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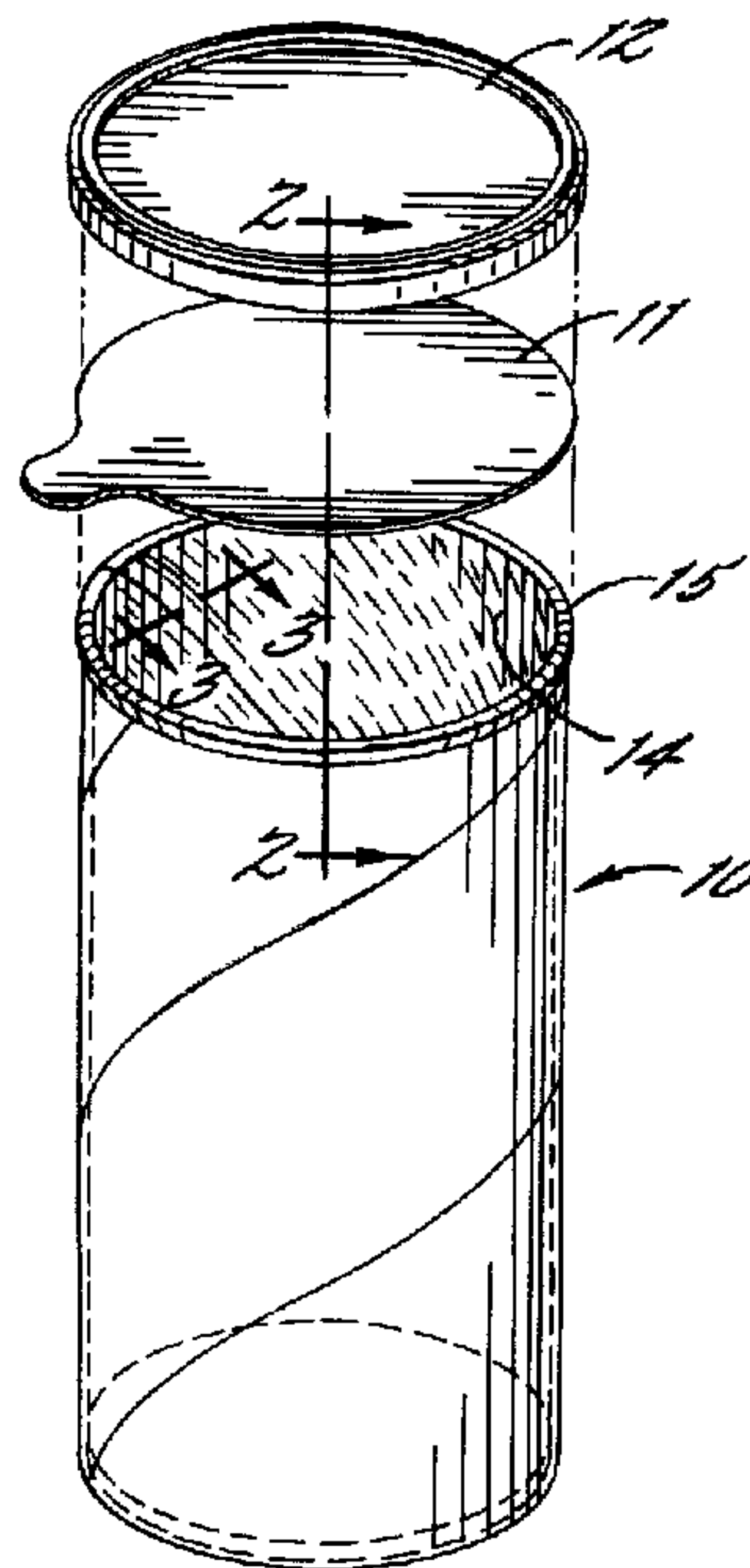
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(54) Title: POLYMERIC LINER PLY FOR TUBULAR CONTAINERS AND METHODS AND APPARATUS FOR MANUFACTURING SAME



(57) **Abrégé/Abstract:**

A method of manufacturing multi-ply tubular containers for food products is provided including the steps of advancing a continuous body ply formed of paperboard towards a shaping mandrel and advancing a continuous polymeric liner ply adjacent to one surface of the paperboard body ply. The polymeric liner ply includes a moisture barrier layer and an adhesive layer defining one surface of the liner ply, wherein the adhesive layer includes a polymeric adhesive which is activated at a predetermined activation temperature. The body ply is heated to a temperature above the activation temperature of the adhesive, and the body ply and the liner ply are then passed in face-to-face contact through a nip to adhere the liner ply to the body ply. The body ply and liner ply are then wrapped around a shaping mandrel to create the tubular container. Accordingly, an advantageous tubular container can be manufactured having an unsupported and polymeric liner ply which is adhered to a body ply without the application of any separate adhesives.

