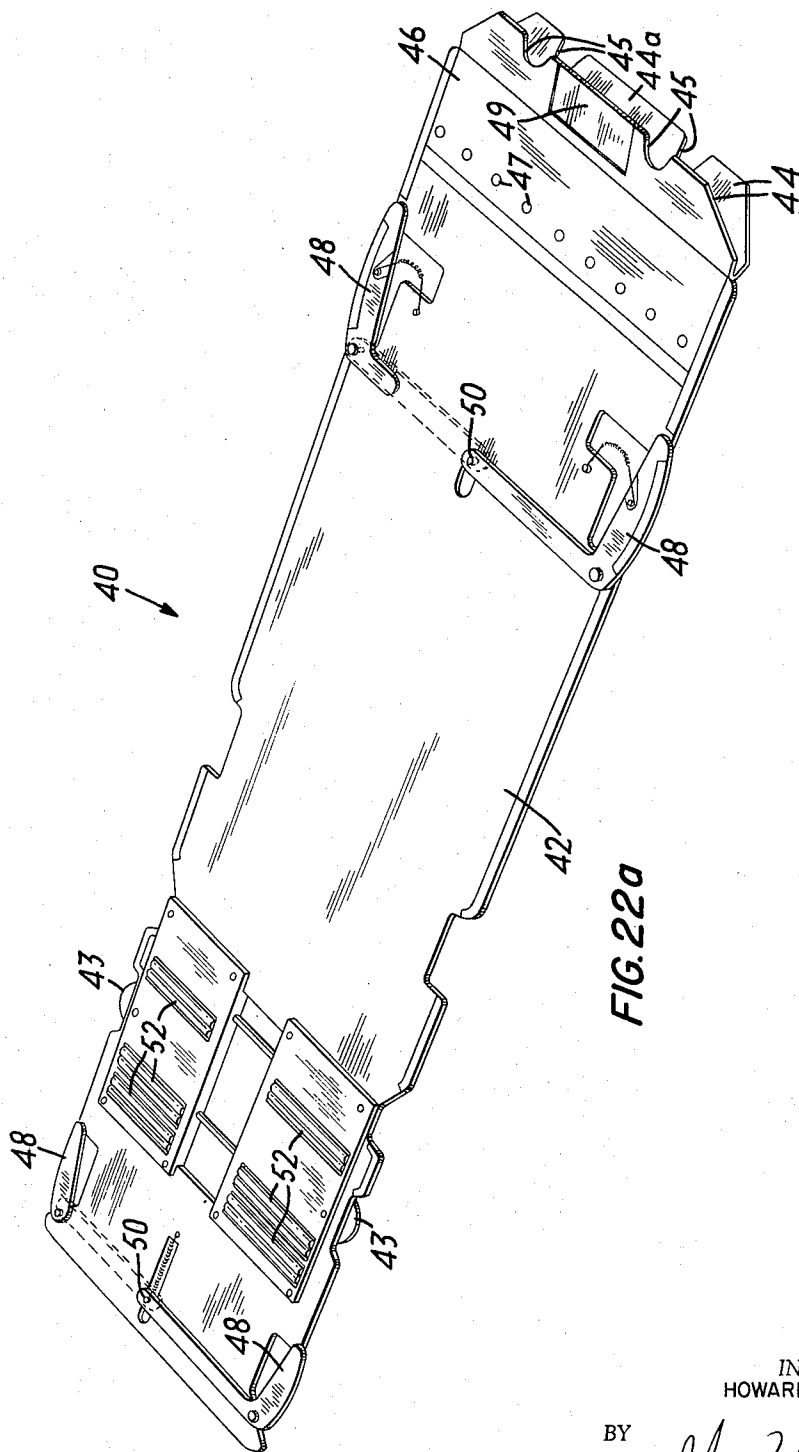


FIG. 22a

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3,250,187

BAG MAKING MACHINE

Filed June 26, 1963

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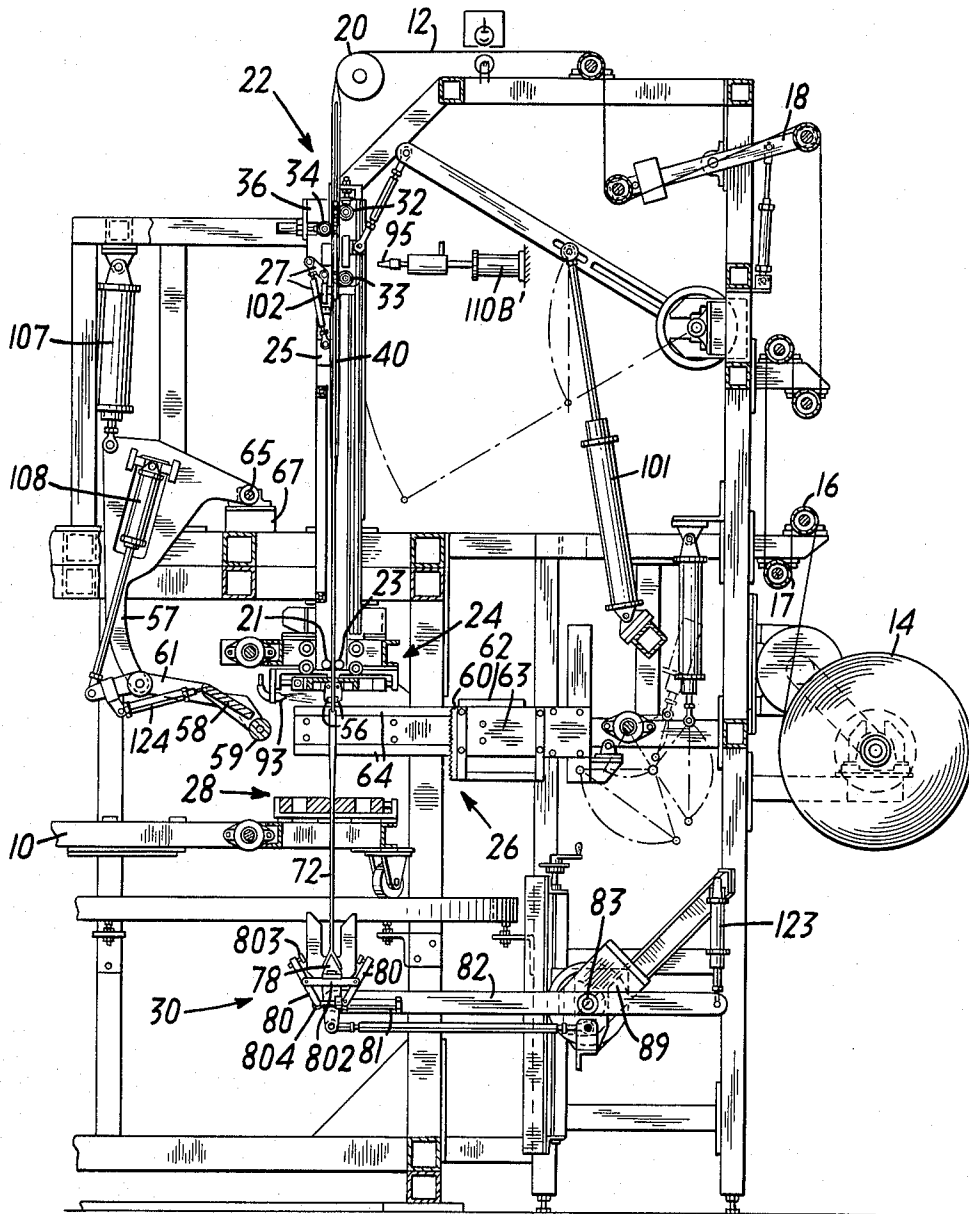


FIG. 23

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3,250,187

BAG MAKING MACHINE

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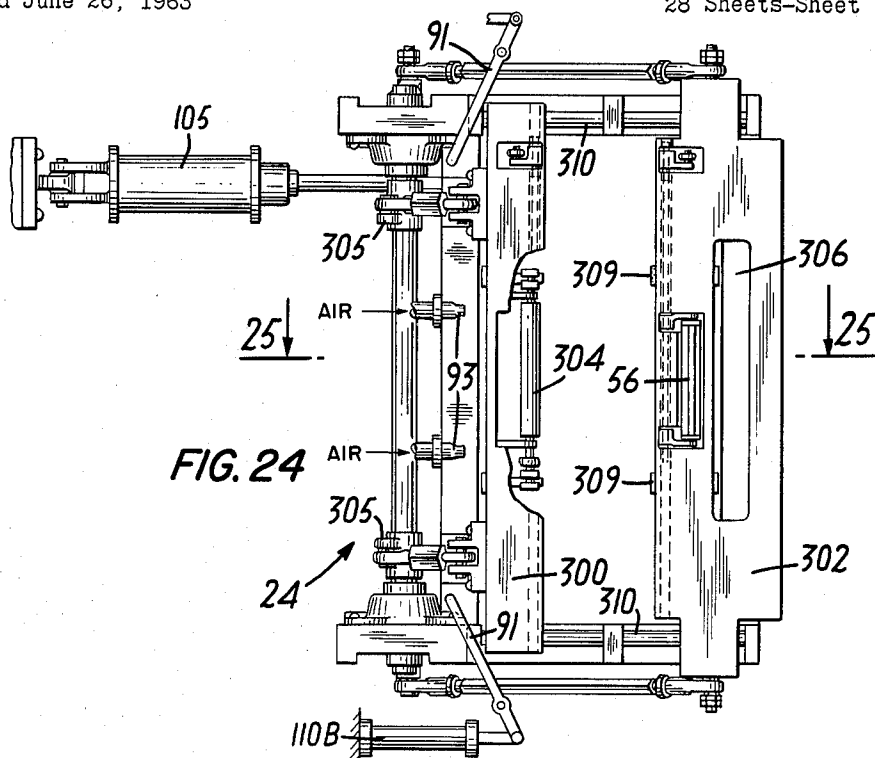


FIG. 24

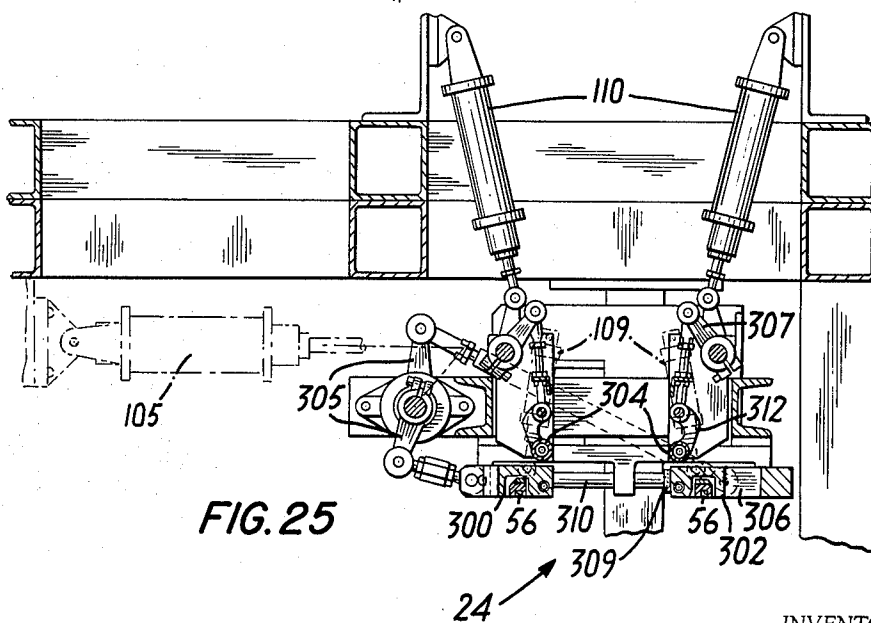


FIG. 25

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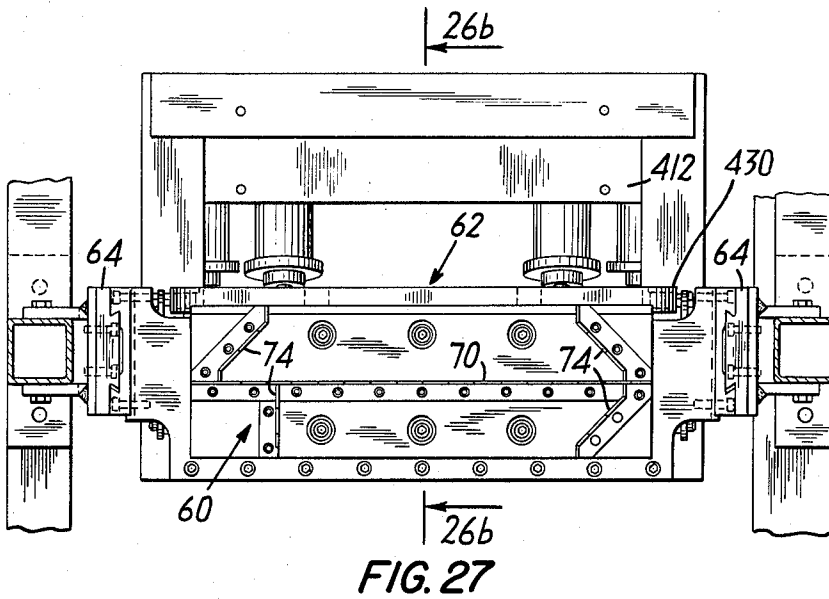
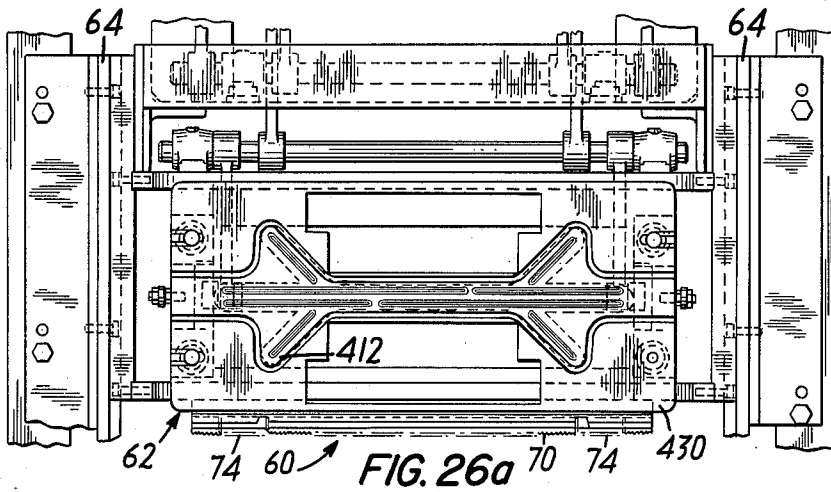
H. E. KASTING

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BAG MAKING MACHINE

Filed June 26, 1963

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INVENTOR
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BAG MAKING MACHINE

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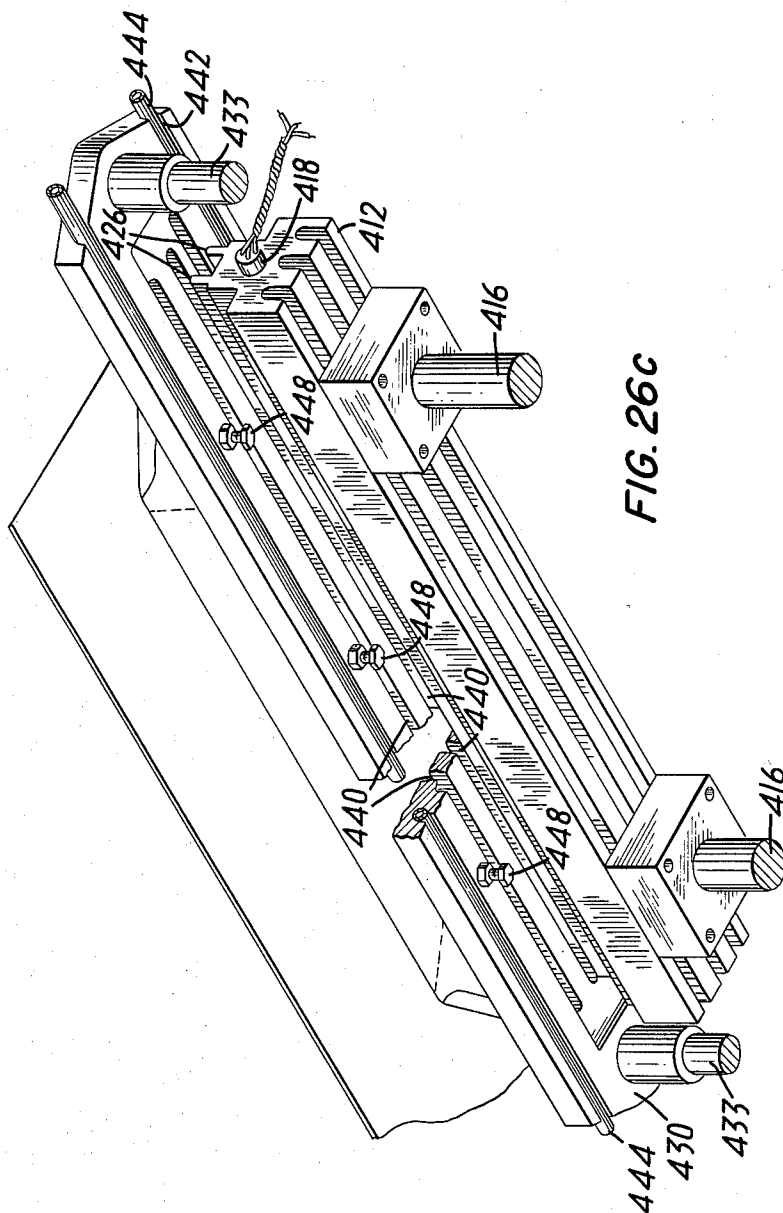


FIG. 26c

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H. E. KASTING
BAG MAKING MACHINE

