(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 090 740 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
11.04.2001 Bulletin 2001/15

(51) Int. Cl.[7]: **B31B 19/74**, B31B 39/00, B31B 1/02

(21) Application number: **00307788.0**

(22) Date of filing: **08.09.2000**

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **07.10.1999 GB 9923726**

(71) Applicant: **MOLINS PLC**
Blakelands, Milton Keynes MK14 5LU (GB)

(72) Inventor: **Whitlock, Peter John**
Westwood Business Park, Coventry CV4 8HS (GB)

(74) Representative:
Baldwin, Mark et al
fJ Cleveland
40-43 Chancery Lane
London WC2A 1JQ (GB)

(54) Bag making

(57) A method of making a bag comprises providing a plurality of lengthwise extending folds (84) in a web (56) of flexible packaging material and positioning a length of flexible material (114) on the folded web. The length of material (114) is attached to the web (56) at positions spaced from the folds, by seals (24), caused to adopt a tubular configuration, and then sealed to form a tube. The tube is then sealed transversely to define a bag. The length of material is attached to the inside of each upright face of the finished bag and provides a strengthening ring for the bag.

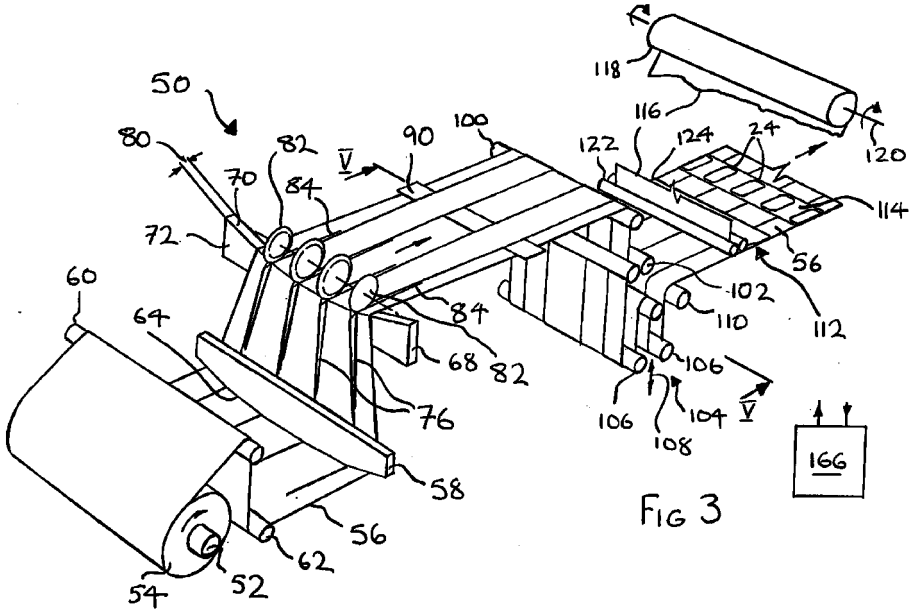

FIG 3

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Description

[0001] The invention relates to making bags.

[0002] Figure 1 is a plan view of the open end of a known bag 10 made from plastics sheet material. The bag has an outer skin 12 and an inner part 14 secured to the outer skin at discreet the locations. The inner part 14 is made of a flexible plastics material and is arranged such that it adopts an octagonal shape when the bag is filled and causes the bag to have a generally rectangular configuration. EP-A-0824065 discloses apparatus and a method of making such a bag.

[0003] The method disclosed in EP-A-0824065 involves: feeding a length of a first flexible plastics sheet material onto a table; superposing a length of a second, narrower, plastics sheet on the first sheet; manipulating the table to produce depressions which extend in the widthwise, or transverse, direction of the sheets; drawing portions of the first sheet into the depressions; forming seals between the first and second sheets between the depressions by means of a suction force; cutting the first and second sheets to a length which defines the circumference of the bag; swinging an octagonal former over the cut lengths to a position in which it extends perpendicular to the length of the sheets; wrapping the two lengths around the former and sealing the ends of the two lengths together to form a tube; and sealing one end of the tube to define a bag. The former can then be swung away from the table and collapsed to permit the bag to be removed for filling and the process repeated to make another bag.

[0004] The invention provides a method of making a bag comprising the steps of: providing a plurality of folds in a web of flexible material, said folds extending in a lengthwise direction of said web; positioning a length of a flexible material on said folded web; attaching said length of material to said web at positions spaced from said folds; causing said web and attached length of material to adopt a generally tubular configuration and forming a longitudinally extending joint to form a tube; and forming a seal extending transversely of said tube, which seal defines an end of said bag.

[0005] The invention also includes apparatus for making a bag, said apparatus comprising means for providing a plurality of folds in a web of a flexible material, said folds extending in a lengthwise direction of said web, means for positioning a length of a flexible material onto said folded web and attaching said length of material to the web at positions spaced from said folds, means for forming said web and attached length of material into a tube and means for forming a seal extending transversely of said tube.

[0006] In order that the invention may be well understood, an embodiment thereof, which is given by way of example only, will now be described with reference to the drawings, in which:

Figure 1 is a plan view on the open end of a bag;

Figure 2 is a side elevation view of the bag in a flattened condition prior to filling and looking in the direction of the arrow II in Figure 1;

Figure 3 is a schematic perspective view of the upstream end of an apparatus for making the bag shown in Figure 1;

Figure 4 is a continuation of Figure 3 showing the downstream end of the apparatus;

Figure 5 is a section on line V-V in Figure 3;

Figure 6 is a side elevation view of a bow-forming device of the apparatus shown in Figure 3; and

Figure 7 is an enlarged view of a portion of the apparatus shown in Figure 4.

[0007] Referring to Figures 1 and 2, a bag 10 comprises an outer skin 12 formed from a web of flexible plastics material and an inner part 14 also made from a flexible plastics material. When filled, the outer skin has the form of a generally rectangular section tube closed at one end 16 by a transverse seal 18 and along its length by a continuous backseal 20. The closed end 16 defines the base of the bag and, after filling, the outer skin can similarly be closed at the opposite end 21 by means of a transverse seal (not shown).