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ABSTRACT

A method of manufacturing multi-ply tubular containers for food products is provided including the steps of advancing a continuous body ply formed of paperboard towards a shaping mandrel and advancing a continuous polymeric liner ply adjacent to one surface of the paperboard body ply. The polymeric liner ply includes a moisture barrier layer and an adhesive layer defining one surface of the liner ply, wherein the adhesive layer includes a polymeric adhesive which is activated at a predetermined activation temperature. The body ply is heated to a temperature above the activation temperature of the adhesive, and the body ply and the liner ply are then passed in face-to-face contact through a nip to adhere the liner ply to the body ply. The body ply and liner ply are then wrapped around a shaping mandrel to create the tubular container. Accordingly, an advantageous tubular container can be manufactured having an unsupported and polymeric liner ply which is adhered to a body ply without the application of any separate adhesives.

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POLYMERIC LINER PLY FOR TUBULAR CONTAINERS AND
METHODS AND APPARATUS FOR MANUFACTURING SAME

5 The present invention relates to food
containers and methods and apparatus for making food
containers, and more particularly relates to tubular
containers wound from at least one paperboard body ply
and a liner ply.

BACKGROUND OF THE INVENTION

10 Food and drink products and other perishable
items are often packaged in tubular containers which
are sealed at both ends. These tubular containers
typically include at least one structural body ply and
are formed by wrapping a continuous strip of body ply
material around a mandrel of a desired shape to create
a tubular structure. The body ply strip may be
15 spirally wound around the mandrel or passed through a
series of forming elements so as to be wrapped in a
convolute shape around the mandrel. At the downstream
end of the mandrel, the tube is cut into discrete
lengths and is then fitted with end caps to form the
container.

20 Tubular containers of this type typically
include a liner ply on the inner surface of the
paperboard body ply. The liner ply prevents liquids
such as juice from leaking out of the container and
also prevents liquids from entering the container and
25 possibly contaminating the food product contained
therein. Preferably, the liner ply is also resistant
to the passage of gasses, so as to prevent odors of the
food product in the container from escaping and to
prevent atmospheric air from entering the container and
30 spoilage the food product. Thus, the liner ply
provides barrier properties and the body ply provides
structural properties.

Conventional liner plies are most often made
of aluminum foil which has good barrier properties and

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also has advantageous strength properties. In particular, the liner is wound onto the mandrel prior to the winding of the body ply and must be sufficiently strong and stiff to be independently wound on the
5 mandrel without stretching or wrinkling. Because of the support provided by the foil layer of the liner, such liners are known as "supported" liners.

One or more polymeric layers are normally adhered to the foil to further improve the barrier
10 properties of the liner and it is sometimes the case that the foil layer is not necessary for barrier properties but is included in the liner only to provide support. Such foils are expensive and thus it is desired to provide an "unsupported" liner having the
15 requisite barrier properties without the aluminum foil layer. However, because of the problems associated with winding an unsupported liner on the mandrel, such as stretching, creasing or other misshaping of the liner, it has not been commercially feasible with
20 conventional winding apparatus and methods to manufacture a container having an unsupported liner ply.

In addition, the aluminum foil layer typically includes a kraft paper backing for allowing
25 the foil layer to be adhered to the paperboard body ply. Aqueous based adhesives (or "wet adhesives") are preferably used to adhere the liner ply to the body ply because solvent based adhesives have become disadvantageous in light of various environmental
30 concerns. However, it has heretofore been difficult to get the aqueous adhesives to stick to the smooth and impervious surface of the aluminum foil layer. Accordingly, a kraft paper backing has been preadhered to the foil layer so that the liner can be adhered to
35 the paperboard body ply with wet adhesives. However, the kraft paper adds further cost and thickness to the liner.