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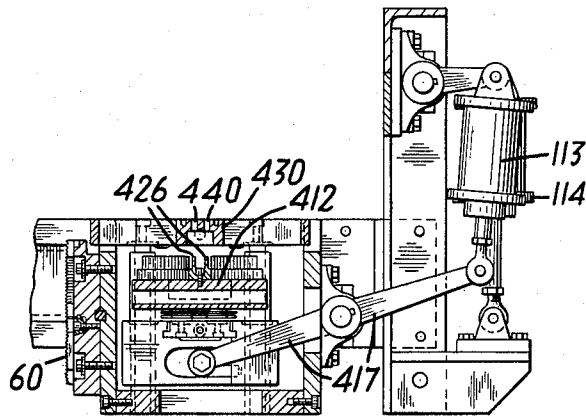


FIG. 26b

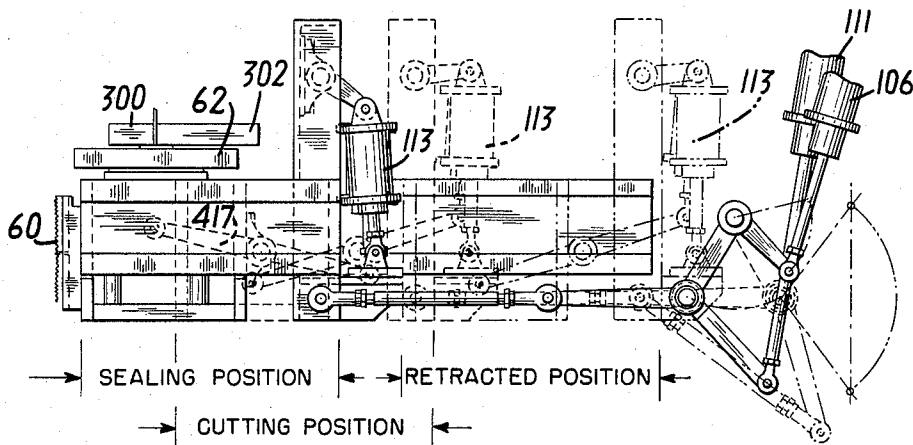


FIG. 28

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3,250,187

BAG MAKING MACHINE

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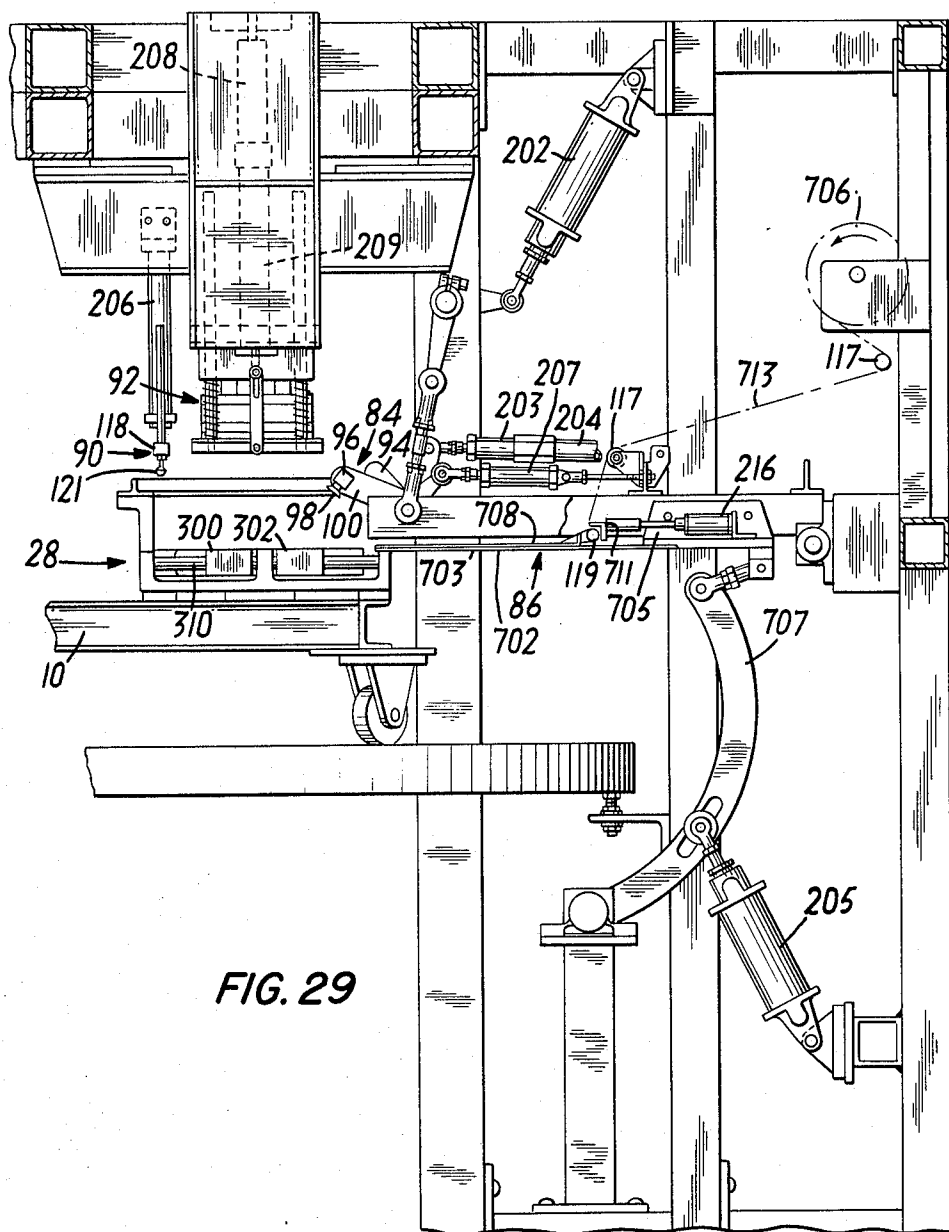


FIG. 29

STATION II

INVENTOR
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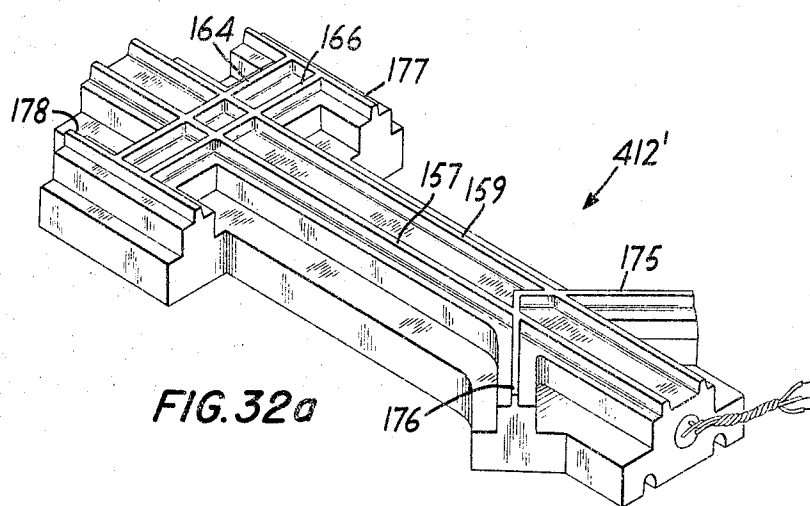
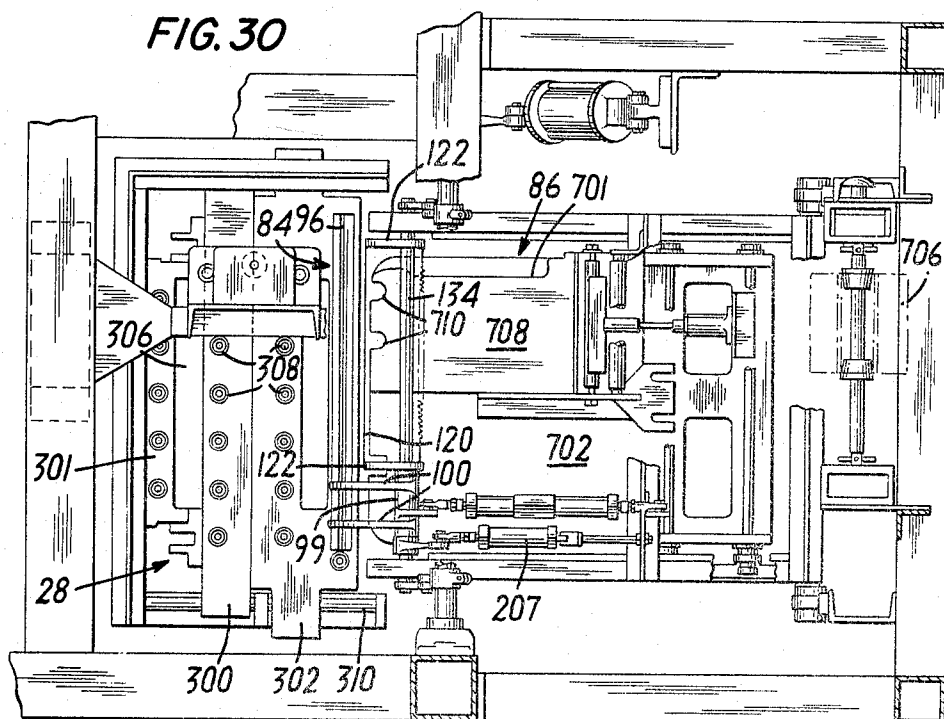
H. E. KASTING

3,250,187

BAG MAKING MACHINE

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3,250,187

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FIG. 31

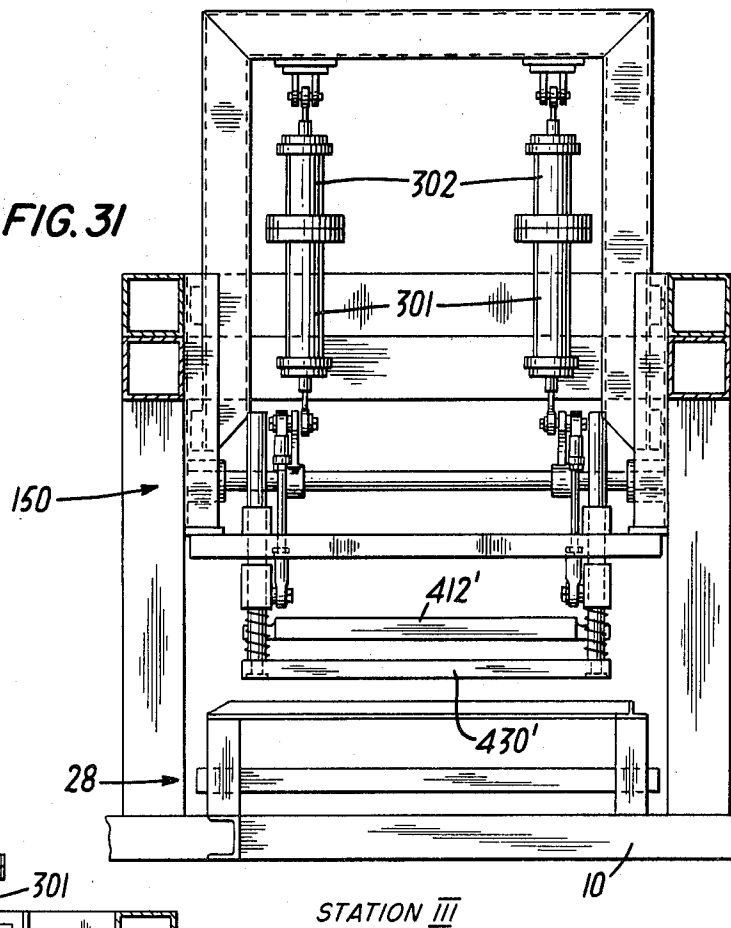
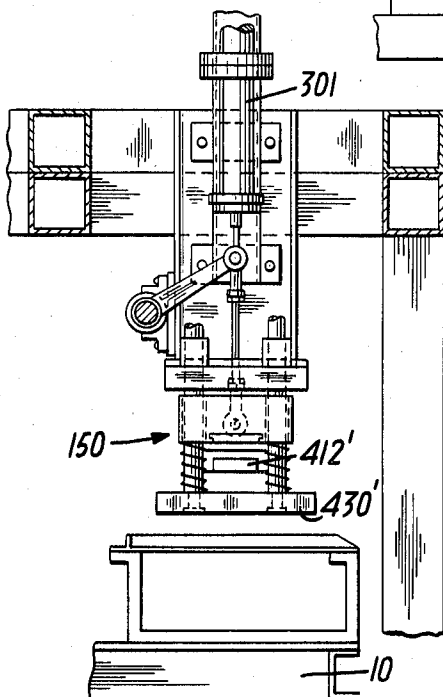