[0008] The inner part 14 is in the form of an open-ended tube which has a generally octagonal cross-section and is disposed intermediate the bag ends 16, 21. The inner part 14 is attached to the outer skin 12 at positions remote from the corners 22 of the bag. Attachment is preferably by means of heat sealing. Seals formed between the outer skin and inner part are indicated at 24 and as shown in Figure 2, consist of two longitudinally extending seals and two transverse seals which join one another to define a rectangular line seal.

[0009] Respective diagonal seals 26 extend from the transverse seal 18 at the centre of closed end 16 to each of the four corners 22 of the bag. The diagonal seals 26 serve to ensure that there are no recesses or corners in the base of the bag in which product could collect. The bag may also have angled seals 28 provided at its end 21. The seals 28 are optional and serve to assist in obtaining a top with clean lines when the bag is sealed at the end 21.

[0010] If desired, the bag can be provided with a discharge device, such as a spout 30.

[0011] An apparatus 50 for making the bag 10 is shown schematically in Figures 3 to 7. The apparatus 50 includes a reel stand 52 for mounting a reel 54 of a flexible plastics web. The web 56 is fed from the reel 54 to a bow-forming device 58 via guide rollers 60, 62. The bow-forming device 58 extends widthwise across the web and includes an arcuate forming surface 64. The bow-forming device 58 is positioned above the web (as viewed in the drawing) and the forming surface 64 is arranged to press against a central portion of the web causing the web to bow about its centreline. As an alternative to a fixed member, the bow-forming device could comprise a crowned roller.

[0012] A V-forming device 68 is positioned downstream of the bow-forming device 58 and in a different horizontal plane. The V-forming device 68 has an arcuate surface 70 which faces in the opposite direction to the forming surface 64. The V-forming device has a substantially planar surface 72 disposed perpendicular to the surfaces 64, 70. The surface 72 defines, or has fixed to it, four V-section ridges 74 (Figure 6) which serve to form correspondingly shaped ridges 76 in the web 56. The ridges 74 converge in the downstream direction of the surface 72. The forming surface 70 defines four V-shaped grooves 78 (Figure 6) which are aligned with the downstream ends of the ridges 74 and extend in parallel spaced apart relationship over the full length 80 of the forming surface 70. Respective rotatable discs 82 may be provided for pressing the web into the grooves 78. The discs 82 would preferably be freely rotatable on a common shaft (not shown). The arrangement of the ridges 74, grooves 78 and discs 82 is such that as the web flows over the surface 70 and beneath the discs 82, the ridges 76 are converted into V-shaped depressions 84.

[0013] Downstream of the V-forming device 68, there is a shingle former 90, which is shown in detail in Figure 5. The shingle former comprises five plates 92: three of those plates 92a are suspended from a machine frame 94 on the ends of respective supporting members 96 and the two remaining plates 92b sit on respective supporting members 98 which are supported from below by the frame 94. The plates 92a are disposed in a common plane and the plates 92b, which are disposed intermediate the plates 92a in an alternating arrangement, are likewise disposed in a common plane, which is parallel to and spaced from the plane of the plates 92a. The arrangement is such that adjacent plates 92a, 92b overlap. The corners on the leading edges of the plates are radiused to prevent tearing of the web and the width of the plates may increase in the downstream direction of the shingle former such that the extent of each overlap increases in that direction, although this is not essential.

[0014] Downstream of the shingle former 90, there is a guide roller 100 which turns the web through 90° and feeds it between the opposed rollers of a nip drive 102. The nip drive 102 serves to draw the web 56 from the reel 54. A braking arrangement may be provided on the reel stand 52 to assist in controlling the web tension in a manner well known to those skilled in the art. Downstream of the nip drive, there is an accumulator 104 which includes two floating, or dancer, rollers 106. The dancer rollers 106 are capable of movement in the directions indicated by the arrow 108.

[0015] At the downstream end of the accumulator 104, there is a guide roller 110 which is arranged to turn the web through 90° and direct it towards a sealing and cutting station 112 at which a length 114 of a flexible plastics material, cut from a web 116, is attached to the web 56. The web 116 is fed from a reel 118 rotatably mounted by a reel stand indicated at 120. The web 116 is fed between the rollers of a nip drive 122 which serves to draw the web from the reel 118. As described above, a braking arrangement may be provided to assist in controlling the web tension. A guide block 124 is provided downstream of the nip drive and above the web 56. The guide block has an upwardly facing guide surface, which is inclined in the direction of travel of the web 116 and arranged to support the web as it passes between the nip drive and a position in which it is both superposed on the web 56 and beneath a combined sealing and cutting device 126 (Figure 4). The sealing and cutting device 126 is arranged to cut the length of material 114 from the end of the web 116 and seal it to the web 56 and may comprise any suitable arrangement of known cutting and sealing elements capable of cutting the required length of material 114 from the web 116 and securing it to the web 56. The length of material 114 attached to the web 56 forms the inner part 14 of the bag 10 and in the description which follows will be referred to as such.

[0016] Referring to Figures 4 and 7, downstream of the cutting and sealing device there is a guide roller 130. The guide bar 130 is arranged to deflect the web 56 and the inner part 14 onto a forming shoulder 132. The forming shoulder 132 is arranged to guide the web so that it wraps itself around a vertically orientated forming tube 134, which in cross-section is octagonal. The arrangement of the forming shoulder 132 and forming tube 134 is such that the web 56 and inner part 14 adopt a generally tubular configuration with the lengthwise extending edges 56a, 56b of the web in overlapping relationship and the inner part 14 disposed between the forming tube and the web.