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5 The liner ply is also sealed to itself along
a helical seam which is typically slightly offset from
the helical seam of the body ply. Wet adhesives have
typically not been able to adhere directly to the foil
layer as discussed above, and thus the liner ply seam
is formed with an "anaconda" fold, wherein the
overlying edge of the liner ply is folded back on
itself and adhered to the underlying edge. The
anaconda fold allows the polymeric layers on the
10 surface of the foil layer to be heat sealed together.
Alternatively, a hot melt adhesive can be used to seal
the anaconda fold of the overlying edge of the liner
ply to the underlying edge. An additional advantage of
the anaconda fold is that the edge of the kraft paper
15 is not exposed to the interior of the container and
thus liquids in the container will not be absorbed by
the kraft paper. An example of such a fold is
illustrated in U.S. Patent No. 5,084,284 to McDilda, et
al.

20 Anaconda folds are undesirable, however,
because of their increased thickness. The thickness of
an anaconda fold seam is equal to three thicknesses of
the liner ply and poses difficulties when attempting to
hermetically seal the ends of the tubular container.
25 Specifically, the ends of the tube are often rolled
outwardly after being cut so as to form a rolled
circular bead or flange on one or both ends of the tube
and then end caps or covers are sealed to the bead with
an adhesive sealant or compound. However, in the area
30 where the thick anaconda fold seam forms a portion of
the edge surface, the end surface of the bead or flange
can be substantially non-planar thus forming hill-like
and/or valley-like irregularities. Accordingly, an
extra amount of adhesive sealant must be applied to the
35 edge surface at least in the area of the anaconda fold
seam to fill the discontinuities and hermetically seal
the tubular container. The additional application of

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adhesive sealant is disadvantageous because of the extra sealant which must be used and the increased difficulty in removing the seal by the consumer due to the additional adhesive sealant.

5 Prior tubular containers having a liner without an anaconda fold seam include the container disclosed in U.S. Patent No. 3,520,463 to Ahlemeyer. The container disclosed therein includes a liner ply of aluminum foil which is coated on one surface to inhibit
10 chemical attack. The liner ply web is fed to a pair of combining rolls where its uncoated surface is forced into contact with an adhesively coated surface of a body ply web. Solvent based adhesives are disclosed and include animal glue, casein-latex emulsion, vinyl-
15 copolymer emulsion, and sodium silicate. The composite web is then spirally wound into tubular form about a mandrel to create a continuous tube. The overlapping edges of the liner ply are secured together with a hot melt adhesive.

20 A method of making wound tubular products without a water based adhesive is disclosed in U.S. Patent No. 3,524,779 to Masters, et al. The method includes winding an inner ply made of a metal foil onto a shaping mandrel. An outer ply is then wound onto the
25 mandrel from the opposite direction. A thermoplastic resin adhesive is precoated on the outer ply and optionally on the inner ply, and the outer ply is heated as it approaches the mandrel to activate the adhesive. A winding belt then firmly presses the plies
30 together to obtain a solid container wall. As noted above, the metal foil provides a relatively stiff inner ply which allows the liner to be wound independently on the mandrel but which adds extra expense and thickness to the container construction.

35 U.S. Patent No. 4,717,374 to Elias and assigned to the assignee of the present invention discloses a method for forming a composite container

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with a high barrier liner layer. The liner layer includes a metal layer of aluminum which is vacuum deposited on a resinous base film made of oriented polyethylene terephthalate. The liner also includes a
5 second resinous layer opposite the first so as to form a sandwich around the metallized layer. On the exposed surfaces of the first and second resinous films are surface layers of copolyester which are heat seal compatible with each other so that the liner can be
10 sealed to itself along the seam.

The Elias patent notes that the surface layer adjacent to the product must have sufficient mobility over a winding mandrel to allow the tubes to be wound and that the opposite surface is adhered to the inner
15 ply of the paperboard layer by any of the then known techniques. The liner is heated only along an edge thereof as the liner is wound onto the mandrel so that the heated edge is heat sealed to the opposite edge of the preceding convolution. Heating more than the edge
20 would cause the liner to adhere to the mandrel. The paperboard layer and label layer are then wound over the edge-sealed liner layer. Although the Elias patent discloses an exemplary liner, conventional techniques are disclosed for adhering the liner to the paperboard
25 ply and as such include the added steps of separately applying an adhesive and/or precoating the paperboard with some type of adhesive or adherable surface to allow the liner ply to be adhered thereto.