FIG. 32



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May 10, 1966

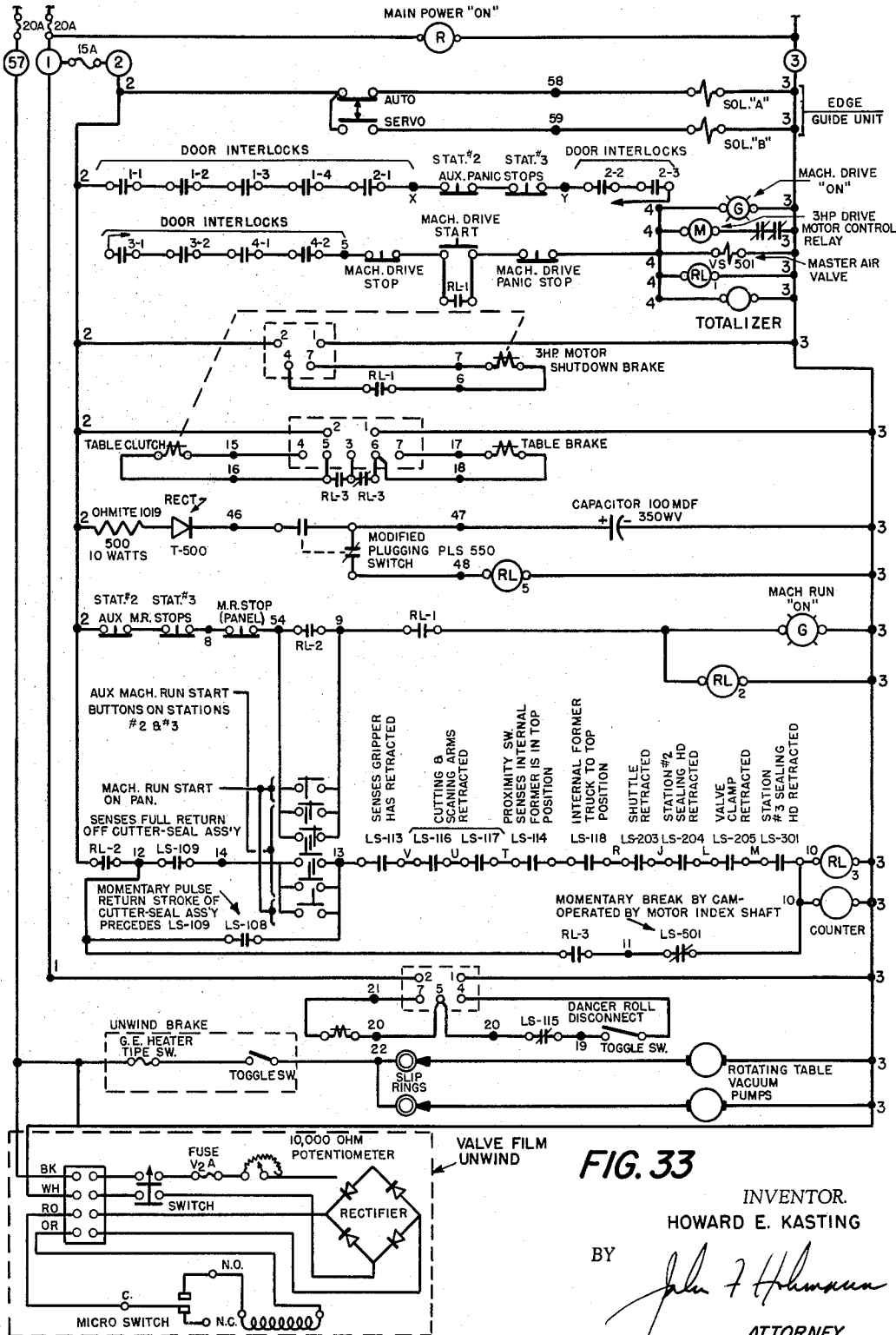
H. E. KASTING

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BAG MAKING MACHINE

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H. E. KASTING

3,250,187

BAG MAKING MACHINE

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FIG. 34b

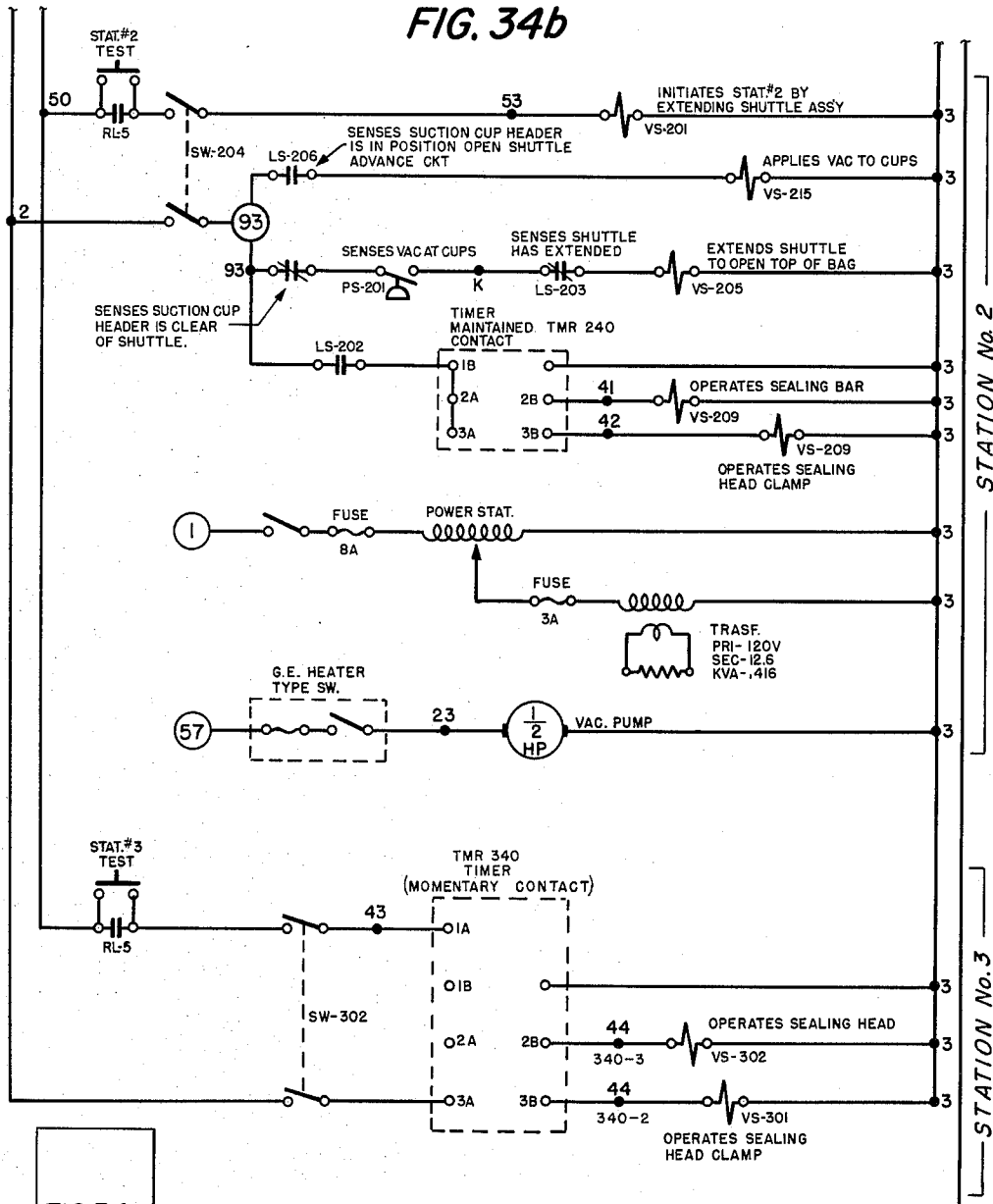


FIG. 34a

FIG. 34

FIG. 34b

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3,250,187

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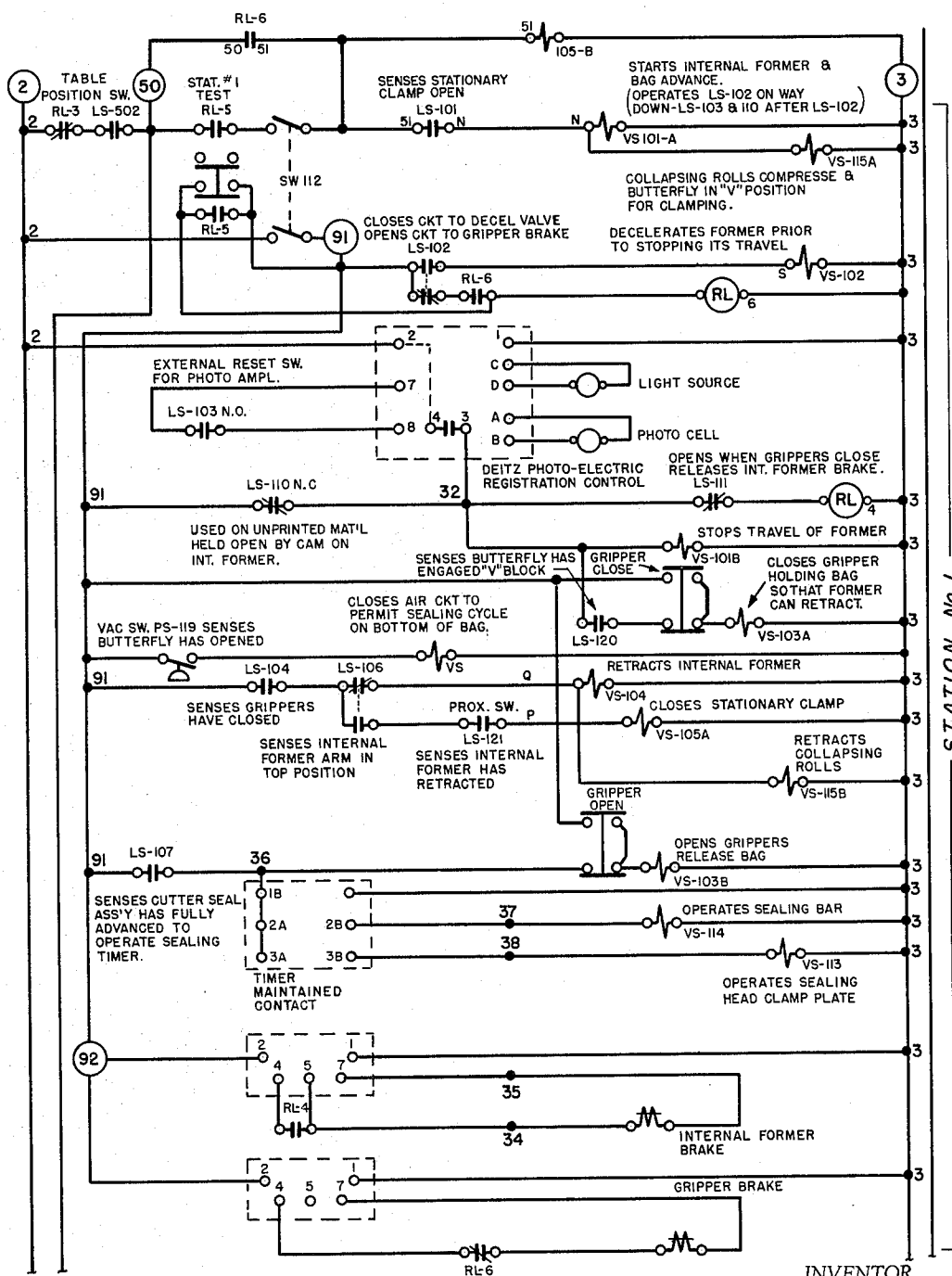


FIG. 34a

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H. E. KASTING
BAG MAKING MACHINE

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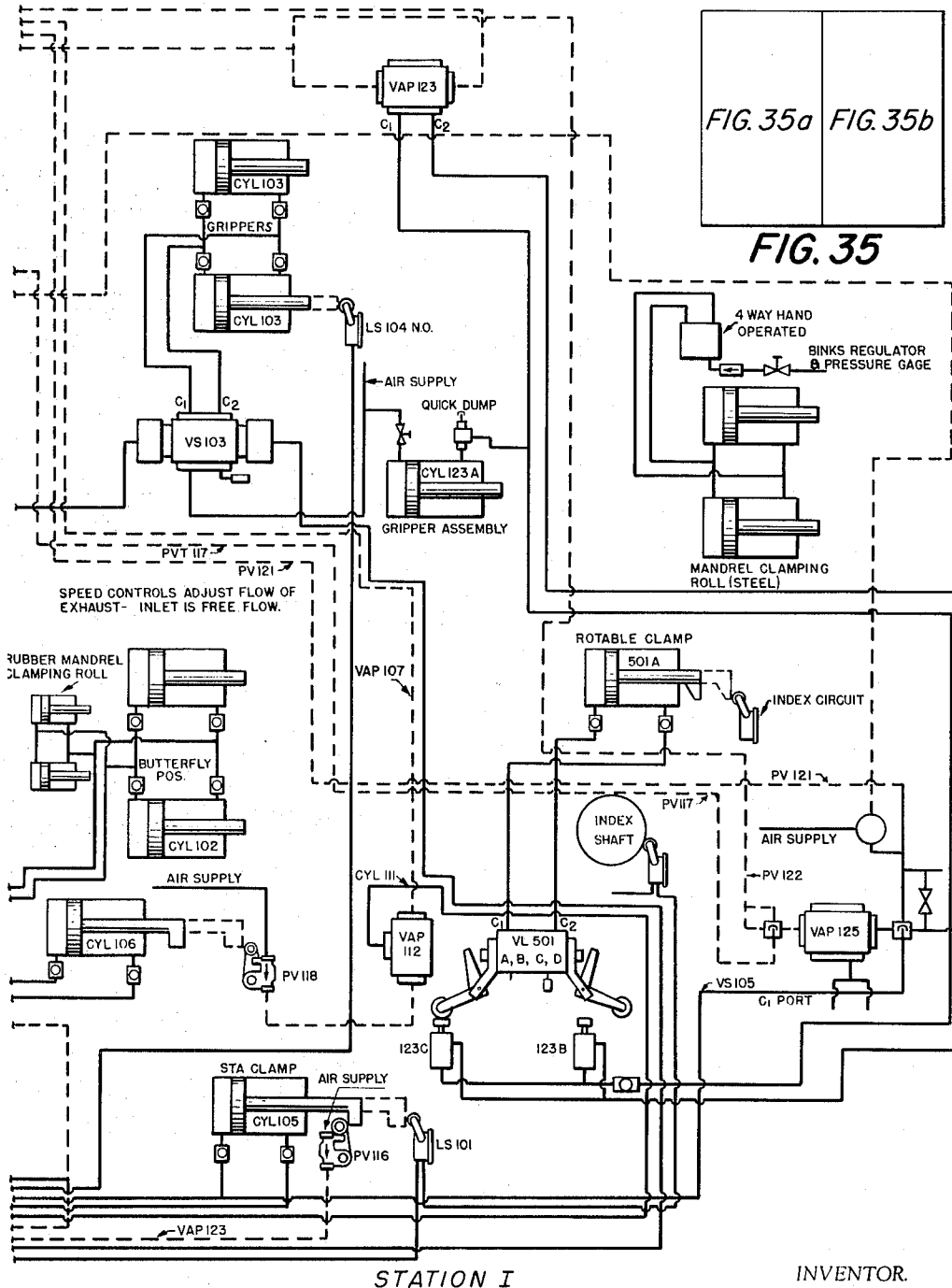


FIG. 35b

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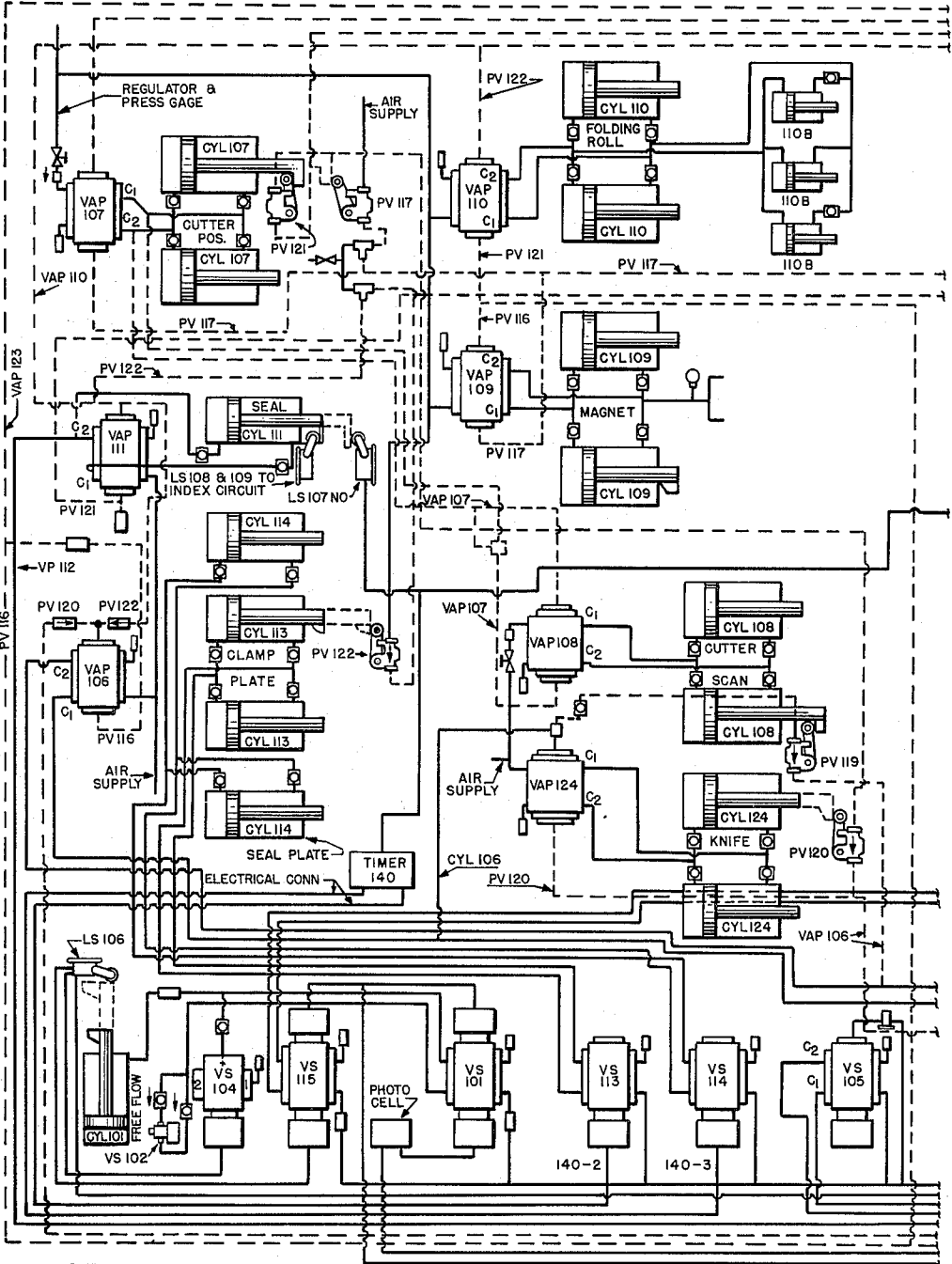
H. E. KASTING

3,250,187

BAG MAKING MACHINE

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STATION I

FIG. 35a

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BAG MAKING MACHINE

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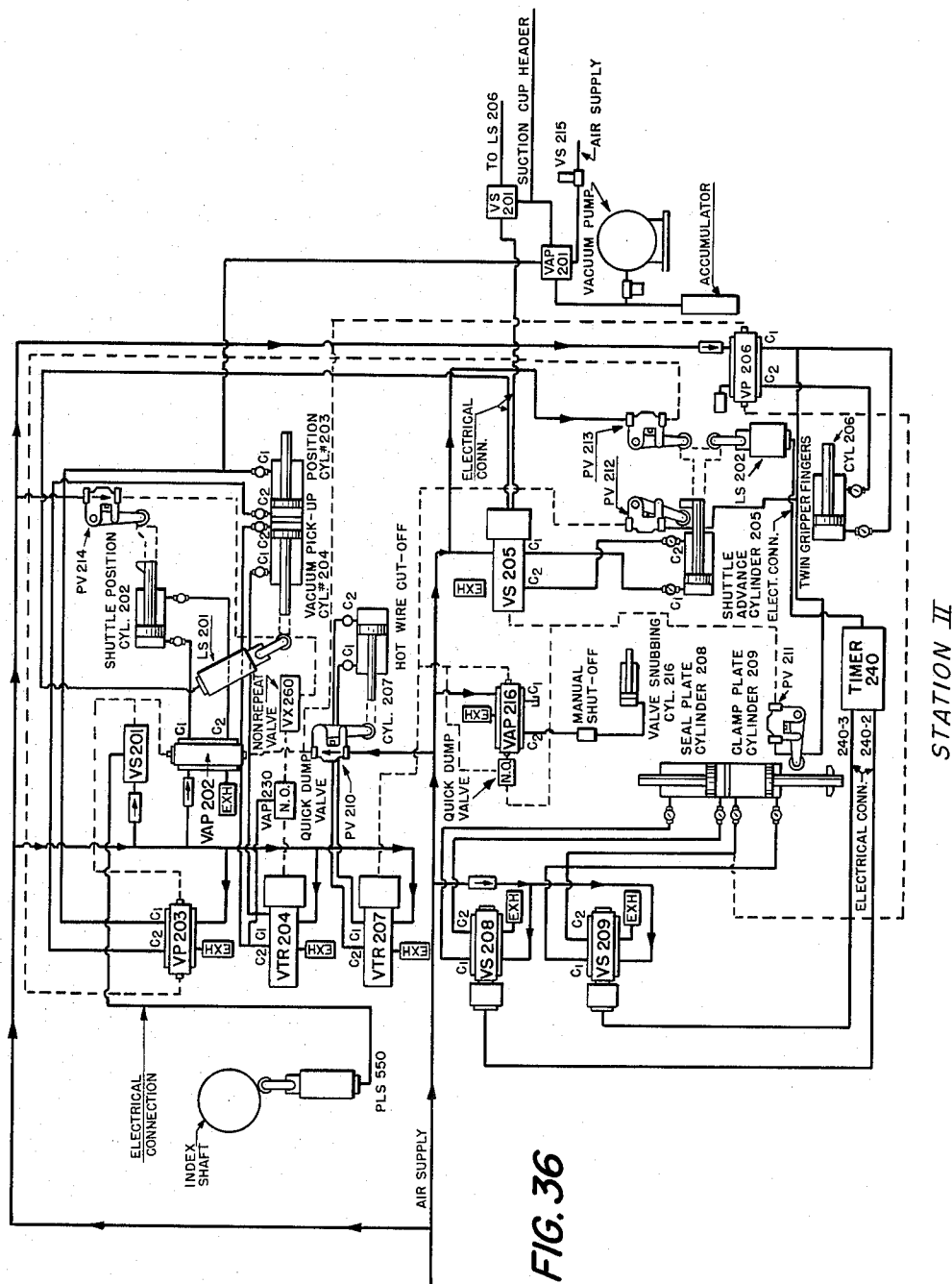