[0017] A sealing unit 136 (Figure 7) is provided adjacent the forming tube 134 to seal regions of the web 56 adjacent the edges 56a, 56b to one another in order to form the backseal 20 and thereby secure the web 56 and inner part 14 in the form of a tube.

[0018] A pair of vacuum drive belts 138 are positioned on opposite sides of the forming tube 134 to draw the web 56 over the forming shoulder 132 and feed it downwardly along the forming tube towards a first transverse sealing station 140. At the downstream end of the forming tube 134, there are two gusset-forming plates 142. The gusset-forming plates are disposed opposite one another in a vertical plane which is at 90° to the backseal 20. As indicated in Figure 7, the gusset-forming plates each have an inclined face 144 arranged to progressively push the respective sides of the tubular web towards the tube axis so as to form opposed side gussets.

[0019] The first transverse sealing station 140, which is shown schematically in Figure 4, comprises two reciprocating sealing jaws 146 (Figure 7), only one of which is shown. The sealing jaws 146 are positioned opposite one another and each have heat applying ribs 148, 150 which are arranged to form the diagonal seals

26 and angled seals 28 respectively.

[0020] A second transverse sealing station 154 is positioned downstream of the sealing station 140. The second transverse sealing station 154, which is shown schematically in Figure 4, comprises two sealing and cutting jaws 156 (Figure 7), only one of which is shown. The sealing jaws 156 each have a heat applying rib 158. The ribs 158 are arranged to cooperate to form the transverse seal 18. One of the jaws 156 carries a cutting edge 160 which is cooperable with the other jaw 156 to sever the web 56 downstream of and adjacent a transverse seal 18. The other jaw may have a suitably formed depression which is positioned opposite the cutting edge 160.

[0021] One, or both of the transverse sealing stations 140, 154 may be mounted on carriages which can be moved vertically (as viewed in the drawing) relative to one another to permit the bag length to be varied.

[0022] A control system 166, indicated schematically in Figures 3, 4 and 7, is provided for controlling the motions of the machine and in particular for coordinating the operation of the nip drives 102, 122, the sealing and cutting station 112, the first and second transverse sealing stations 140, 154 and the vacuum belts 138. It will be understood that the operation of these devices requires synchronisation and that the control system, which could, for example, include a PLC, may take any convenient form known to those skilled in the art of bag making machinery and accordingly will not be described in further detail herein.

[0023] In use, the web 56 is fed continuously from the reel 54. As the planar web 56 passes the bow-forming device 58, it is caused to bow so that in transverse cross-section it is curved. The web then turns through 90° at the downstream end of the bow-forming device and flows onto the upright surface 72 of the V-forming device 68. As the web flows over the surface 72, four generally V-shaped ridges 76 are formed by the ridges 74.

[0024] At the downstream end of the surface 72, the web again turns through 90° and passes between the arcuate surface 70 and the discs 82. The discs 82 press the web into the grooves 78, converting the V-shaped ridges 76 into a corresponding number of V-shaped depressions 84 extending in the lengthwise direction of the web in a parallel spaced apart relationship.

[0025] The web 56 passes from the V-forming device to the shingle former 90. The shingle former 90 cooperates with the V-forming device 68 to cause the grooves 84 to twist through 90° and produce respective folds each comprising three overlapped portions of the web 56 as shown in Figure 5.

[0026] The folded web 56 progresses from the shingle former 90 over the guide roller 100 100, through the nip drive 102 and into the accumulator 104. From the accumulator, the web is fed to the sealing and cutting station 112. The web 56 is fed continuously between the reel stand 52 and the accumulator 104, but downstream of the accumulator, movement of the web becomes intermittent. It will be appreciated that the dancer rollers 106 rise and fall in order to take up the length of folded web produced whilst the web downstream of the accumulator is stationary.

[0027] The folded web 56 is brought to rest at the sealing and cutting station 112 in order to permit the application of the inner part 14. The length of material 114 which defines the inner part is obtained by drawing a suitable length of the web 116 from the reel 118 and feeding the web over the guide block 124 such that the free end thereof is superposed on the web 56. The cutting and sealing device 126 then operates to seal the inner part 14 to the web 56 and sever the inner part 14 from the web 116. The sequence of operation of the cutting and sealing device is not critical. The inner part is preferably attached to the web before the cutting operation takes place, but may be cut first and then sealed to the web in which case, it may be necessary to provide a clamping arrangement to hold the inner part in place prior to sealing.

[0028] As shown in Figure 3, the inner part 14 is sealed to the web 56 at five positions which are spaced apart in a direction perpendicular to the lengthwise direction of the web. Importantly, the seals 24 are laterally spaced from the folds in the web 56 permitting relative movement during subsequent forming and filling processes. As indicated in Figures 2 and 3, the seals 24 which attach the length 114 to the web, preferably consist of two welds extending in the lengthwise direction of the web and arranged in parallel spaced apart relationship and two welds extending perpendicular to and interconnecting those welds so as to define a substantially rectangular line seal. It will be observed that the seals 24 adjacent the edges 56a, 56b combine to define a rectangular line seal when the web is formed into a tube about the forming tube 134.

[0029] Once the inner part 14 is attached to the web 56, the web is indexed forward in the direction of the forming shoulder 132. As described above, the web feed downstream of the accumulator 104 is intermittent. Each feeding step moves the web 56 forward a distance determined by the desired bag length and each time the web 56 is brought to rest, another inner part 14 is attached to the web and further sealing and cutting operations occur at downstream locations as described hereinbelow.

[0030] The web 56 and the inner parts 14 are drawn progressively from the sealing and cutting station 112 by the vacuum belts 138 and pass around the guide roller 130 and onto the forming shoulder 132. The forming shoulder guides the web into a space between a downstream edge of the forming shoulder and the periphery of the forming tube 134. As the web is fed into that space, it is caused to wrap around the forming tube and adopt a tubular configuration having a substantially octagonal cross-section corresponding substantially to the circumference of the forming tube. As the tubular

web is drawn downwardly along the forming tube, the overlapping edges 56a, 56b thereof are sealed together to form the backseal 20 and secure the web in the form of a tube. The backseal 20 is formed by the sealing unit 136 which engages the web 56 during the intervals when the web feed is interrupted and is moved away from the web whilst the web is feeding along the forming tube 134.

[0031] The tubular web thus formed is then advanced between the sealing jaws 146 of the first transverse sealing station 140. As the web advances towards the sealing station, it passes between the gusset plates 142 which press opposed side portions of the tubular web towards the web axis to produce inwardly directed folds which define respective side gussets. Whilst the web feed is interrupted, the sealing jaws are moved towards one another, for example, by means of respective pneumatic cylinders, and into engagement with the web. Heat is applied to the web via the ribs 148, 150 in order to form respective seals 26, 28. The gusset plates 142 prevent the seals 26, 28 forming through the gusset so that two opposed seals 26 and 28 are formed on each side of the backseal 20.

[0032] At the same time as the first transverse sealing station is operated, the sealing jaws 156 of the second transverse sealing station are moved toward one another and into engagement with the web so that heat can be applied to the web via the opposed ribs 158 to form a transverse seal 18. Simultaneously, the web is severed below the seal 18 so that when the jaws 156 move apart, a bag 10 falls away from the tubular web. It will be appreciated that each time the web is fed forward, another bag 10 will be separated from the tubular web.

[0033] The bags 10 falling from the apparatus 50 can be collected to be supplied to customers for filling by hand or by suitable bag filling machinery. The bags 10 could, for example, be filled and sealed on a machine such as that disclosed in CH323793 (Hesser Maschinenfabrik) which includes devices for removing bags one-by-one from a stack and then opening, filling and sealing each bag as the bags are moved progressively around a track carried in respective containers.

[0034] Alternatively, the bags 10 could be filled and sealed by a modified version of the apparatus 50, which would include a product feed device 168 (Figure 4) arranged to drop product down the inside of forming tube 134 in synchronisation with the operation of the transverse sealing stations. Suitable product feed devices are commonly used with vertical form, fill and seal packaging machines and will therefore be familiar to those skilled in the art. Accordingly, no further description of such devices will be provided herein.

[0035] It will be understood that in order for the bags 10 to be filled by feeding product down the forming tube, the gusset-forming plates 142 will have to be made retractable. The plates 142 could, for example, be reciprocated by means of respective pneumatic cylinders so as to be withdrawn to permit product feed and advanced into a gusset-forming position whilst the web is being fed and the seals 26, 28 are being formed. Synchronisation of the movement of the gusset-forming plates 142 and product feed device 168 would preferably be obtained using control signals from the control system 166.

[0036] Sealing of the end 21 of the bag 10 subsequent to filling could, for example, be achieved by modifying the sealing jaws 156 such that a transverse seal is formed above and below the cutting edge 160. Alternatively, forming of a top seal and the cutting operation could take place at separate stations downstream of the sealing jaws 156.

[0037] In cases where the bags 10 are filled and sealed by the apparatus 50, it may be desirable to feed the bags to a bag finishing machine such as that disclosed in WO 98/33709 (Molins PLC), the content of which is incorporated herein by reference. Such a machine could be arranged to receive filled and sealed bags 10 directly from the apparatus 50 and shape and seal the end 21 of the bag to form a so-called block top bag which is a bag form well known to those skilled in the art. For the purposes of shaping and sealing the end 21 using such a bag finishing machine, it may be preferable for the diagonal seals 26 and 28 to be omitted and the transverse seal at the end 21 to be partial, with resealing taking place on the bag finishing machine as disclosed in WO 98/33709. This would have the advantage that the first transverse sealing station could be omitted, which would allow the apparatus to vary the bag length more easily.

[0038] It is to be understood that the diagonal seals 28 are non-essential or may be made separately downstream of the sealing jaws 156. This would provide the advantage that the apparatus 50 could readily produce bags of various lengths by varying the length of the webs 56 and 116 fed between each sealing operation.

[0039] It will be appreciated that although preferable, it is not essential for the process downstream of the shingle former to be intermittent. The inner part could be attached to the web 56 utilising an arrangement of rotary sealing and cutting jaws as the web 116 is fed continuously onto the web 56.

[0040] It will be appreciated that although it is preferable that the web is fed continuously during the fold-forming process, it would be possible for this to be carried out as an intermittent process, which would make the accumulator 102 redundant. It is envisaged that for an intermittent fold-forming process, an accumulator may be desirable upstream of the bow-forming device.

[0041] It will be understood that the bags 10 formed by the apparatus do not have to be separated from one another. Instead, the cutting edge 160 could be omitted and the bags fed from the transverse sealing station 154 to a coiling machine which would produce a reel of bags for supply to customers.

[0042] It will be appreciated that the inner part 14

may be cut from a web fed transverse to the lengthwise direction of the web 56.

[0043] It will be appreciated that the length of the inner part may be slightly less than the length of the sides of the bag. As a means of reducing the consumption of packaging material, the bag may be provided with a plurality of inner parts at spaced intervals along the length of the side panels. Each inner part would be relatively narrow so that each bag would have a number of hoop-like inner parts, for example, one adjacent each end of the bag and one positioned substantially midway between those ends. Such an arrangement could be obtained by simultaneously feeding three narrow webs of packaging material transversely of the web 56 and attaching each of those webs to the web 56. Alternatively, the arrangement shown in Figure 3 could be adapted to feed the web 56 downstream of the accumulator 104 in steps which are less than one bag length so that three narrow strips 114 can be successively severed from the web 116 and attached to the web 56 at the desired positions.

[0044] It is to be understood that an octagonal cross-section forming tube is not essential. A circular cross-section forming tube may be used which provides the advantage that the machine may be more closely based on a conventional vertical form, fill and seal machine allowing the machine to be readily converted for producing conventional bags without the inner part 14, if desired.