FIG. 36

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BAG MAKING MACHINE

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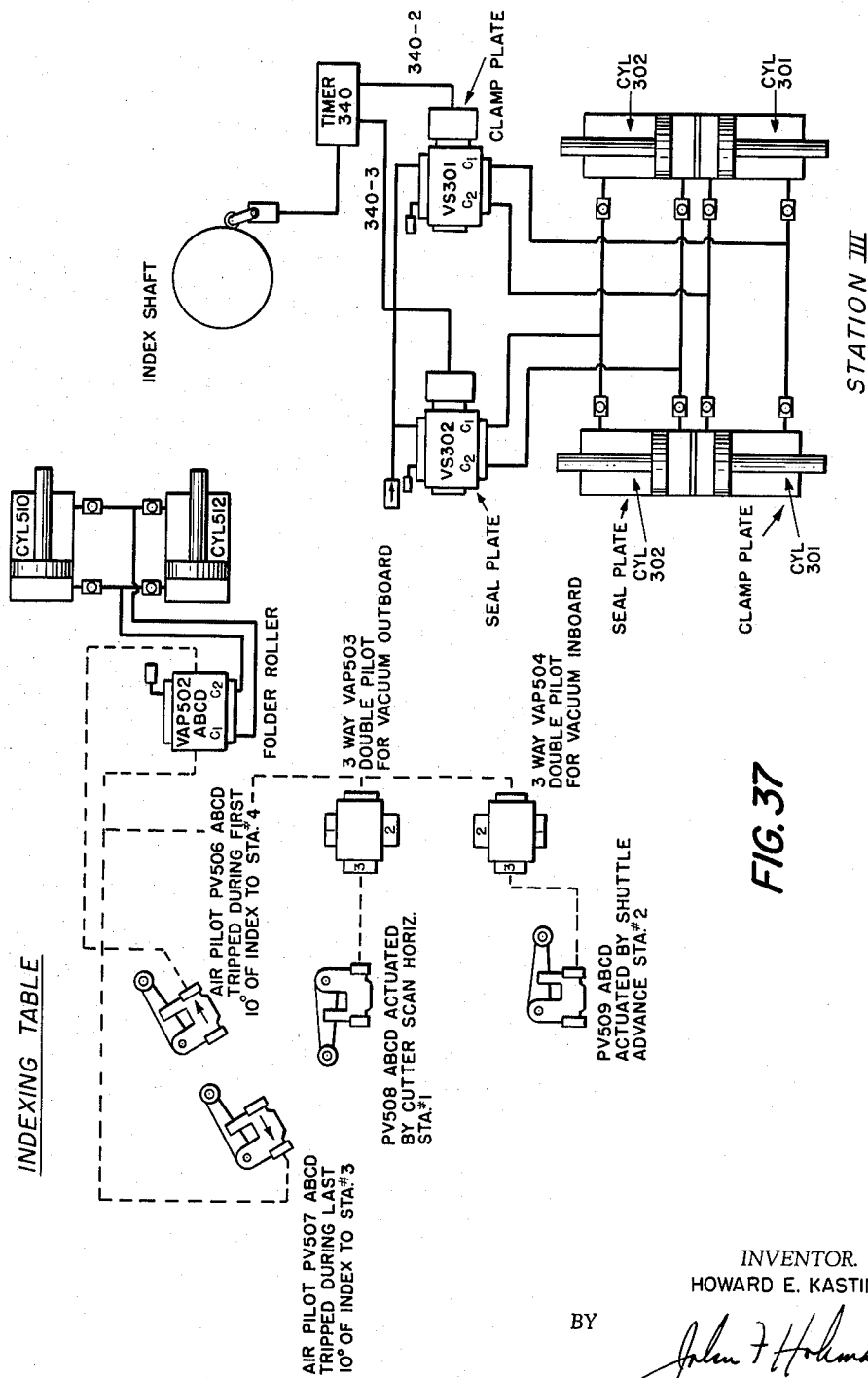


FIG. 37

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3,250,187

BAG MAKING MACHINE

Howard E. Kastig, Park Forest, Ill., assignor to Union Carbide Corporation, a corporation of New York
Filed June 26, 1963, Ser. No. 290,665
27 Claims. (Cl. 93-8)

This invention relates generally to a bag making machine and, more particularly, to an automatic machine for making industrial shipping bags from heavy gauge thermoplastic film.

It is the main object of this invention to provide an improved apparatus for making industrial bags from tubular thermoplastic film.

It is another object of the invention to provide an improved apparatus for making rectangular lapped heat sealed end closures in tubular thermoplastic film.

It is still another object of the invention to provide such an apparatus wherein the heat seals in the end closure are made against an internal mandrel-supported work piece or platen.

A further object of the invention is to provide an apparatus for forming a valved end closure in tubular thermoplastic film.

Other aims and advantages of the invention will be apparent from the following description and appended claims.

In accordance with the present invention, there is provided an apparatus for making a bag having rectangular heat-sealed end closures from flattened tubular thermoplastic film, which apparatus comprises an internal mandrel adapted to fit within the flattened tubular film and means for disposing the mandrel within the film; collapsible work piece means for infolding a pair of opposed side portions and a pair of opposed end portions at one end of said film over the mandrel so as to form a first rectangular end closure; means for heat sealing the infolded side and end portions together so as to seal the end closure; means for displacing the internal mandrel and the film relative to each other along the axis of the tubular film; means for infolding a pair of opposed side portions and a pair of opposed end portions at the other end of the film so as to form a second rectangular end closure; means for disposing a flat forming platen within the second end closure and lap heat sealing the infolded side and end portions together against the flat platen; and means for withdrawing the flat forming platen from the sealed closure.

In one embodiment of the invention, there is provided an apparatus for receiving flattened continuous tubing of bag-forming material; to blank flaps into and cut off a predetermined length of the tubing; to fold the blanked flaps about an internal collapsible work piece and forming mandrel and seal overlapping layers of the bag-forming material into a flat rectangular-shaped bottom closure at the advance end of the tubing; to withdraw the internal forming mandrel; to insert into the other end of the bag a sheet of valve-forming material between overlapping blanked flaps of the bag-forming material; to fold both materials about an internal forming-sealing platen; overlapping the materials and heat-sealing them into a flat rectangular-shaped top closure having a tubular filling valve integral with the closure; to collapse the work piece; and to withdraw the internal form, and thereby make a rugged bag wherein the overlapped areas are substantially as resistant to rupture as the film of the bag walls.

In the drawings:

FIG. 1 is a schematic isometric view illustrating the basic operating elements of the four stations (I, II, III, IV) in the preferred embodiment of the invention;

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FIGS. 2 and 3 show the form of the tubular film at various stages throughout the apparatus of FIG. 1;

FIGS. 4-11 are schematic elevation views illustrating sequentially the position of the various elements of Station I through one complete cycle of the operation thereof;

FIGS. 12-14 are elevation views illustrating sequentially the position of the various elements of Station II through one complete cycle of the operation thereof;

FIGS. 15 and 16 are elevation views illustrating sequentially the position of the various elements of Station III through one complete cycle of the operation thereof;

FIGS. 17 and 18 are elevation and sectional views, respectively, illustrating the operation of Station IV;

FIGS. 19a-19c are a series of isometric views illustrating the driving and control mechanisms for the indexing table 10 and the forming platen 120 in the device of FIG. 1;

FIGS. 20 and 21 are plan and sectional views, respectively, of one of the clamping platen-foldover roll assemblies on the indexing table;

FIGS. 22 and 23 are front and side elevation views, partially in section, of Station I;

FIG. 22a is an enlarged isometric view of the internal mandrel 40 shown in FIGS. 22 and 23;

FIGS. 24 and 25 are bottom plan and sectional elevation views, respectively, of the stationary clamping platen-foldover roll assembly in Station I;

FIGS. 26a-26c are plan, elevation, and isometric views, respectively, of the blanking knife-heat sealer assembly in Station I;

FIG. 27 is an elevation view of the face of the male cutting member in the device shown in FIG. 26;

FIG. 28 is a sequence of elevation views illustrating the various positions of the blanking knife-heat sealer assembly through one complete cycle of the operation thereof;

FIGS. 29 and 30 are enlarged side elevation and plan views, respectively, of the flap spreading and valve inserting assembly in Station II;

FIGS. 31 and 32 are elevation views of the heat sealing assembly in Station III;

FIG. 32a is an isometric view of the face of the heat-seal bar in the heat sealing assembly in Station III;

FIG. 33 is a schematic diagram of the general electro-pneumatic control system;

FIGS. 34-37 are schematic diagrams of the electro-pneumatic control systems for Stations I, II, III, respectively.

A preferred embodiment of the present invention will now be described in detail by referring to the drawings.

Referring first to FIG. 1, the automatic machine generally comprises a rectangular frame of square tubular steel members supporting four fixed operating stations identified as Stations I, II, III, and IV. Central to the machine and rotatably mounted on the frame is a square horizontal indexing table 10. Symmetrically mounted on the corners of the indexing table are four identical clamping platens which are successively intermittently indexed to cooperate with the four fixed operating Stations I, II, III, and IV. During the dwell period of the indexing table when the clamping platens are indexed with the fixed operating stations, sequential operations of cutting, overfolding, and sealing of the bag flaps and valve are performed on the film walls of the bag blanks. Thus, at any given instant, there are at least three bags in successive stages of completion clamped in the clamping platens on the turntable. All major cutting, forming, and sealing operations are performed on the blanks when the turntable is stationary and indexed at the fixed stations, while insertion and withdrawal of a top forming platen for the top closure of the bag is performed

while the turntable is moving from Stations II to III and III to IV, respectively.

The operations performed at Station I include the input of the flattened tubular film, blanking and cutting off the bag blanks, and forming and sealing the bottom closures of the bags. At Station II, sequential operations are performed to spread open the flaps of the top closures of the bags, to lay onto the opened flaps a film sheet that subsequently forms the valve, and to make a first heat seal to weld the valve sheet to the underside of one end tab. Between Stations II and III, a forming platen is introduced over the outfolded side flaps and the valve sheet and under the infolded end tab at the opposite end from the valve sheet. The side flaps are then infolded at Station III so as to form the valve sheet into a tube which opens into the interior of the bag, and a composite second heat seal is made to complete the top closure. At Station IV, the clamping platen is opened to discharge the finished bag into a receiving chute.

Referring now in more detail to FIG. 1, flattened tubular film 12, such as 10-mil seamless polyethylene tubing, is withdrawn from a supply roll 14 over idler transport rolls 16, 17 and then over a weighted dancer roll unit 18 and an axial guiding or steering roll 20. The weighted dancer roll unit 18 serves to maintain the desired tension in the tube 12, and the guiding roll 20 controls the side register of the tube. From the roll 20, the tube is passed downwardly through a series of assemblies comprising Station I.

Station I—Structure

Referring first to FIG. 4, Station I comprises in general an internal mandrel-clamping roll carriage assembly 22, an upper stationary clamping platen-foldover roll assembly 24, a blanking knife-heat sealer assembly 26, any one of a plurality of lower clamping platen assemblies 28 mounted on the rotatable indexing table, and a gripper assembly 30.

The elements of Station I are shown in more detail in FIGS. 22 and 23. The clamping roll carriage generally comprises two vertically spaced apart horizontally mounted clamping rolls 32, 33 on one side of the flattened tube 12 and a third clamping roll 34 positioned between the rolls 32, 33 on the other side of the tube 12. All the clamping rolls 32, 33, and 34 are rotatably mounted in a single movably mounted rigid frame or carriage 36 provided with pinions which mesh with vertical racks 38. The purpose of the clamping rolls 32, 33, and 34, which are all in continuous contact with the outer surface of the tube 12, is to support and transport a relatively thin flat internal mandrel 40 within the tube 12.

As shown in more detail in FIG. 22a, the internal mandrel 40, which is adapted to fit within the flattened tubular film 12 and to remain therein while the tube 12 is continually fed into Station I, generally comprises a body portion 42 of sheet metal with a pair of collapsible trapezoidal leaves 44 of a magnetic metal hinged on the bottom edge thereof. The leaves 44 can be spread into a horizontal position, thereby forming an internal mandrel-supported collapsible work piece or platen against which heat sealing operations may be performed. The lower edges of the metal leaves 44 are provided with notches 45 which mate with the hereinafter described gripper clamps 803 in the gripper assembly 30. The width of the body portion 42 of the mandrel should be slightly smaller than the flat width of the tube 12 to permit free movement of the mandrel through the film. The metal leaves 44 are hinged to the body portion 42 by means of flexible sheets 46, such as canvas, bonded to the outer surfaces of the leaves 44 (as by suitable adhesive) and to the body portion 42 (as by rivets 47). A portion of the outer surfaces of the leaves 44 is preferably left uncovered, as at 49, so as to permit optimum magnetic contact therewith. The inner surfaces of the leaves 44 are permanently bonded to a single sheet of

flexible heat-resistant rubber 44a, such as silicone rubber, which hinges the two leaves together and provides a resilient work surface for the hereinafter described heat sealing of the bottom closure. The rubber sheet also acts as a hinge between the two leaves 44 and tends to keep the leaves spread apart. The mandrel 40 is also provided with two pairs of spring-mounted ears 48 which press outwardly on the edge folds of the tube 12 as it passes over the mandrel so as to keep the flattened tube taut across the surface of the mandrel. Each pair of ears 48 is pivotably linked together, as at 50, so that the two ears of each pair always move the same distance inwardly or outwardly, thereby centering the tube 12 on the mandrel 40. The mandrel 40 is also provided with a pair of discs 43 which are rotatably mounted to protrude slightly beyond the side edges of the body portion 42. The purpose of these discs 43 is to center the mandrel 40 in the transverse direction, as described below.

The internal mandrel 40 is held in place within the tube 12 by a series of pairs of small parallel inside rollers 52 which are rotatably mounted in the mandrel so as to cooperate with the clamping rolls 32, 33, and 34 outside the film. The surfaces of the rollers 52 should protrude slightly beyond the planar surface of the mandrel 40 so that one outside clamping roll protrudes inwardly between each pair of closely spaced inside roller surfaces. In other words, each outside clamping roll 32, 33, and 34 engages one pair of closely spaced inside rollers 52, thereby providing means for supporting and transporting the mandrel 40 within the continuous tube 12. Although the outer clamping rolls 32, 33, and 34 and the inner rolls 52 must press against each other (through the tube 12) firmly enough to hold the mandrel in place, the clamping roll carriage and the mandrel 40 can still be moved vertically without moving the tube 12 because all the rolls are rotatably mounted. Moreover, this unique supporting system permits relative displacement of the mandrel 40 and the tube 12 with a minimum of tube spreading.

The mandrel 40 is centered in the transverse direction, i.e., in the direction parallel to the axes of the clamping rolls 32, 33, and 34, by a pair of rubber-covered centering rolls 41 which are rotatably mounted on the carriage 36 so as to press against the rotatable discs 43 on the mandrel. The rolls 41 and discs 43 press against each other (through the tubular film 12) firmly enough to prevent the mandrel from swinging parallel to the clamping rolls, but they do not interfere with relative movement between the mandrel and the film because both the rolls 41 and the discs 43 are rotatably mounted.

As shown in FIG. 23, an air injection needle 95 driven by a pneumatic cylinder 110B' is mounted between the outboard clamping rolls 32 and 33. This needle is advanced to penetrate one ply of the flattened tube 12 and inject air therein at some point during the Station I operations, as hereinafter described, to prevent the drawing of a vacuum in the tube when the mandrel 40 is withdrawn upwardly through the tube.

A pair of rolls 21 and 23 is rotatably mounted in a rigid frame 25 which is suspended from the clamping roll carriage 36 by means of pivotably connected arms 27. The rolls 21 and 23 are located on opposite sides of the mandrel 40 just above the metal leaves 44. The purpose of the rolls 21 and 23 is to collapse the metal leaves 44 after they have been spread open and to provide back-up support for the leaves 44 when they are forced downwardly against the gripper assembly 30, as hereinafter described. For collapsing the leaves 44, the frame 25 is provided with an independent driving means, such as a pneumatic cylinder 102, which moves the rolls 21 and 23 downwardly over the metal leaves 44 while the clamping roll carriage 36 is stationary. Of course, since the rolls 21, 23 are suspended from the clamping roll carriage 36, they move concomitantly with any movement of the clamping roll assembly and mandrel 40.

Still referring to FIGS. 4, 22 and 23, an upper stationary clamping platen-foldover roll assembly 24 is mounted below the clamping roll carriage with the lower surfaces of the platen member aligned with the upper edges of the mandrel leaves 44. This clamping platen-foldover roll assembly 24 is shown in more detail in FIGS. 24 and 25 and comprises in general an inboard platen member 300, an outboard platen member 302, and a pair of foldover rolls 304. The clamping platens 300, 302 have several functions, i.e., they serve as mounting and guiding members for the foldover rolls 304, they provide back-up surfaces for the sealing operations in forming the bag end closures, they provide means for transporting and indexing the partially completely bag blanks to the various operating stations. The platen members 300, 302 are mounted on polished parallel slide rods 310 extending through bushed openings in the platen ends, and a suitable driving means, such as a pneumatic cylinder 105 and bell cranks 305, is provided to move the two members 300, 302 together and apart. The mating surfaces of the platen members are provided with rubber pads 309 to insure good clamping action when the platen members are moved together and to compensate for machine tolerances and small variations in the thickness of the tube that is clamped.

Above each platen member 300, 302 is a foldover roll 304 which is spring mounted by means of independent brackets 312 and coil springs to a conventional bell crank 307 and pneumatic cylinder 510 or 512. The outboard platen member 302 is provided with a longitudinal slot 306 so that the foldover roll 304 thereabove can be advanced and retracted through that platen member when it is in its closed (clamping) position. The inboard platen 300 is sufficiently narrow that the foldover roll thereabove can be advanced and retracted through that platen member when it is in its closed (clamping) position. The spring mountings and support brackets 312 of the foldover rolls 304 first urge the rolls about the side edge of the slot 306 and the side edge of the platen 300, respectively, and thence upwardly toward the mating surfaces of the platen members 300, 302. Thus, as the platens move toward each other to close, the rolls 304 and their supporting brackets 312 are advanced below the lower surfaces of the platen members, and the rolls 304 are forced up against the lower surfaces of the platens and move thereacross toward the mating clamping surfaces of the platen members. The rolls 304 are mounted so that they are locked (non-rotating) when they are being advanced and rotate (free-roll) when they are being retracted. Thus, the rolls have a wiping action when being advanced and a rolling action when being retracted.