[0045] It is envisaged that in order to satisfactorily produce the gussets, it may be necessary to augment the gusset plates 142. This could be achieved by means of respective pairs of fingers extending from an inner surface of the forming tube, air pressure, or rollers. These arrangements are well known to those skilled in the art and accordingly will not be described in further detail herein.

[0046] It will be appreciated that the inner part 14 does not have to be secured to the web 56 by rectangular line seals 24. Alternatively, attachment may be achieved by means of one or more seals extending in the lengthwise direction of the web, which would be preferable if the inner part is to be secured to the web 56 whilst the web is moving in a continuous process.

[0047] It is to be understood that the folds may be produced without bowing the web or turning it twice through 90° as in the embodiment. The folds may be produced by an essentially planar flow forming process. However, it has been found that by turning the web through 90° twice as shown, the folds can be produced whilst moving the web over a relatively shorter distance and produces reduced levels of stress in the web.

[0048] It will be appreciated that the inversion of the ridges 76 as the web turns through 90° when it passes from the surface 72 to the surface 70 reduces the stresses produced in the material since during the turning process, all portions of each ridge 76 move through substantially the same distance.

Claims

1. A method of making a bag comprising the steps of: providing a plurality of folds in a web of flexible material, said folds extending in a lengthwise direction of said web; positioning a length of a flexible material on said folded web; attaching said length of material to said web at positions spaced from said folds; causing said web and attached length of material to adopt a generally tubular configuration and forming a longitudinally extending joint to form a tube; and forming a seal extending transversely of said tube, which seal defines an end of said bag.

2. A method as claimed in claim 1, wherein said fold-providing step includes causing said web to bow in a direction transverse to said lengthwise direction.

3. A method as claimed in claim 2, wherein said bow is caused at a position upstream of a position at which said folds are formed.

4. A method as claimed in claim 1, 2 or 3, wherein said fold-providing step comprises forming a plurality of ridges extending in said lengthwise direction.

5. A method as claimed in claim 4, wherein said fold-providing step comprises converting said ridges into depressions which extend in said lengthwise direction.

6. A method as claimed in any one of the preceding claims, wherein said fold-providing step includes causing relative movement of portions of said web in a direction transverse to said lengthwise direction, whereby in cross-section in said transverse direction said folds are defined by overlapped portions of said web.

7. A method as claimed in claim 6, wherein each said fold comprises three said overlapped portions.

8. A method as claimed in any one of the preceding claims, wherein said tube has a generally octagonal cross-section.

9. A method as claimed in any one of the preceding claims, wherein said fold-providing step includes feeding said web over a flow forming device.

10. A method as claimed in any one of the preceding claims, wherein said web is fed substantially continuously during said fold-providing step.

11. A method as claimed in any one of the preceding claims, wherein said web and attached length of material is caused to adopt said tubular configuration whilst being fed substantially continuously

through a flow forming device.

12. A method as claimed in any one of the preceding claims, wherein said tube is oriented such that a longitudinally extending axis thereof extends upwardly, further comprising causing predetermined amounts of product to be released into an upper end of said tube in synchronisation with said step of forming a transversely extending seal such that said bag contains a predetermined amount of said product.

13. Apparatus for making a bag, said apparatus comprising means for providing a plurality of folds in a web of a flexible material, said folds extending in a lengthwise direction of said web, means for positioning a length of a flexible material onto said folded web and attaching said length of material to the web at positions spaced from said folds, means for forming said web and attached length of material into a tube and means for forming a seal extending transversely of said tube.

14. Apparatus as claimed in claim 12, wherein said fold-providing means comprises at least one flow forming device.

15. Apparatus as claimed in claim 13 or 14, wherein said fold-providing means includes an element arranged to cause said web to bow in a direction transverse to said lengthwise direction.

16. Apparatus as claimed in claim 13, 14 or 15, wherein said fold-providing means comprises an element arranged to form a plurality of ridges extending in said lengthwise direction.

17. Apparatus as claimed in claim 16, wherein said element is further arranged to invert said ridges.

18. Apparatus as claimed in claim 16 or 17, wherein said fold-providing means comprises a device cooperable with said element to turn said ridges to produce respective folds each comprising three overlapped portions of web.

19. Apparatus as claimed in any one of claims 13 to 18, wherein said tube forming means comprises an upwardly orientated forming tube.

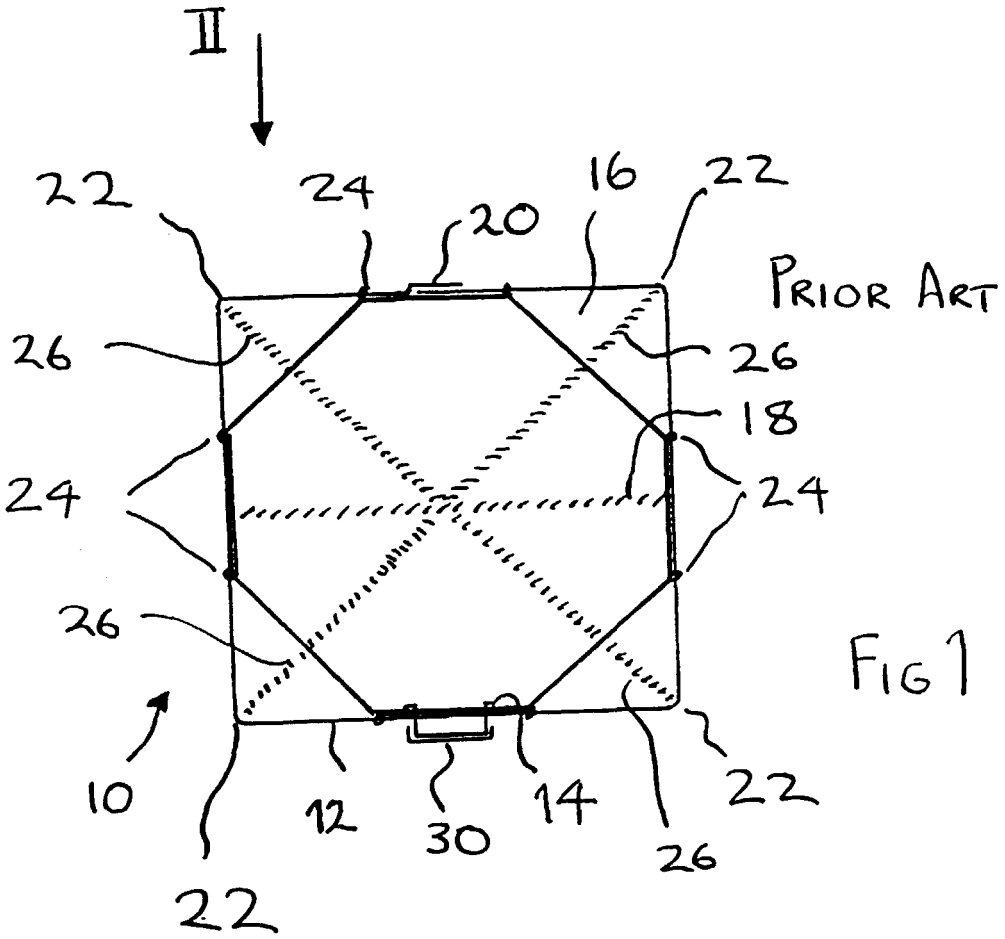
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FIG 1