The purpose of the rolls 304 is to infold the previously blanked and outfolded side flaps of the thermoplastic tube into overlapping relationship with each other and with infolded end tabs, as will be described hereinafter under the heading Station I—Operation. Thus, one of the rolls 304 must lead the other roll by a short time interval, suitably 0.3 to 0.4 second, so that one side flap is infolded slightly ahead of the other flap.

As shown in FIGS. 23 and 24, a pair of wiper arms 91 and a pair of air nozzles 93 are mounted just below the platen member with the leading foldover roll 304 to insure that one side flap is infolded ahead of the other. The wiper arms 91 are swingably mounted on air-driven rods to wipe the side portions of the inboard side flap up against the surface of the platen 300 before the outboard side flap is infolded. The air nozzles 93 are mounted to direct jets of air across the middle of the platen 300, thus forcing the mid-portion of the inboard side flap toward the platen surface.

The lower surfaces of the platen members 300, 302 are provided with recesses in which magnetic clamps 56 are swingably mounted. A suitable driving means, such as a piston-driven bell crank, is provided to swingably advance and retract the magnetic clamps 56 through an

arc of 90°. This permits the magnetic clamps to be swung out of the recesses and down onto magnetic engagement (spaced by the tube plies) with the metal leaves 44 on the mandrel 40. After the clamps 56 have magnetically engaged the leaves 44, the clamps can be retracted into the recesses so as to spread the engaged mandrel leaves 44 horizontally against the platen surfaces. The magnetic clamps 56 are mounted so as to remain coplanar with the leaves 44 during the spreading of the mandrel leaves.

Referring back to FIGS. 4, 22, and 23, mounted below the clamping platen-foldover roll assembly 24 is a blanking knife-heat sealer assembly 26 comprising a blanking platen or female member 58 and a wiping roller 59 on one side of the tube 12 and a male cutting member 60 and a heat sealer 62 on the other side of the tube. The male cutting member 60 and the heat sealer 62 are mounted on a single carriage 63 which is movably mounted on horizontal tracks 64 so that it can be moved transversely in a direction perpendicular to the plane of the flattened tube 12.

The face of the male cutting member 60 is shown in FIG. 27. A protruding transverse knife edge 70 cuts completely across the flat width of the tube 12 so as to sever an individual bag blank 72 (with a previously formed bottom closure) below the knife from the continuous length of tubing above the knife. At the same time the vertical and diagonal knives 74 form longitudinal slits which form opposed end tabs and side flaps both for the top closure of the bag blank 72 below the transverse knife 70 and for the bottom closure of the next bag blank to be cut from the continuous tubing 12 above the transverse knife 70.

The heat sealer 62 is shown in detail in FIGS. 26a through 26c. The heat sealer 62 has two main elements; a clamping platen 430 and a heat-seal bar 412. The heat-seal bar 412 is connected by shafts 416 and bell cranks 417 to pneumatic cylinders 113 that advance and retract the bar 412 in the vertical direction. The bar 412 is provided with a passage to receive an electrical resistance heater element 418, and the upper face of the bar is provided with a plurality of protruding sealing surfaces 426. The configuration of the sealing surfaces for the particular bag closure structure resulting from the blanking knife pattern shown in FIG. 27 is shown in FIG. 26a, but the configuration of sealing surfaces may obviously be varied for different bag closure configurations and bag sizes.

The aforedescribed heat sealer 62 is described in more detail in a copending United States patent application bearing Serial No. 198,014, entitled "Plastic Film Welding Process and Apparatus," filed May 28, 1962. However, it is to be understood that this is only one example of the many different heat sealers which may be used in the inventive apparatus.

The clamping platen 430 of the heat sealer is supported above the bar 412 by means of shafts 433 and bell cranks connected to additional pneumatic cylinders 114 which advance and retract the platen 430 in the vertical direction. The platen 430 is provided with slots 440 to pass the corresponding sealing surfaces 426 on the bar 412 through the platen and into contact with the thermoplastic film to be sealed. The platen 430 also has grooves 442 equally spaced from the slots 440 to retain water-circulating tubing 444 for cooling the film around the sealing areas. A plurality of tapped holes is also provided in the platen 430 to receive adjustment screws 448 which limit the advance of the sealing surfaces 426 with respect to the upper surface of the platen 430, and thereby control melt penetration into the surface of the film to be sealed. The depth of sealing surface penetration in combination with the cooling of the walls of the slots 440 controls and limits the fused film zone in the film plies being sealed. In operation, the clamping platen 430 is first moved upwardly against the

film to be sealed, and the bar 412 is then moved through the slots 440 to seal the film plies. The sealing bar 412 is then retracted from the weld surface while the platen 430 continues to clamp the plies of film and chill the fused zones therein, thus permitting the stripping of the sealing surface 426 cleanly from the film weld.

Referring back to FIG. 23, mounted on the opposite side of the tube 12 from the male cutting member 60 is the blanking platen or female cutting member 58. The face of the member 58 is provided with a plurality of slots or grooves which receive the protruding knives on the male cutting member 60 when the two cutting members are struck together. Just below the lower edge of the member 58 is a wiping roll 59 which is mounted so that it is locked (non-rotating) when it is being advanced and rotates only when it is being retracted. Both the female cutting member 58 and the wiping roll 59 are mounted on the end of an arm 61, which is pivotally connected to a second arm 57. The second arm 57 is pivotally mounted at 65 on a rigid frame member 67. In its retracted position, the member 58 is inclined in a raised position, as shown in FIG. 23, so as not to interfere with rotation of the indexing table 10. Pneumatic cylinders 107, 108, and 124 are provided to swing the member 58 downwardly into a vertical position in alignment with the male cutting member 60, to advance the member 58 transversely so that it strikes the male member 60 and cuts the tube 12, to further advance the member 58 and roll 59 as the male member 60 is retracted so that the wiping roll 59 wipes the upper portion of the blank 72 down onto the lower outboard platen member, and finally to retract the member 58 and roll 59 to their original position (FIG. 23).

Still referring to FIGS. 4, 22, and 23, a lower clamping platen-foldover roller assembly 28 is mounted on the rotatable indexing table 10 below the cutting members 58 and 60. The distance between the top surface of the lower assembly 28 and the bottom surface of the upper assembly 24 must be at least four times the width of the leaves 44 of the internal mandrel 40. This spacing is necessary to provide sufficient lengths of the tubular film 12 below the assembly 24 and above the assembly 28 to form the desired closure structures against the platen surfaces, as hereinafter described.

Since the four clamping platen-foldover roll assemblies mounted on the corners of the indexing table 10 are identical, the assembly 28 is the same regardless of which corner of the table 10 is positioned at Station I. The assembly 28, which is shown in more detail in FIGS. 20 and 21, is similar to the upper clamping platen assembly 24 except that it is inverted, i.e., the platen members 300, 302 are on top rather than the bottom of the assembly, and the foldover rolls 304 are mounted under the platen members and driven upwardly therethrough onto the upper platen surfaces. In order to facilitate rotation of the indexing table 10, the driving members for the assembly 28 are mounted horizontally rather than vertically. Also, the assembly 28 has no magnetic clamps, but a plurality of suction cups 308 are recessed in the upper platen surfaces. The inboard platen member 300 is provided with an additional section 301 also containing suction cups 308 in order to increase the suction area. The member 301 is shaped to provide an opening 306 through which the foldover roll 304 can be moved onto the upper platen surface. The operation of the platen members and foldover rolls in the assembly 28 is the same as described above for the assembly 24.

Referring back to FIGS. 4, 22, and 23, at the bottom of Station I, below the indexing table 10 and the clamping platen assembly 28 mounted thereon, is a gripper assembly 30 comprising a central contact saddle 78, four clamping arms 80 swingably mounted to be advanced against the saddle 78 and retracted therefrom, and lever arm 82 for moving the contact saddle 78 and clamping arms 80 in a vertical direction. The main purpose of the

gripper assembly 30 is to hold the bottom of the partially formed bag blank 72 while the internal mandrel 40 is withdrawn upwardly therefrom. The contact saddle 78, which is mounted on the inboard end of the lever arm 82, has a triangular vertical cross section and a length about equal to the width of the mandrel 40. The angle between the skirts of the saddle 78, which determines the angle between the metal leaves 44 on the bottom of the mandrel 40 as it is withdrawn from the blank 72, must be large enough to prevent the plies of the previously completed bottom closure of the tube 12 from being pinched between the leaves 44 but small enough to permit free withdrawal of the mandrel 40 upwardly through the tube. An included angle of 50 to 60°, preferably 55°, between the saddle skirts is suitable for most applications.

The clamping arms 80 are pivotally mounted on connecting bars 802 that are fastened centrally on the underside of the saddle 78. A padded gripper clamp 803 is attached to the upper end of each clamping arm 80. The lower ends of the inboard clamping arms are pivotally attached to piston rods 804, and the outboard clamping arms are pivotally attached to a clamp fastening the barrels of pneumatic cylinders 103 to swing the gripper clamps into self-centering contact with the saddle 78 and also to retract them. The arms 80 are spaced so that the gripper clamps 803 fit into the notches 45 in the mandrel leaves 44 when the leaves are resting on the saddle surface. The lever arm 82 is pivotally mounted at 83, and a pneumatic cylinder 123 is attached to the outboard end of the arm 82 so that the gripper assembly can be raised and lowered by movement of the lever arm 82 about its fulcrum 83. An electric brake 89 is also provided to prevent the gripper assembly from moving upwardly during the cutting and sealing operations.

Station I—Operation

The operation of Station I is illustrated by the sequence of schematic elevation views in FIGS. 4 through 11. Referring first to FIG. 5, the flattened tubular film 12 extends downwardly from the steering roll over the internal mandrel 40 with one ply of the film on each side of the mandrel, through the upper stationary clamping platen assembly 24, between the cutting members 58 and 60, through the lower clamping platen assembly 28, and into the gripper assembly 30. The bottom closure in the lower end of the tube 12, having been previously formed in a manner to be described, is spread over the contact saddle 78 of the gripper assembly 30 and clamped thereto by the gripper clamps 803 while the gripper assembly is in its raised position. At this point, Station I appears as shown in FIG. 5, i.e., with the mandrel 40 held in its raised position by the clamping roll carriage, both clamping platens open, and the cutting member retracted.

After the bottom closure in the tube 12 has been firmly clamped in the gripper assembly 30, the upper clamping platen 24 is closed so as to clamp the flattened tube 12 therein. Next, the gripper assembly 30 is lowered slightly to tension the tube. The vertical movement of the gripper assembly is not narrowly critical, and movements of about 1 to 5 inches are sufficient to tension the tube in most applications. After the gripper assembly 30 has tensioned the tube, the lower clamping platen 28 is closed, and the magnetic clamps 56 in the upper platen members are swung downwardly to magnetically engage the mandrel leaves 44 that are disposed interiorly of the tube 12. At this point, Station I appears as shown in FIG. 6. The lower end of the tube remains clamped in the gripper assembly 30, the mandrel 40 remains in its raised position, and the cutting members are still retracted.

Referring now to FIG. 7, the cutting members 58 and 60 are advanced together to form the desired cuts in the tube 12. The cutting operation is preferably carried out by advancing the male member 60 to the plane of the flattened tube 12, and then advancing the female member 58 to strike the tube against the protruding

knives 70 and 74 on the male member 60. At this point, the plastic tube is in the form shown as C in FIG. 2. The transverse knife 70 cuts completely across all plies of the tube 12 so as to sever an individual bag blank 72 below the knife from the continuous length of tubing 12 above the knife. At the same time, the vertical and diagonal knives 74 form a pair of opposed similar side flaps 211, 213 and a pair of opposed end tabs 215, 217 at the top end of the blank 72 and a pair of opposed similar side flaps 219, 221 and end tabs 223, 225 at the lower end of the remaining tube 12.

In the particular embodiment illustrated, three of the knives 74 are shaped to form diagonal cuts terminating at both ends in vertical cut portions, while the fourth knife 74 forms a straight vertical cut. However, although the particular die cuts illustrated are preferred to form a strong bag with a minimum of film, it will be apparent that the present invention is equally applicable to numerous other blanking patterns. The particular bag and bag blank illustrated are described in more detail in a copending United States patent application bearing Serial No. 198,099, entitled "Thermoplastic Film Bag," filed May 28, 1962, now U.S. Patent No. 3,220,601, and the description therein is incorporated therein is incorporated herein by reference.

After the tube has been cut by the mating cutting members 58 and 60, the male member 60 is retracted, as shown in FIG. 8. At the same time, the female member 58 is advanced past the tube so that the wiping roll 59 wipes the portion of the blank 72 protruding above the platen assembly 28 down onto the outboard platen member 302 (FIG. 8). The tube is then held against the platen member 302 by the suction cups therein while the female member 58 and the wiping roll 59 are retracted to the position shown in FIG. 9. Next, the magnetic clamps 56 are swung upwardly into their recesses in the upper clamping platens (FIG. 9). Since the magnetic clamps 56 are in magnetic engagement with the mandrel leaves 44, the upward movement of the clamps spreads the leaves 44 against the lower surfaces of the clamping platens 300, 302, the leaves forming a hexagonal resilient work surface for forming and sealing a bottom closure for the next blank. The spreading of the leaves 44 outfolds the side flaps 219, 221 and causes the end tabs 223, 225 to be infolded over the planar rubber surface provided by the leaves 44. The form of the tube as the side flaps 219, 221 are being outfolded is shown as D in FIG. 2.

After the mandrel leaves 44 have been spread into horizontal position and the end tabs 223, 225 infolded, the foldover rolls 304 are advanced downwardly through the opening in the upper clamping platen 302 and the side wall of platen 300 to fold the side flaps 219, 221 inwardly in overlapping relationship with each other and with the infolded end tabs against the lower surfaces of the spread mandrel leaves 44. As the rolls 304 are moved downwardly through the platens, the inboard roll 304 leads the outboard roll by about 0.4 second so that the inboard side flap underlies the outboard flap. To prevent catching of the two side flaps as they are successively infolded, the inboard side flap is forced upwardly against the platen surface by the wiper arms 91 and air jets from the nozzles 93. At this point, Station I appears as shown in FIG. 9. The upper portion of the blank 72 is still held against the lower outboard platen member.

While the foldover rolls 304 are still in their advanced positions holding the side flaps 219, 221 in the infolded position, the blanking knife-heat sealer assembly 26 is again advanced inwardly until the heat sealer 62 is positioned under the infolded side flaps and end tabs. The clamping platen 430 of the heat sealer 62 is then moved upwardly. The heat-seal bar 412 seals the side flaps to each other and to the end tabs in the overlaps, thus forming the bottom closure illustrated as E in FIG.

2. At this point, Station I appears as shown in FIG. 10. The shape of the protruding sealing surfaces on the heat-seal bar 412 obviously depends on the shape of the infolded flaps and tabs in the bottom closure, and the present invention is equally applicable to a wide variety of different shapes and sealing configurations. A heat-seal width of $\frac{1}{8}$ inch is usually adequate to provide a good bond between the layers of film in the bottom closure. Since the seals in the closure are made through overlapped plies of film against an internal platen, the closure has excellent strength.

While the heat seals are being made by the sealer 62, the clamps in the gripper assembly 30 are opened (see FIG. 10) so as to free the blank 72 for indexing to Station II. As the gripper clamps are opened, the gripper assembly 30 is lowered to its lowermost position. The platen members of the lower clamping platen assembly 28, which is mounted on the indexing table, remain closed so as to transport the blank 72 when the indexing table is rotated.

Referring now to FIG. 11, after the bottom closure has been formed and sealed, the heat sealer assembly 62 is lowered to its original position (first the heat-seal bar 412, then the clamping platen 430) and retracted outwardly along with the male cutting member 60. The three different stationary positions of the male cutting member 60 and the heat sealer 62 during one complete cycle of operations are illustrated in FIG. 28. The retracted position is the same as that shown in FIG. 23, with the heat sealer 62 in its lowermost position. In the cutting position, the ends of the knives 70 and 74 are advanced just to the plane of the flattened tube 12 ready for striking by the blanking platen. The heat sealer remains in its lowermost position during the cutting operation. In the sealing position, the cutting member 60 is advanced inboard past the plane of the flattened tube 12 so that the heat-sealer 62 is positioned under the spread leaves 44 of the mandrel. The heat-sealer 62 is then advanced and retracted in the vertical direction while the assembly is in this position.

While the heat sealer assembly 62 is being retracted, the gripper assembly 30 is lowered to its lowermost position so as not to interfere with the indexing operation. Finally, the indexing table 10 is rotated 90°, thereby transporting the clamping platen assembly 28 and the blank 72 clamped therein to Station II. At this point, Station I appears as shown in FIG. 11.

After the indexing table has been rotated 90° so as to move the next clamping platen assembly 28 into position as Station I (FIG. 4), the upper clamping platen assembly 24 is opened and the rolls 21 and 23 are moved downwardly to partially collapse the mandrel leaves 44. At about the same time, the gripper assembly is moved upwardly a predetermined distance, as later described in the control description. The mandrel 40 and enveloping tubing 12 are then lowered by means of the clamping roll carriage 22 until the leaves 44 that are pocketed within the previously formed bottom closure, engage the contact saddle 78 of the raised gripper assembly. The rolls 21, 23 remain in contact with the leaves 44 as the mandrel is moved downwardly and thereby control the angle between the leaves 44 and urge the leaves 44 into engagement with the skirts of the saddle 78. After the leaves have come to rest on the saddle 78, the gripper clamps 803 are again closed to clamp the film plies of the bottom closure to the skirts of the saddle 78. The mandrel 40, the mandrel carriage 22, and rolls 21, 23 are then returned to their raised positions, thereby stripping them from bag blank 72, and the Station I operations are repeated as described. While the mandrel is in its raised position, air is injected into the tube 12 by the air injection needle 95.