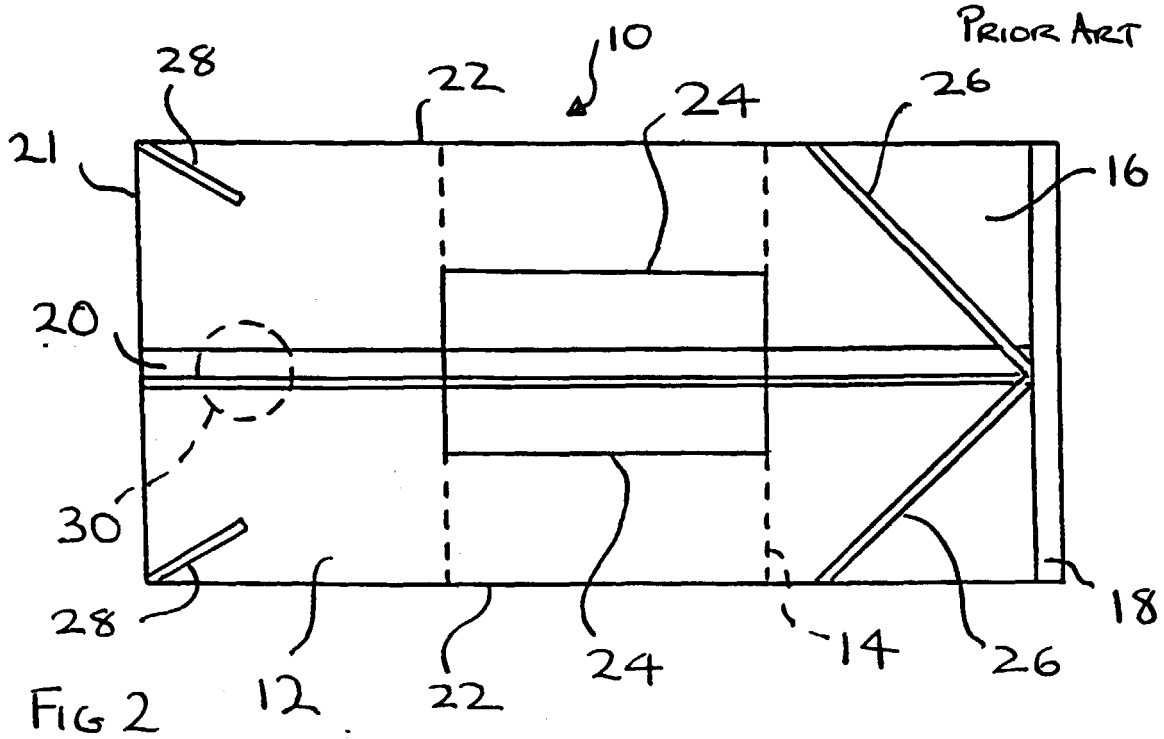
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FIG 2