The forming of the aforedescribed side flaps and end tabs in the end of the thermoplastic tube 12 is pre-

ferred in order to form a strong end closure with a minimum of film. However, it will be apparent that the apparatus of Station I is equally applicable to other end closure constructions and can even be used to form a rectangular end closure without any cuts whatever in the end of the tube. In such a case, the cutting members 58 and 60 would be eliminated, and the spreading of the mandrel leaves 44 would form a pair of opposed similar infolded end portions and a pair of opposed similar outfolded side portions in the end of the tube. The foldover rolls 304 would then infold the side portions over the infolded end portions, and the heat sealer 62 would heat seal the overlapping portions together against the spread leaves.

Whatever the specific form of the closure structure, it should be recognized that the internal mandrel provides both an internal resilient work surface for the heat sealing operations and a convenient means for advancing the completed closure. The resilient work surface is provided by the hinged leaves 44, which may be spread and collapsed by the magnetic clamps and collapsing rolls or by any other convenient means. The work surface provided by the leaves 44 is geometrically shaped to infold the end tabs 223, 225 and side flaps 219, 221 snugly thereabout. The transporting mechanism is provided by the combination of the mandrel and the outside clamping roll assembly; this combination of elements can be used not only to advance the completed bag closure, but also to retract the mandrel to its original position for the next operation.

Station II—Structure

As shown in FIG. 29, Station II comprises in general the clamping platen 28 mounted on the rotatable indexing table 10, a suction means 84 for slightly raising the upper ply only of the two plies of that portion of the flattened tubular film that was folded down onto the outboard platen member at Station I, a shuttle assembly 86 for outfolding the raised ply of film onto the inboard platen member (thereby infolding the end tabs of the bag blank) while simultaneously inserting a valve sheet 88 across the top surface of both outfolded side flaps of the blank and under the bottom surface of one end tab, a clamping means 90 for holding the forward end of the valve sheet against the inboard platen member while the shuttle assembly 86 is withdrawn, a heat sealer 92 for sealing the valve sheet to the overlying end tab, and cutting means 94 for severing the valve sheet at the outer edge of the side flap outfolded on the outboard platen member.

Referring now to FIGS. 29 and 30, the suction means 84 comprises a bar 96 having a row of suction cups 98 mounted thereon, the suction cups being connected to suitable vacuum lines (not shown). The bar 96 is mounted on the ends of arms 100 extending from a rotatable sleeve 99 on a rod 134. The sleeve 99 is connected to a pneumatic cylinder 203-204 so that the suction cups 98 can be lowered onto the film on the outboard platen member, raised slightly to separate the two plies of film while the shuttle assembly 86 is inserted therebetween, and then retracted to their original position. In other words, the bar 96 is movable to three different positions: a completely retracted position, a completely advanced position where the suction cups 98 are in contact with the film on the outboard platen, and an intermediate position where the suction cups hold the upper film ply above the lower film ply while the shuttle assembly 86 is inserted therebetween. The control mechanism for moving the bar 96 to these three positions will be described hereinafter.

The shuttle assembly 86 comprises a shuttle plate 102 resting on a supporting table 703 and connected to a rigid shuttle carriage 705. The carriage 705 is pivotally connected to an arm 707 and pneumatic cylinder 205 so that the shuttle plate 702 can be advanced and

retracted across the surface of the clamping platen 28. The width of the shuttle plate 702 is about equal to the smallest width of the side flaps of the bag blank 72 so that insertion of the shuttle plate 702 between the film plies outfolds the upper side flap and causes the end tab to infold. The outboard end of the shuttle plate 702 is preferably slightly elevated above the table 703 so that the shuttle is progressively lowered slightly as it is advanced across the surface of the platen 28. One side of the plate 702 is provided with a clamping plate 708 on the upper surface thereof so that the valve sheet 88 can be held in place between the two plates 702 and 708 as the shuttle is inserted between the plies of the bag blank. The clamping plate 708 is required to push the thin flexible valve sheet 88 between the side flaps and end tab of the bag blank on the platen 28. The inboard edges of both plates 702 and 708 are provided with notches 710 so that the inserted valve sheet can be clamped to the inboard platen member while the shuttle is withdrawn. The plate 708 is also provided with a notch 701 to permit engagement of the heat sealer 92 with the valve sheet.

A supply roll 706 of flat film 113 for forming the valve sheet is mounted above the shuttle plate 702 in line with the clamping plate 708. The width of the valve film on roll 706 should be smaller than the width of the side flaps on the bag blank, and is preferably about half the width of the side flaps. The valve film 713 is passed downwardly from the roll 706 over the idler rolls 117 and 119 and in between the plates 702 and 708. The film is unwound from the roll 706 by the action of the shuttle as it is advanced over the platen 28. Mounted on the outboard portion of the shuttle carriage 705 is an angular snubbing clamp 711 connected to a pneumatic cylinder 216 so that it can be moved horizontally. In its advanced position, the snubbing clamp 711 engages the film 713 and presses it against the roll 117, thus locking the film and also slightly rotating the roll 117 in the reverse direction so as to tension the film 713 for cutting at the outboard edge of the clamping platen 28. The lower surface of the horizontal portion of the snubbing clamp 711 is preferably lined with rubber so that the clamp does not scratch or tear the film 713. The snubbing clamp is always in its advanced position except when the shuttle is being retracted, i.e., when the film 713 is being fed between the plates 702 and 708.

The cutting means 94 is mounted adjacent to the suction means 84 (see FIG. 30) and comprises an electrically heated cutoff wire 120 held taut between two arms 122. The arms 122 are swingably mounted on a rotatable rod 134 which is driven by a pneumatic cylinder 204, thus moving the wire 120 in an arc around the rod 134. The cutoff wire 120 is located so that as it is lowered it strikes the valve sheet just off the outboard edge of the outboard platen member 302. The wire 120 extends over the outboard platen member when the arms 122 are horizontal so that the wire is moving outwardly over the platen member as it strikes the valve film, thereby subjecting the film to a slight degree of tension as it is cut. As the film is cut, the tension is released and the cut edge of the valve sheet springs back to the edge of the platen so that it is coterminous with the end of the side flap of the bag blank.

The clamping member 90 is movably mounted in a vertical track 116 above the inboard edge of the inboard platen member 300 so that the clamping member 90 can be vertically advanced and retracted with respect to the platen surface. The clamping member 90 comprises a rigid bar 118 from which are suspended two gripper clamps 121 positioned to mate with the notches 710 in the inboard edges of the plates 702 and 708.

The heat sealer 92 is mounted on the outboard side of the clamping member 90 over the ends of the two platen members. The heat sealer 92 is identical to the

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heat sealer 62 described above in Station I except that the face of the heat seal bar in the sealer 92 is provided with only a single protruding sealing surface. This sealing surface extends perpendicularly to the mating surfaces of the platen members 300, 302 and is adapted to seal the valve sheet to the overlying end tab along a line parallel to the end of the end tab, as hereinafter described.

Station II—Operation

As the indexing table 10 moves the clamping platen 28 and the bar blank 72 clamped therein into position at Station II, both plies of the upper portion of the bag blank are folded over onto the outboard platen member 302 and held there by the suction cups 308. The form of the bag blank 72 at this point is shown as item F in FIG. 3. After the bag blank has been registered at Station II, the suction means 84 is lowered into engagement with the upper ply of the folded film and then raised to its intermediate position. This separates the two plies of film so that the shuttle assembly 86 can be inserted therebetween. The shuttle assembly 86 is then advanced across the upper surface of the clamping platens, thereby outfolding the upper side flap of the bag blank onto the inboard platen member and concomitantly causing the end tabs to be infolded. At the same time, the shuttle assembly 86 feeds the valve sheet 88 across the outfolding side flaps and in overlapping relationship with one of the infolded end tabs. The suction means 84 is retracted at the beginning of the shuttle advance. When the shuttle 86 is in its most advanced position, Station II appears as shown in FIG. 12, and the bag blank 72 appears as item G in FIG. 3. Although the valve sheet 88 is shown as being inserted under the overlapping end tab, it may be inserted over the end tab, as long as a back-up plate is provided under the end tab so that the valve sheet and end tab can be heat sealed together without being sealed to the underlying portion of the bag blanks.

While the shuttle assembly 86 is still in its most advanced position, the heat sealer 92 is lowered (first the clamping platen, then the heat-seal bar) onto the end tab overlying the valve sheet 88 to seal that end tab and the valve sheet together along a line extending across the end of the tab. The shuttle plate 702 beneath the valve sheet 88 prevents the valve sheet from being sealed to the underlying side walls of the bag.

After the heat seal has been made, the clamping member 90 is lowered to clamp the inboard edge of the valve sheet firmly to the inboard clamping platen. At this point, Station II appears as shown in FIG. 13. The heat sealer 92 and the shuttle 86 are then retracted to their original positions. As the shuttle is retracted, the snubbing clamp is advanced to lock the valve film between the roll 119 and to tension the valve film between the clamp 90 and the roll 119. The cutting means 94 is then swung downwardly so that the hot cutoff wire 120 severs the valve sheet even with the edge of the outboard platen member. At this point, Station II appears as shown in FIG. 14. The cutting means 94 and the clamping member 90 are then retracted, thus completing the operations at Station II.

As shown in FIGS. 1 and 19b, a forming platen 130 is pivotally mounted at each of the four sides of the indexing table 10. One end of each forming platen 130 is pointed to mate with the apex in the hexagon formed in the film by the infolding of the end tabs. The pointed end of each platen 130 is preferably provided with an air nozzle 502 to blow the film off the platen after the side flaps and end tabs have been heat sealed thereagainst. The forming platens 130 are mounted on arms 122 which are pivotally mounted at the center of the table 10, the inner ends of the arms 122 being provided with cam followers 124 which follow a stationary cam groove 126 machined into the underside of a radial disc cam 128 centrally mounted on the top of the indexing table 10 (see FIG.

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19a). The upper surfaces of the forming platens 130 are covered with silicone rubber which provides a resilient surface for the hereinafter described heat sealing operation.

Rollers 131 on the side edges of the platen 130 are mounted in horizontal tracks 133 so that the platen 130 can be moved horizontally. The tracks 133 slope downwardly slightly so that the forming platen is lowered as it is advanced, thus facilitating entry of the platen 130 into the pocket formed by the distal end tab without dragging across the flaps. In order to maintain the platen 130 horizontal as it is lowered along the sloped track 133, it is provided with two pairs of rollers 131 with the axis of the two rear rollers being slightly above the axis of the two front rollers. As the clamping platen 28 and the bag blank 72 are moved from Station II to Station III, the cam 126 causes the arms 122 and platen 130 to move parallel to the edge of the table 10 in a direction counter to the direction of movement of the table. The platen 130 passes over the middle of the valve sheet 88 and the end tab joined thereto and, due to the progressive lowering of the platen, under the opposed end tab of the bag blank. The insertion of the platen 130 is illustrated in item H in FIG. 3. This platen 130 then forms the working surface for the operations carried out at Station III.

Station III

As shown in FIGS. 31 and 32, Station III comprises the clamping platen 28 mounted on the rotatable indexing table 10 and a heat sealer 150. The heat sealer 150 is identical to the heat sealer 62 described above in Station I except for the configuration of the protruding sealing surfaces on the heat-seal bar. The face of the heat-seal bar in the sealer 150 is shown in FIG. 32a and comprises two long parallel sealing surfaces 157, 159 to join the infolded side flaps together in the overlap; two short sealing surfaces 177, 178 parallel to the surfaces 157, 159 to join the infolded ends of the valve sheet 88 to the infolded side flaps at the valve end of the bag closure; and two diagonal surfaces 175, 176 to join the infolded side flaps to the edges of the end tab at the other end of the closure.

As described above, the forming platen 130 is inserted over the infolded end tab 215 at the valve end of the bag closure and under the infolded end tab 217 at the other end of the bag closure, between Stations II and III. This forming platen 130 then forms the working surface for all operations performed at Station III. These operations include infolding the side flaps 211, 213 and those portions of the valve sheet 88 which overlie the side flaps, and then heat sealing the side flaps, the valve sheet, and the end tabs together in the overlaps. The side flaps 211, 213 are infolded in the same way that the side flaps of the bottom closure were infolded at Station I, i.e., the foldover rolls 304 are advanced through the openings in the clamping platens 300, 302 to fold the side flaps 211, 213 inwardly in overlapping relationship with each other and with the infolded end tabs 215, 217 and the valve sheet 88. The infolding of the side flaps also infolds those portions of the valve sheet which overlie the side flaps.

While the foldover rolls 304 are still in their advanced positions holding the side flaps 211, 213 and the ends of the valve sheet 88 in the infolded positions, the heat sealer 150 is lowered as illustrated in FIGS. 15 and 16. The heat sealer 150 operates in the same manner as the sealer 62 described in Station I, the clamping platen being lowered first and then the heat seal bar. The sealing surfaces 157, 159 join the side flaps to each other and to the infolded ends of the valve sheet; the sealing surfaces 164, 166 join the side flaps to the valve sheet transversely to the surfaces 157, 159; the surfaces 177, 178 join the valve sheet to the infolded portions of the side walls; and the surfaces 175, 176 join the edges of the side flaps to the edges of the end tab 217. The heat sealer 150 and the foldover rolls 304 are then retracted. This completes the valved top closure, and the bag appears as item J in FIG. 3.

As shown in FIG. 18, Station IV comprises only a discharge chute 500 for receiving the finished bags. As the table 10 is indexed into position at Station IV, the clamping platens 300, 302 are opened and the forming platen 130 is withdrawn to discharge the finished bag onto the chute 500. As the forming platen 130 is withdrawn, a plurality of small air jets from the air nozzle 502 are directed between the completed bag closure and the upper surfaces of the clamping platens to break the bag loose from the platen surfaces. The discharged bag appears as item K in FIG. 3.

While the apparatus of Stations II, III, and IV have been described above with specific reference to the forming of a valved end closure, this apparatus is equally applicable to the production of other end closures which do not require an internal forming mandrel. For example, the shuttle assembly 86 could be used to insert a membrane sheet which overlaps both infolded end tabs, the end tabs then being heat sealed to the edges of the membrane sheet by using the shuttle plate as a back-up platen. The side flaps would then be infolded and heat sealed together in the overlap by using the forming platen 130 and foldover rolls 304 as described above. This type of end closure is described in more detail in a copending United States patent application bearing Serial No. 236,495, filed November 9, 1962, now Patent No. 3,220,635, entitled "Thermoplastic Bag." The apparatus of Stations II, III, and IV can also be used to form end closures which do not require the insertion of a supplemental sheet, but still require the flat forming platen 130.

Driving and control system

The electro-pneumatic driving and control system for the aforedescribed apparatus will now be described by referring to FIGS. 19c and 33-36 of the drawings.

Drive for indexing table.—Referring to FIG. 19c, the horizontally rotatable indexing table 10 is intermittently driven by power from a continuously driven motor 511 with a flywheel directly coupled thereto. This main drive motor 511 powers a clutch-brake assembly 499 energizing the input of a double shafted speed reducer 503. Opposite the motor end of the speed reducer input is mounted an electrically operated brake 504. A silent chain drive 505 connects the output of the speed reducer 503 to the input of an intermittent motion drive 506. The intermittent motion drive 506 is preselected to couple an input rotation of 300° to an output rotation of 90° with the remaining 60° of input rotation providing an output dwell (no rotation). The square, horizontally rotatable indexing table 10 is centrally mounted on the output shaft 507 of the intermittent motion drive 506 and rotates 90° per bag cycle.

Indexing controls.—Controls to sequence the transfer of the bag blanks between Stations I, II, III, and IV and the operations of the bag blanks at the various stations are arranged as a combination of mechanical-pneumatic-electric controls interrelated on the "cascade" principle. Thus, input to a primary control triggers one or more units of a secondary control that triggers units of a tertiary control etc. The prefix of switch and valve numbers designate function as:

Symbol	Description	Input	Output
LS.....	Limit switch.....	Mechanical.....	Electric.....
PS.....	Pressure switch.....	Pneumatic.....	Do.....
PLS.....	Plugging switch.....	Electric.....	Do.....
RL.....	Relay.....	Do.....	Do.....
TMR.....	Timer, multiple circuit.....	Do.....	Do.....
SW.....	Selector switch.....	Mechanical.....	Do.....
PV.....	Pilot valve.....	Do.....	Pneumatic.....
VAP.....	Valve, air piloted.....	Pneumatic.....	Do.....
VL.....	Valve, lever operated.....	Mechanical.....	Do.....
VTR.....	Valve, time regulated (pneumatic time delay).....	Pneumatic.....	Do.....
VS.....	Valve, solenoid operated.....	Electric.....	Do.....
VX.....	Valve, sequencing (flip-flop).....	Pneumatic.....	Do.....

500	Station I.
100	Station II.
200	Station III.
300	Station IV.
500	Rotatable indexing table.

Rotation of indexing table.—Referring to FIGS. 19c and 33, in the normal sequencing operation of the machine, limit switch LS180 at Station I is tripped by the blanking knife-heat sealer assembly 62 to provide a momentary signal for the indexing table 10 to rotate. This triggers RL3 which concurrently releases the electric brake 504 on the output shaft of the speed reducer 503, and energizes the clutch component of the clutch-brake unit 499 on the input shaft of the speed reducer 503. The input shaft of the intermittent motion drive 506 is thereby rotated somewhat in excess of 300° (rotating the indexing table 90°), until a cam mounted on the speed reducer output actuates limit switch LS501. This opens the holding circuit to relay RL3 and concurrently deenergizes the clutch component on the speed reducer input and energizes the brake on the speed reducer output, thus bringing the speed reducer 503 and input to the intermittent motion drive 506, to rest. The output of the intermittent motion drive 506 has previously come to rest at the 300° dwell point of the intermittent motion drive input (additional speed reducer rotation is accommodated in the 60° dwell of intermittent motion drive mechanism).