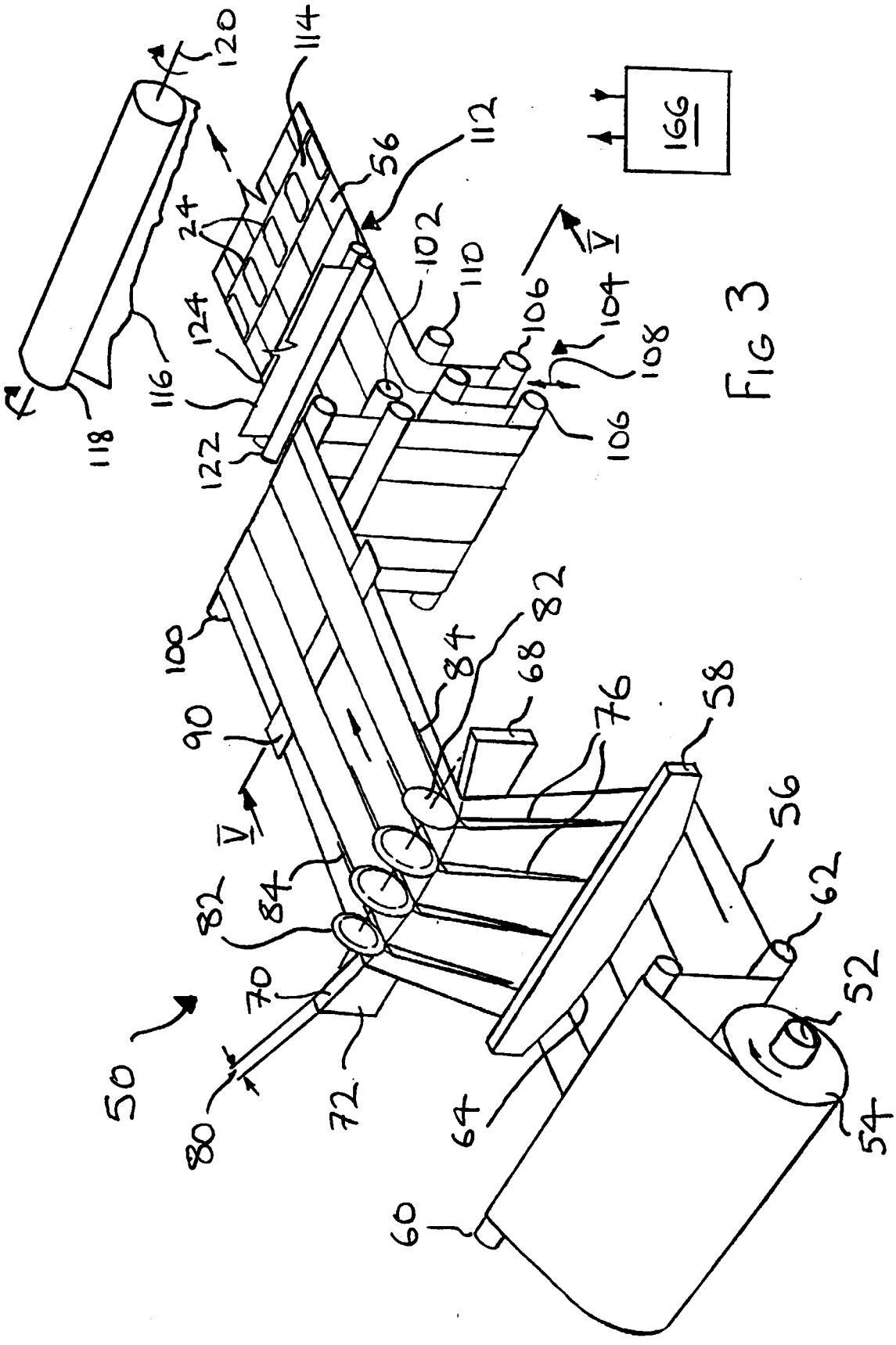
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FIG 3