The shaft of the main drive motor 511 operates continuously during a machine run. After the holding circuit of relay RL3 opens, a decrease in the speed of the speed reducer input shaft is sensed by a modified plugging switch PLS550. This switch provides a momentary pulse for initiating the operation motions at work Stations I, II and III.

Normally open limit switches are provided at each of the three work stations, that are arranged to sense when operating components are clear of the intermittently rotating indexing table. Nine of these limit switches are arranged in series with each other and with RL3; and are connected into the machine run circuit noted above. Five switches are provided at Station I, three at Station II, and one at Station III arranged to sense the all-clear position of the following operating components:

- LS109*—Blanking knife-heat sealer assembly in retracted position
- LS113—Gripper assembly
- *LS108—LS109 is used only at the initial (start-up) cycle—thereafter LS108 sense the all-clear for this assembly.
- LS114—Internal mandrel raised to correct position
- LS116—Blanking platen assembly retracted
- LS117—Blanking platen assembly retracted
- LS118—Internal mandrel clamping roll carriage in raised position

Film input section.—Referring to FIGS. 1 and 33, as described above, the flattened tubular thermoplastic film 12 is supplied on rolls 14 mounted on a cantilevered unwind shaft. The tube is laced through the idler rolls 16, 17 and into a weighted dancer roll unit 18 to control tension in the tube. Movement of the dancer roll assembly actuates limit switch LS115 that provides an "on-off" control for an electric brake on the unwind shaft. The tubular film is then laced through an electric eye unit and an edge-guide unit and is advanced downwardly, spreading the plies of the tube over the internal mandrel 40. Continuing downwardly over hinged leaves 44 at the lower edge of the mandrel, the tubular film is led through the opened clamping platens of Station I. The stationary and movable clamping platens that cooperate with the internal mandrel 40 at Station I are prearranged in open position, thus permitting the tubular film to be led

downwardly to the contact saddle 78 of the gripper assembly 30.

Machine start-up.—After the tube has been laced through to the gripper assembly and also registered with any printing thereon, the main power supply disconnect switch is turned "on." Cooling water must be circulated through all of the clamping platens of the heat-seal assemblies. A source of compressed air is provided for the main air disconnect valve VS501, interlocked with the machine main drive circuit. An independent source of compressed air is provided for the mandrel clamping rolls 32, 33, 34 to insure retention of the mandrel in the operating position throughout the start-up procedure. The temperature controllers are turned "on" and checked to their predetermined control settings.

A warm-up time of about 20 to 30 minutes is required to bring the heat seal bars up to optimum operating temperature. The tube 12, laced from the supply reel of the input section and advanced to the gripper assembly 30, is clamped to the contact saddle 78 by the following procedure. Initially the gripper assembly is elevated to the bag transfer position by turning on the manual air supply of the machine. This also provides pneumatic power to close the clamps of the gripper assembly 30 onto the bottom closure in the tube 12. After the tube 12 has been clamped by the gripper assembly 30, No. 1 station selector switch SW112 is turned on, supplying an electrical control circuit to all of the interlocking switches of Station I.

Station I operation.—Referring now to FIGS. 33, 34a, and 34b, the control circuit from SW112 is cascaded sequentially through the following series-connected operating switches: SW112 to N.O. LS104 (senses when the gripper clamps 203 are closed), to N.O. LS106 (senses when the internal mandrel carriage 36 is elevated); and thence to N.O. LS121 (senses when the internal mandrel 40 is in operating position) which electrical circuit energizes VS105A (pneumatic solenoid operated valve) that actuates cylinders 105A, B, C or D closing the stationary clamping platen 24 at Station I. Succeeding sequencing controls at Station I are pneumatic. Closing of the stationary clamping platen 24 actuates pilot valve PV116 which supplies pilot air to VAP123, that in turn energizes cylinder 123A thereby lowering the gripper assembly 30 from the bag transfer position to tension the film. Compressed air from VAP123 to cylinder 123A also supplies air (via a speed control valve) to actuate cylinders 123B and 123C.

The piston rod of cylinder 123B is the force member mechanically connecting pneumatic circuits at Station I to the pneumatic circuits on the rotating indexing table 10 that control closing of the clamping platens 28 mounted on the corners thereof. This piston rod of cylinder 123C connects Station IV with the pneumatic circuits on the indexing table 10 that open the clamping platens 28.

Cylinder 123B at Station I and cylinder 123C at Station IV actuate opposite ends of the respective lever-operated valves VL501A, B, C or D indexed therewith as the table is intermittently advanced to Station I and thence to II, III, and IV. Valve VL501A energizes cylinder 510A (FIG. 35b) to open the movable clamping platens at Station IV and close it at Station I, valves VL501B, C or D acting in a like manner with cylinders 501B, C or D.

As noted above, closing of the stationary clamping platen of Station I actuates pilot valve PV116 which concurrently supplies pilot air to VAP106 that actuates cylinder 106 linkage to advance the blanking knife-heat sealer assembly 62 into the plane of the flattened tube 12, preparatory to the bag blanking operation. PV116 also concurrently supplies pilot air to VAP109 that actuates cylinders 109 (FIG. 25) thereby lowering the magnetic clamps to contact the hinged leaves 44 of the internal mandrel.

As cylinder 106 is actuated to advance the blanking knife-heat sealer assembly 26, it trips PV118 thereby providing pilot air to VAP112. VAP112 is a pneumatic

interlock passing air from PV118 to VAP102 only when cylinder 111 is retracted. VAP107 actuates cylinder 107 advancing the blanking platen assembly fulcrum to the plane of the tube 12. The output of PV107 is concurrently used as pilot air to VAP108 that actuates cylinder 108 connected with linkage to lower the female blanking platen 58 into striking position. Indexing of the blanking platen into striking position is sensed by PC119 (deriving supply air from output of VAP106) that supplies pilot air to VAP124 that actuates cylinder 124 to pivotally advance the blanking platen about its fulcrum to strike the tube 12 against the mating knife blades, thereby effecting the composite blanking cut. As the blanking platen 58 strikes the mating knife blades, it actuates PV120 that supplies pilot air to VAP124, thereby actuating cylinder 124 that pivotally retracts the blanking platen 58. Concurrently, PV120 supplies pilot air to VAP106 that actuates cylinder 106 retracting the blanking knife-heat sealer assembly 26.

As the blanking knife-heat sealer assembly retracts, it permits the blanking platen assembly to continue to advance, and a one-way wiper roll transversely mounted thereon, engages the blanked bag top flaps to wipe and fold over the flaps onto the outboard suction cups of the closed movable clamp platen top surface.

As the wiping roller is advanced, it actuates a three-way pilot valve PV503A (see FIG. 37) that in turn controls a three-way valve VAP503A admitting vacuum to the suction cup manifold of the clamping platen.

When the blanking platen assembly has advanced to the end of its stroke, it contacts PV117 that supplies pilot air to VAP107 and VAP108, retracting cylinders 107, 108 in reverse manner to that in which they were advanced. PV117 also supplies pilot air to VAP109 that actuates cylinder 109 thereby to retract the magnets contacting the hinged leaves 44 of the internal mandrel, to spread open the leaves and thereby the side flaps of the bag blank. PV117 also supplies pilot air to VAP125 which provides an air blast directed against the spread-open side flaps of the bag blank to assist in infolding them about the opened hinged leaves 44.

As cylinder 107 retracts the blanking platen assembly, it trips PV121 that supplies pilot air to VAP110, thereby actuating cylinder 110 to pivotally advance the foldover rollers 304 about the edges of the opened hinged leaves 44 and concurrently provide pilot air to VAP106 and VAP111 that actuate cylinders 106, 111 to advance the blanking knife-heat sealer assembly 26 to its fully advanced position central to the plane of the tube 12 beneath the opened hinged leaves. VAP110 concurrently actuates cylinder 110B that pivotally swings the horizontally-mounted wiper blades inwardly thereby elevating the ends of the bag side flaps to the opened hinged leaves. PV121 concurrently pilots VAP125 thereby terminating the air blast directed against the bag flaps. (During this portion of the cycle, PV118 is inoperative.)

When the blanking knife-heat sealer assembly 26 is fully advanced to heat-sealing position, it engages N.O. LS107 to give a maintained electrical pulse that operates timer TMR140. TMR140 has three separate adjustable timed circuits (1, 2, 3) controlling the raising and lowering of the combination assembly to make the controlled penetration heat-seal, forming the bag bottom closure. Timer circuit TMR140-2 is preset to close for 2.7 seconds thereby energizing VS113 to operate cylinder 113 connected to the platen, flattening the bag flaps onto the hinged leaves 44 for that interval. Timer circuit TMR140-3 is preset to close for 1.0 second thereby energizing VS114 to operate cylinder 114 connected to the heat-seal bar 412 to provide the sealing time interval. Timer circuit TMR140-1 is preset to 3.0 seconds to clear and reset the timer for the next cycle.

LS107 concurrently actuates VS103, opening the clamps of the gripper assembly 30 thus in turn actuating LS104 to open position. As the gripper clamps 203 are opened

they contact LS111, which is restored to its normally closed position.

When the heat-seal operation has been completed, lowering of the assembly trips PV122 to supply pilot air for VAP106 and VAP111, which in combination return the blanking knife-heat sealer assembly 26 to its starting position. PV122 concurrently supplies pilot air to VAP123 discharging air from cylinder 123A, thus permitting the gripper assembly 30 to retract to its lowermost position, and thereby closes N.O. limit switch LS113 (see FIG. 33) signaling that the gripper assembly 30 has cleared the indexing table 10. Concurrently, pressure air from VAP123 retracts force member cylinders 123B and 123C thereby clearing them for rotation of movable Station A to Station II.

Retraction of the blanking knife-heat sealer assembly 26 trips N.O. limit switch LS108 providing the momentary pulse to reset the controls for the next bag making cycle.

Station I—bottom closure transfer.—At the end of a machine cycle (90° rotation of the indexing table) a signal from the plugging switch PLS550 energizes relay RL5. This in turn closes RL6 (FIG. 34a), thus providing a holding circuit releasing the electric brake that locks the gripper assembly 30, and concurrently energizes VS105 (FIG. 35a) which in turn directs air to cylinder 105 thereby opening the stationary clamping platen 24, which in turn engages LS101, thereby energizing VS101 and VS115. VS101 opens to exhaust the air on the bottom side of cylinder 101 and thereby lowers the mandrel carriage assembly 22 and thus advances the tube downward through the opened stationary and movable clamps. Piston motion of cylinder 101 is closely regulated by concurrently pressurizing both ends of the cylinder with line air pressure, and then bleeding air from either one side or the other of the cylinder.

VS115 supplies air to the bottom side of cylinder 102 which collapses the internal hinged metal leaves 44 to about 55° included angle. Adjacent the terminus of its downward travel, a cam on the internal mandrel fulcrum arm trips LS102 (FIG. 34a) which energizes VS102. VS102 is a three-way valve which serves to throttle the air being exhausted from cylinder 101, acting as a variable length piston cushion and thus causing the piston to decelerate. The cam on the internal mandrel fulcrum arm concurrently trips LS103 (FIG. 34a) that activates the electric eye positioned on the input unit to sense register marks printed on the tube 12. When this occurs, the electric eye energizes RL4 (FIG. 34a) which in turn activates the electric brake that locks the mandrel carriage at its instant position. Concurrently, RL4 actuates VS101 that stops the motion of the gripper assembly 30 by concurrently closing the lower exhaust port and reapplying air pressure to the bottom of cylinder 101. RL4 also concurrently energizes VS103 (FIG. 35b) that actuates dual cylinders 103 thereby closing the gripper clamps 203 upon the bag bottom spread upon the contact saddle 78. Switch LS110 (FIG. 34a) is used in place of the electric eye circuit when running unprinted film stock.

In order to insure that the internal mandrel 40 and the gripper assembly 30 have mated, N.O. LS120 is mounted on one end of the gripper saddle 78 to be engaged by the opened metal leaves 44 of the internal mandrel 40. LS120 is interposed in series in the circuit between RL4 and VS103 and must be closed before VS103 can operate. Closing of the gripper clamps 203 concurrently trips N.O. LS111 thereby dropping out RL4 to deactivate the electric brake locking the mandrel carriage 36 releasing it to be returned to its elevated position. LS104 energizes VS104 which bleeds air off the top side of cylinder 101, thus raising the internal mandrel fulcrum arm to its starting position. When the internal mandrel carriage 36 reaches its uppermost or starting position, it trips N.O. LS106 which energizes valve VS105A that in turn directs air to cylinder 105 closing the stationary clamping platen 24. Concurrently as cylinder 105 closes the top clamp, it trips PV116

thereby reestablishing the pneumatic control sequence for the next bag cycle.

Station II operation.—Referring now to FIGS. 33 and 35, three normally open limit switches are provided to sense when operating components at Station II are clear of the intermittently rotating indexing table 10. These switches sense the all-clear position of the following operating components:

- LS204—Valve flattening platen-heat sealer assembly in retracted (raised) position.
- LS205—Valve film gripper assembly in retracted (raised) position.
- LS206—Shuttle carriage frame assembly in raised position.

The pulse from plugging switch PLS550 which initiates operations at Station I, concurrently initiates operations at Station II by energizing VS201, thereby supplying pilot air to VAP202 and VAP203. VAP202 actuates cylinder 202 which lowers the shuttle 86 to its operation position. VAP203 actuates cylinder 203 (of combination cylinder 203-204) which advances the suction bar 96 to its intermediate position. Cylinder 203-204 is a tandem compounded unit, having a unitary shell with two independently operated pistons and rods.

As the shuttle carriage frame is lowered into operating position it trips PV214 that provides a pneumatic pulse through sequencing valve VS260. The valve VX260 operates as a flip-flop, i.e., input air initially passes through to its output port, then when the output line is exhausted, the valve closes the input port and input flow is reestablished only when input pressure is exhausted and then repressurized. The valve VX260 pilots N.O. VAP230 that pilots VTR204.

VTR204 supplies air to the inboard side of cylinder 204 (of combination cylinder 203-204) thereby extending the suction bar 96 to its lowermost position to contact the top surface of the bag blank folded over the suction cups 308 of the outboard clamping platen. VTR204 concurrently pilots VAP230 to interrupt the air supply from the valve VX260 and concurrently exhausts air from the time delay chamber of VTR204. When the time delay piston returns to its initial position, VTR204 reverses to exhaust cylinder 204 and thereby retracts the suction bar 96 to its intermediate position, which raises and separates the top ply of the bag blank from the bottom ply held to the outboard clamping platen by the suction cups.

Vacuum for the suction bar 96 is provided by a vacuum pump connected to an accumulator tank. The accumulator tank is connected to N.C. VAP201 that in turn is connected to the suction bar 96. Vacuum is not applied to the bar 96 in its retracted position. In its extended position the suction bar contacts (N.O. and N.C.) and plugging pilot air to VAP201 opening it to thereby provide plugging pilot air to VAP 201 opening it to thereby provide and maintain vacuum to the suction cup header until the shuttle 86 is advanced.

When the suction bar 96 is raised by retracting to its intermediate position (described above) by the exhausting cylinder 204 (of combination cylinder 203-204), it disengages LS206 to reverse its (N.O. and N.C.) contacts, and engages N.O. LS203. LS206 is connected in series to LS203, PS201 and VS205 (solenoid pilot operated four-way). PS201 (pressure switch) is connected to close only when vacuum is sensed in the suction bar 96. When LS203 and PS201 are both closed, VS205 is energized to supply air to the bottom of cylinder 205. Cylinder 205 advances the plates of the shuttle to spread open the top side flap and unfold the end flaps of the bag blank upon the inboard clamping platen suction cups.

PV213 is tripped at the beginning of the shuttle advance to pilot VAP203 operating cylinder 203 (of combination cylinder 203-204), to fully retract the suction bar 96. Concurrently the air line from VAP203 supplies a pilot signal to the opposite end of VAP201 thereby shutting off

the vacuum accumulator and opening PS201 to break the series circuit to VS205 (VS205 is thus positioned to have pilot air reverse it).

Advance of the shuttle carriage engages PV509 (FIG. 37) that applies vacuum to the suction cups on the inboard clamping platen. Advance of the shuttle carriage also engages N.O. LS202 to give a maintained electrical pulse that operates TMR240. TMR240 has three separate adjustable timed circuits (1, 2, 3) controlling the lowering and the raising of the combination assembly to make the primary heat-seal sealing the valve sheet to the bag end tab. Timer circuit TMR240-2 is preset to close for 1.2 seconds thereby energizing VS208 to operate cylinder 208 connected to the platen flattening the valve film web to the bag end flap for that time interval. Timer circuit TMR240-3 is preset to close for 0.8 second thereby energizing VS209 to operate cylinder 209 (of tandem compounded unit cylinder 208-209) connected to the heat-seal bar to provide the sealing time interval. Timer circuit TMR240-1 is preset to 3.5 seconds to clear and reset the timer for the next cycle.

Air that actuates cylinder 209 concurrently supplies pilot air to one side of VAP206 and thereby actuates cylinder 206 to lower the twin gripper fingers that clamp the inboard edge of the valve sheet to the outfolded side flap of the bag blank. When the combination clamping platen and heat-seal bar is raised to its retracted position, it engages PV211 (air supplied by advancing cylinder 206) and thereby pilots VS205 to retract the shuttle assembly 86.

The air pulse that reverses VS206 concurrently supplies pilot air to VAP216 that actuates cylinder 216 to release the valve film web snubbing clamp 90. When the shuttle assembly is retracted, it engages PV212 to supply a pilot pulse to reverse VAP216 thereby reversing cylinder 216 to engage the valve sheet snubbing clamp. PV212 is arranged to engage the shuttle assembly prior to reaching its fully retracted position and thereby actuates the snubbing clamp before the carriage stops moving. The valve sheet is thus tensioned between the gripper fingers clamping the inboard end of the sheet and the snubbing clamp at the outboard end of the sheet.