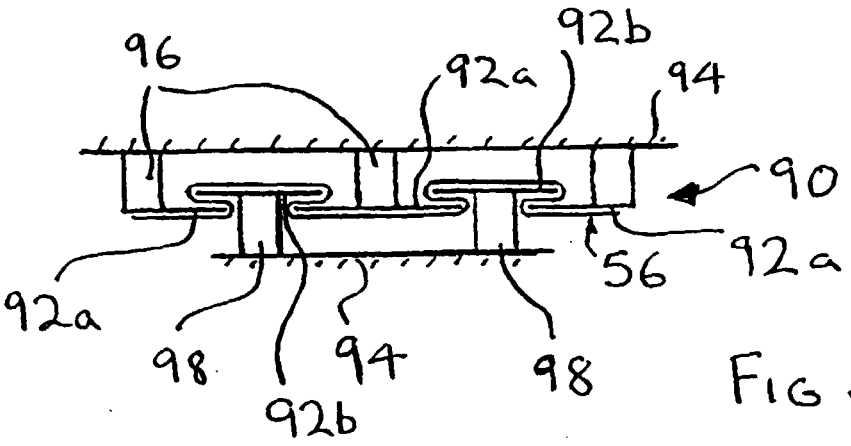

FIG 5

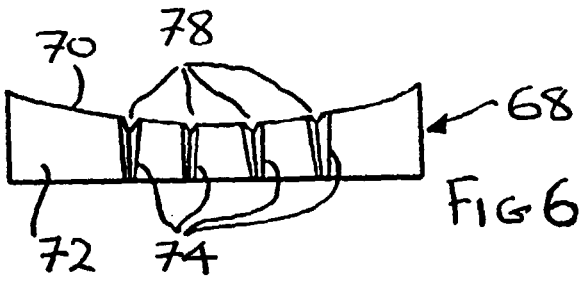

FIG 6

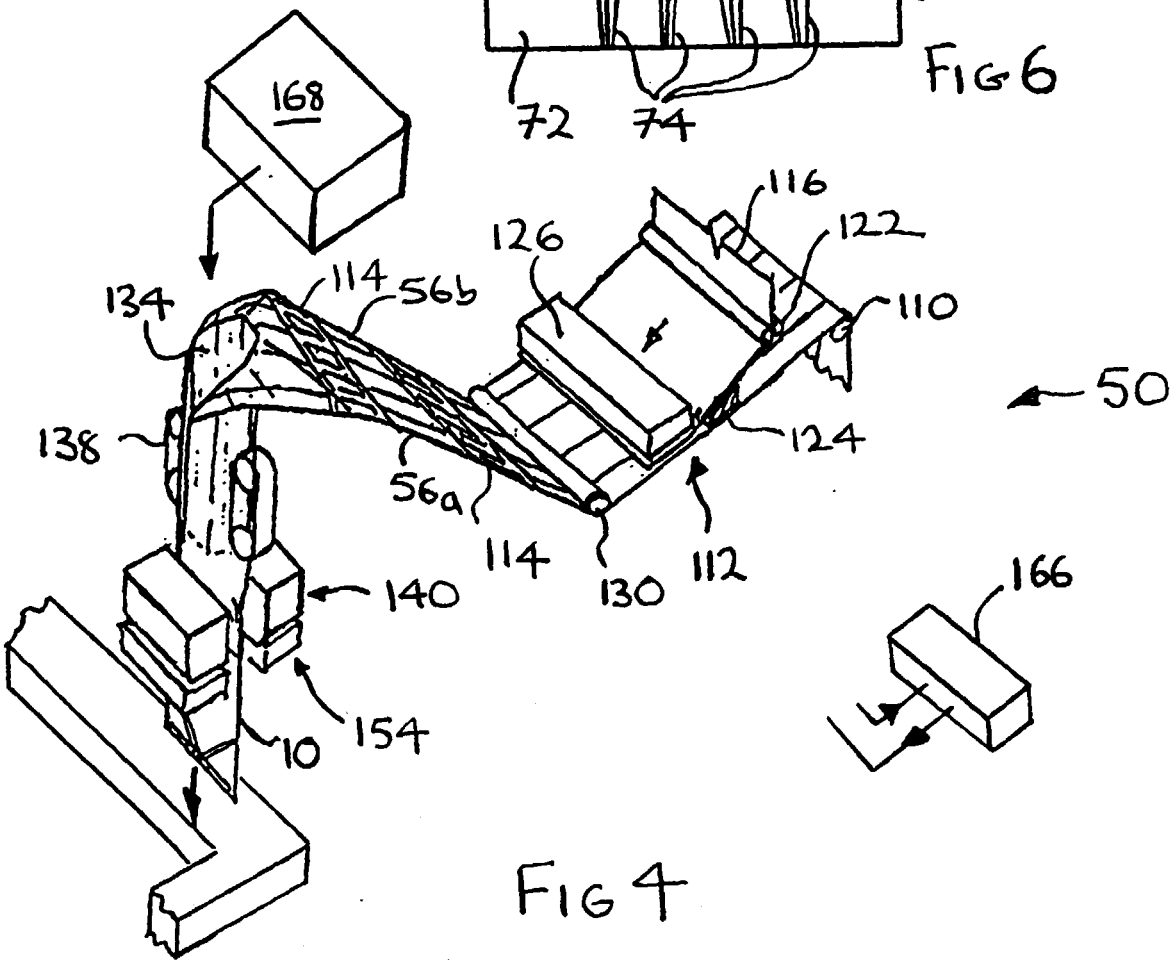

FIG 4

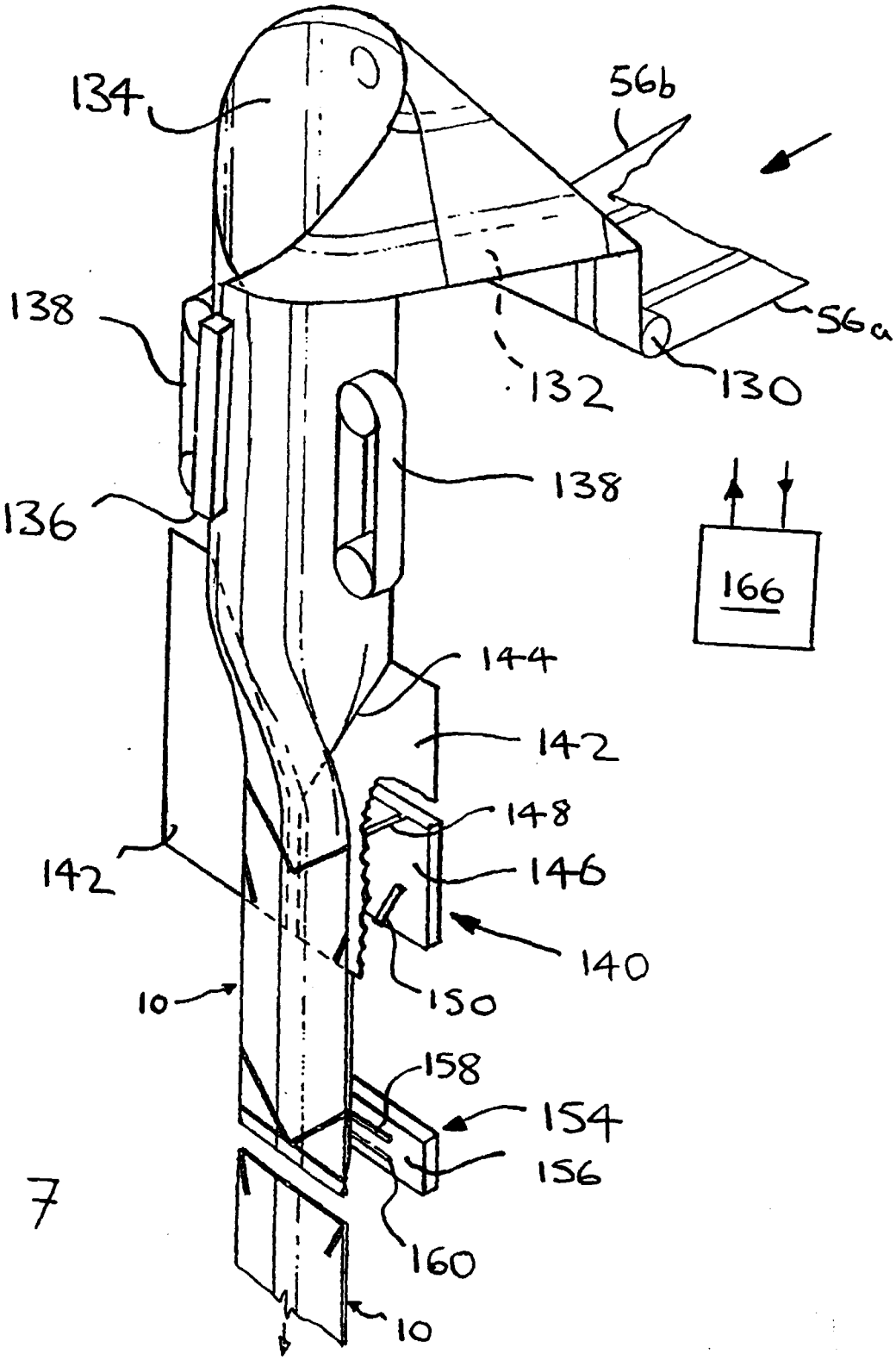
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FIG 7