PV212 concurrently supplies a pilot pulse to VTR207 and thereby actuates cylinder 207 through a pneumatic time delay in the valve to successively advance and retract the hot-wire film cutoff assembly. When the film cutoff assembly advances fully, it engages PV210 that supplies pilot air to VAP206 thereby reversing cylinder 206 to raise the twin gripper fingers. PV210 concurrently supplies pilot air to VAP202 thereby reversing cylinder 202 and retracting the shuttle carriage frame assembly to its raised position where it engages N.O. LS203 to signal an "all clear" for the indexing table.

Station III operation.—Referring now to FIGS. 33, 34b, and 37, normally open limit switch LS301 senses when the heat sealer 150 at Station III is in the retracted (raised) position and is clear of the intermittently rotating indexing table.

The pulse from plugging switch PLS550 which initiates operations at Stations I and II concurrently initiates operations at Station III by energizing electrical timer TMR340.

TMR340 has three separate adjustable timed circuits (1, 2, 3) controlling the lowering and the raising of the combination assembly to make the controlled penetration heat-seal, forming the overlapped flaps and valve web into the finished bag top closure. Timer circuit TMR340-1 is preset to 5.0 seconds and wired to hold in the momentary pulse for that interval, then clear and reset the timer for the next cycle.

Circuits TMR340-2 and TMR340-3 are preset to close 0.2 second after the timer starts to operate, thereby permitting the inboard and outboard bag flap foldover rollers to fully infold the flaps about the internal platen, before initiating the heat-seal cycle. Timer circuit TMR340-2

is preset to close for an interval of 1.7 seconds thereby energizing VS301 to operate cylinder 301 connected to lower and clamp the flattening platen to the bag flaps retained by the foldover rollers and internal platen. Timer circuit TMR340-3 is preset to close for 4.0 seconds thereby energizing VS302 to operate cylinder 302 connected to the heat-seal bar to provide the sealing time interval.

Station IV operation.—The operation at Station IV consists of opening the clamping platens to discharge the finished bag. Means for opening the clamping platen of the movable station indexed at Station IV is described above in connection with the operation of cylinder 501.

Indexing table operation.—The indexing table drive and rotation control are described above. As the table rotates successively from Station I to Station IV, the pilot valves affixed to the table at the four corners thereof are tripped by fixed strikers on the machine frame and thereby (1) clamp the bag blank, (2) retain by suction cups the outboard and inboard side flaps on the top of the clamping platens, and (3) overfold the bag side flaps to form the top closure. Opening of the clamping platens at Station IV and closing of same at Station I by typical indexing table cylinder 501 actuated by VL501 is described above.

Referring to FIG. 37, vacuum is applied and maintained on the suction cups of the outboard clamping platen when PV508, which is mounted on the indexing table, is momentarily engaged at Station I by advance of the blanking platen assembly, and thereby supplies pilot air to open VAP503 connecting the outboard suction cup manifold of Station I clamping platen, to the vacuum line supplied by the vacuum pump on the indexing table. VAP503 is closed by pilot air from PV507 when it is momentarily engaged at Station III as described below, thereby shutting off vacuum on the outboard suction cup manifold.

Vacuum is applied and maintained on the suction cups of the inboard clamping platen when PV509 mounted on the indexing table is momentarily engaged at Station II by advance of the shuttle carriage and thereby supplies pilot air to open VAP594 to the vacuum line on the indexing table (see also Station II operation on page 17). VAP504 is closed by pilot air from PV507 momentarily engaged at Station III as described below thereby shutting off vacuum on the inboard suction cup manifold.

The outboard and inboard clamping platens each have a pivotally operated foldover roller assembly actuated by cylinders 510 and 512 respectively. As the clamping platen is being indexed from Station II to III, a striker affixed to the machine frame and positioned at the 80° point of the indexing motion, engages PV507 thereby concurrently piloting VAP502 and 503, and VAP504A (noted above). VAP502 energizes cylinders 510 and 512 to advance and elevate the inboard and outboard foldover rollers and thereby fold over the side flaps of the bag top closure about the internal former platen that is advanced into the end flap pocket.

Appropriate speed control valves in the air lines supplying cylinders 510 and 512, are preset to regulate the cylinder motion so that the outboard foldover roller precedes the inboard by 0.2 second, thereby placing the inboard side flap outermost in the top closure.

In the next bag cycle as the clamping platen is indexed from Station III to IV, a striker affixed to the machine frame and positioned at the 10° point of the table indexing motion, engages PV506 thereby reversing VAP502 to retract cylinders 510 and 512 and thus lower both the inboard and outboard foldover rollers below the top surface of the clamping platen.

Concurrently at the 10° position of indexing motion (moving from Station III to Station IV) another pilot valve mounted on the table, is engaged by a fixed cam surface, that is mounted along the inside track of the

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rotating table. This pilot valve provides release air to a blow tube centrally mounted on the top of the internal former platen associated with the movable clamping platen. The release air is diffused from holes along the length of the tube to impinge upon and break loose the internal surface of the bag closure from the top surface of the platen. The release air inflates the completed top closure permitting the internal former platen to be withdrawn from the bag on a cushion of air, through the tube formed by the bag valve.

While various specific forms of the present invention have been illustrated and described herein in some detail, it will be apparent that the same are susceptible of numerous modifications within the scope of the invention. For example, although the invention has been described with particular reference to specific types of bottom and top closures for the thermoplastic film bag, the subject apparatus is equally applicable to other types of closure structures. As mentioned above, the internal mandrel and the elements associated therewith can even be used to form an end closure in a flattened tube with no flaps or die cuts whatever. Moreover, although the arrangement of the various operating stations has been described as circular, these stations can be positioned in a linear arrangement, either horizontally or vertically. Also, while a particular mechanical-pneumatic-electric control system has been described, the apparatus may be controlled by an electrical system, a hydraulic system, or any other suitable control system. Similarly, it will be apparent that without substantial change, the invention may be applied to any heat-sealable thermoplastic film of various thicknesses, and to produce sacks and bags of various sizes and either opened or closed, with or without valves, single-walled or multi-walled, and using either seamed or seamless tubing. If it is desired to produce a bag with valves at both ends, Station I can be replaced with apparatus identical to that described at Station II. That is, Stations I and II may be used alone as well as in combination with each other.

What is claimed is:

1. Apparatus for making a bag having rectangular heat-sealed end closures from flattened tubular thermoplastic film, which apparatus comprises:

- (a) an internal mandrel adapted to fit within said flattened tubular film and means for disposing said mandrel within said film;
- (b) means for infolding a pair of opposed side portions and a pair of opposed end portions at one end of said film over said mandrel so as to form a first rectangular end closure;
- (c) means for heat sealing said infolded side and end portions together so as to seal said end closure;
- (d) means for displacing said internal mandrel and said film relative to each other along the axis of said tubular film;
- (e) means for infolding a pair of opposed side portions and a pair of opposed end portions at the other end of said film so as to form a second rectangular end closure;
- (f) means for disposing a flat forming platen within said second end closure and heat sealing said infolded side and end portions together against said platen;
- (g) and means for withdrawing said forming platen from the sealed end closure.

2. Apparatus for making a bag having a rectangular heat-sealed end closure from flattened tubular thermoplastic film, which apparatus comprises:

- (a) a relatively thin flat mandrel adapted to fit within said flattened tubular film, said mandrel having a pair of opposed leaves hinged on one end thereof;
- (b) means for disposing said mandrel within said flattened tubular film with said hinged leaves near an open end of said film;

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(c) means for spreading said leaves so that they are substantially normal to the plane of said film, thereby engaging the plies of the film and forming a pair of opposed outfolded side portions and a pair of opposed infolded end portions in the end of said film;

(d) means for infolding said side portions of said film into overlapping relationship with said infolded end portions;

(e) and means for heat sealing said overlapping side portions and end portions together in the overlaps by using said spread leaves as an internal work surface.

3. The apparatus of claim 2 wherein said mandrel is provided with at least one pair of spring-mounted ears which hold said flattened tubular film taut across the surface of said mandrel, said ears being linked together so that they also center said film on said mandrel.

4. The apparatus of claim 2 wherein said opposed leaves on said mandrel form a hexagonal work surface when they are spread normal to the plane of said film.

5. The apparatus of claim 2 wherein the inside work surfaces of said opposed leaves on said mandrel are covered with a sheet of resilient heat-resistant material.

6. The apparatus of claim 2 wherein said leaves are hinged to said mandrel by a flat two-sided hinge comprising a pair of sheets of flexible material, each of said sheets being bonded to the outer surface of one of said leaves and to an adjacent portion of the surface of said mandrel.

7. The apparatus of claim 2 which includes a plurality of inside rollers rotatably mounted in said mandrel so that at least one pair of closely spaced roller surfaces protrudes outwardly from each flat surface of said mandrel so as to contact the inner surface of said film; and at least one outside clamping roller protruding inwardly between each pair of said closely spaced inside roller surfaces, said outside rollers being in contact with the outer surface of said film and engaging said inside rollers in pressing contact through said film, said outside rollers being rotatably mounted in a rigid supporting member.

8. The apparatus of claim 7 wherein said outside rollers are rotatably mounted in a rigid carriage which is movably mounted so as to be movable along the plane of said flattened tubular film, thereby moving said internal mandrel through said film.

9. The apparatus of claim 2 having an automatic electrical-pneumatic cascade control system to successively actuate the spreading means, then the unfolding means, and then the heat sealing means.

10. The apparatus of claim 2 wherein the outer surfaces of said opposed leaves on said mandrel are magnetic and said means for spreading said leaves comprises a pair of magnetic clamps swingably mounted to magnetically engage said leaves through the film and then spread said leaves apart.

11. The apparatus of claim 2 wherein said means for infolding said side portions of said film comprises a pair of foldover rolls which are movable across the inner surfaces of said leaves while said leaves are spread normal to the plane of said film, said rolls being mounted so that they are non-rotating when being advanced and rotating when being retracted.

12. Apparatus for making a bag having a rectangular heat-sealed end closure from flattened tubular thermoplastic film, which apparatus comprises:

- (a) a relatively thin flat mandrel adapted to fit within said flattened tubular film, said mandrel having a pair of opposed leaves hinged on one end thereof;
- (b) means for disposing said mandrel within said flattened tubular film with the ends of said hinged leaves at least one leaf width from the end of said film;
- (c) means for spreading said leaves so that they are substantially normal to the plane of said film and

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means for forming a heat sealed end closure against the work surface provided by the inner surface of said spread leaves;

(d) a gripper assembly in an advanced position from said mandrel for gripping said end closure in said film;

(e) means for advancing said mandrel so as to advance said end closure to said gripper assembly and means for retracting said mandrel through said film.

13. The apparatus of claim 12 which includes means for severing a length of film containing said end closure and forming a second end closure in the remaining open end of the severed length of film.

14. The apparatus of claim 12 wherein said gripper assembly comprises a contact saddle adapted to fit between the leaves on said mandrel and at least one pair of clamps for clamping the end closure in said film to said saddle.

15. The apparatus of claim 14 wherein the included angle at the apex of said contact saddle is between about 50 and about 60°.

16. The apparatus of claim 12 wherein the ends of said leaves on said mandrel are provided with notches which mate with said clamps so that the end closure in said film can be clamped to said contact saddle while said mandrel is retracted through said film.

17. Apparatus for making a bag having a rectangular heat-sealed end closure from flattened tubular thermoplastic film, which apparatus comprises:

(a) a relatively thin flat mandrel adapted to fit within said flattened tubular film, said mandrel having a pair of opposed leaves hinged on one end thereof;

(b) means for disposing said mandrel within a continuous length of said flattened tubular film;

(c) means for severing said film a short distance beyond the free ends of said leaves and forming a pair of opposed side flaps and a pair of opposed end tabs in the end of said film;

(d) means for spreading said leaves so that they are substantially normal to the plane of said film, thereby outfolding said side flaps and infolding said end tabs;

(e) means for infolding said side flaps into overlapping relationship with said infolded end tabs;

(f) means for heat sealing said overlapping side flaps and end tabs together in the overlaps;

(g) and means for withdrawing said mandrel from said film.

18. The apparatus of claim 17 wherein said severing and cutting means comprises means for tensioning said flattened tubular film in the machine direction; a male cutting member on one side of said film and having serrated cutting edges protruding therefrom in a direction normal to the plane of the film; a female cutting member on the other side of the film and having cavities in the face thereof to receive said protruding cutting edges; and means for striking said male and female members together in the plane of said film so that said cutting edges pierce both plies of said film as they pass into said cavities.

19. Apparatus for making a bag having a rectangular valved end closure from flattened tubular thermoplastic film, which apparatus comprises:

(a) means for forming a pair of opposed outfolded side portions and a pair of opposed infolded end portions in an open end of said flattened tubular film;

(b) shuttle means for inserting a valve sheet of thermoplastic film across said outfolded side portions and in overlapping relationship with a first infolded end portion;

(c) means for heat sealing said valve sheet to said first end portion;

(d) a movable forming platen end means for inserting said forming platen over said first end portion and the middle of said valve sheet and under the second end portion;

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(e) means for infolding said outfolded side portions and the end portions of said valve sheet over said platen into overlapping relationship with each other and said end portions;

(f) means for heat sealing the overlapping side portions, valve sheet, and the second end portion together in the overlaps;

(g) and means for withdrawing said forming platen over the first end portion.

20. The apparatus of claim 19 wherein said shuttle means comprises a lower plate and an upper plate with said valve sheet held therebetween, said upper plate having a notch therein so that said valve sheet can be heat sealed to said first infolded end portion by using said lower plate as a work surface.

21. The apparatus of claim 19 which includes means for clamping the forward end of said valve sheet against a first outfolded side portion, means for tensioning said valve sheet across said side portions, and means for severing the tensioned sheet adjacent the outer edge of the second outfolded side portion.

22. The apparatus of claim 19 having a combination electrical-pneumatic automatic cascade control system to successively actuate the shuttle means, then the heat sealing means, then the forming platen, then the infolding means, then the heat sealing means, and then the withdrawing means.

23. Apparatus for making a bag having a rectangular valved end closure from flattened tubular thermoplastic film, which apparatus comprises:

(a) means for cutting a pair of opposed side flaps and a pair of opposed end tabs in an open end of said film;

(b) a clamping platen having two flat platen members;

(c) means for wiping and retaining both plies on an end portion of the film containing said side flaps and end tabs down onto one of said platen members;

(d) combination lifter and shuttle means for outfolding the upper side flap onto the other platen member while inserting a valve sheet of thermoplastic film across the outfolded side flaps, thereby infolding said end tabs so that a first end tab is in overlapping relationship with said valve sheet;

(e) a movable forming platen and means for inserting said forming platen over said first end tab and then over a mid-portion of said valve sheet and under the second end tab;

(f) means for infolding said outfolded side flaps and the end portions of said valve sheet over said platen into overlapping relationship with each other and said end tabs;

(g) and means for heat sealing the overlapping side flaps, valve sheet, and second end tab together in the overlaps.

24. The apparatus of claim 23 which includes suction means for raising the upper side flap of the end portion of the film prior to the insertion of said shuttle means.

25. Apparatus for making a bag having rectangular heat-sealed end closures from flattened tubular thermoplastic film, which apparatus comprises:

(a) a movable indexing table having mounted thereon a plurality of clamping platen-foldover roll assemblies;

(b) means for indexing said table at a first station having an internal mandrel adapted to fit within said flattened tubular film, means for disposing said mandrel within said film, means for infolding a pair of opposed side portions and a pair of opposed end portions at one end of said film over said mandrel so as to form a first rectangular end closure, means for heat sealing said infolded side and end portions together so as to seal said end closure, and means for positioning said film within said clamping platen-foldover roll assembly on said table with the open

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end of said film protruding above the surface of said clamping platen;

- (c) means for indexing said table at a second station having means for forming a pair of opposed outfolded side portions and a pair of opposed infolded end portions in said open end of said flattened tubular film, shuttle means for inserting a valve sheet across said outfolded side portions and in overlapping relationship with a first infolded end portion, means for joining said valve sheet to said first end portion;
- (d) a movable forming platen and means for inserting said forming platen over said first infolded end portion and the middle of said valve sheet and under the second infolded end portion;
- (e) means for indexing said table at a third station having means for actuating said foldover rolls on said assembly to infold said outfolded side portions and the end portions of said valve sheet over said forming platen into overlapping relationship with each other and said end portions, and means for heat sealing the overlapping side portions, valve sheet, and said second end portion together in the overlaps to form a valved end closure;
- (f) means for withdrawing said forming platen from said valved end closure; and
- (g) means for indexing said table at a fourth station having means for opening said clamping platen on said table to discharge the finished bag therefrom.

26. The apparatus of claim 25 having an automatic electrical-pneumatic cascade control system for simultaneously actuating each of said first, second, third, and fourth stations as said table is indexed at said stations, said control system including means for detecting when the operations have been completed at all of said stations and then actuating the next indexing movement of said table.

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27. Apparatus for making bags having rectangular lapped and heat-sealed end closures from flattened tubular thermoplastic film, which apparatus comprises:

- (a) a relatively thin flat mandrel adapted to fit within said flattened tubular film, said mandrel having a pair of opposed hinged leaves on one end thereof;
- (b) means for disposing said mandrel within said flattened tubular film with the ends of said hinged leaves spaced at least one leaf width from an open end of said film;
- (c) a first pair of clamping platens for clamping said tubular film above said leaves, the lower surfaces of said platens being aligned with the upper edges of said leaves;
- (d) means for spreading said leaves upwardly against the lower surfaces of said platens so that they are substantially normal to the plane of said film, and means for forming a heat-sealed end closure in said film against the lower surfaces of the spread leaves;
- (e) a second pair of clamping platens for clamping a severed portion of said tubular film below said leaves, the upper surfaces of said second platens being at least four leaf widths below the lower surfaces of said first platens;
- (f) and means for forming a heat-sealed end closure in the severed portion of film in said second platens against the upper surfaces of said second platens.

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