Accordingly, it would be desirable to provide
30 methods and apparatus for manufacturing a tubular container having an unsupported liner ply which does not include a foil layer and which could be sealed without using an anaconda fold seam. In addition, it would be highly desirable to provide such a container
35 wherein the liner ply is securely adhered to the body ply without the separate application of a solvent based or water based adhesive and without precoating the

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inner surface of the body ply. It would be especially desirable if these objects and advantages could be combined in the same container.

SUMMARY OF THE INVENTION

5 These and other objects and advantages are met by the present invention which include methods and apparatus for manufacturing a tubular container having a paperboard body ply and a polymeric liner ply adhered thereto, wherein the liner ply includes a barrier layer
10 and an adhesive layer that defines one surface of the liner ply. In particular, the adhesive layer includes a polymeric adhesive capable of bonding to the paperboard. The liner ply is bonded to the paperboard before being wound on the mandrel and does not suffer
15 from the wrinkling problems associated with the prior art.

 A method according to the present invention of manufacturing multi-ply tubular containers for food products includes the steps of advancing a continuous
20 body ply formed of paperboard having first and second side edges towards a shaping mandrel, and advancing a continuous polymeric liner ply having first and second marginal edge portions adjacent the edges thereof toward the mandrel while positioning one exterior
25 surface thereof adjacent to one face of the paperboard body ply. The liner ply preferably has a barrier layer resistant to the passage of liquids and gasses and an adhesive layer that defines one exterior surface of the liner ply. The adhesive layer includes a polymeric
30 adhesive which is activated at a predetermined activation temperature and allows high speed commercial winding.

 The liner ply and the body ply are then passed in face-to-face contact through a pair of nip
35 rollers with the adhesive layer of the liner ply adjacent to the body ply. Preferably, the passing step

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includes aligning the liner ply and the body ply such that the first marginal edge portion of the liner ply extends laterally beyond the first side edge of the body ply. The portion of the adhesive layer of the liner ply that contacts the body ply is heated to a temperature above the activation temperature of the adhesive so that the liner ply becomes adhered to the body ply. Preferably, the heating step includes heating the paperboard body ply with a heat source and then passing the liner ply and body ply in face-to-face contact through the nip rollers so that heat is transferred from the body ply to the liner ply upon contact to activate the adhesive.

The body ply and adhered liner ply are then wrapped around the shaping mandrel so that the second edge of the body ply engages the first edge of the body ply and so that the second marginal edge portion of the liner ply engages the first marginal edge portion of the liner ply in face-to-face contact. The body ply may be wrapped spirally or longitudinally around the mandrel to create spiral or convolute tubes. Preferably, the first marginal edge portion of the liner ply is also heated to a temperature above the activation temperature of the adhesive so that the first marginal edge portion of the liner ply becomes adhered to the second marginal edge portion. Heating the first marginal edge portion of the liner ply advantageously includes heating the first marginal edge portion while the liner ply is wrapped on the mandrel. In addition, the mandrel is also preferably heated.

Another aspect of the present invention is a multi-ply tubular container for food products which includes at least one body ply formed of an uncoated fibrous paperboard which is wrapped in a tubular shape. The container also includes a polymeric liner ply having a radially interior inner surface and an outer surface adhered to the radially interior inner surface

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of the body ply. The liner ply preferably has a thickness of less than about three mils and includes a polymeric moisture barrier layer that is more preferably also an oxygen barrier resistant to the passage of liquids and gasses. The barrier layer preferably includes at least one of the group of polyester, nylon, ethylene vinyl alcohol copolymer and blends thereof. In highly preferred embodiments the barrier layer has at least one metallized surface.

10 The adhesive layer preferably includes inner and outer sublayers each having a heat activatable polymeric adhesive including a polymer from the group consisting of ethylene vinyl acetate, ethylene acrylic acid, ethylene methacrylic acid, ethylene methyl acrylate and blends thereof. The inner sublayer advantageously has an adhesive which is adhered to the barrier layer and the outer sublayer has a different adhesive which is adhered directly to the fibers of the body ply prior to the body ply being wrapped. The outer and inner sublayers of the adhesive layer may be coextruded. The liner ply may also include a seal layer defining the inner surface of the liner ply and having a melting temperature higher than the temperature at which the adhesives of the adhesive layer become activated. The seal layer may include a polyolefin polymer such as high density polyethylene.

25 The present invention thus provides a polymeric liner that does not suffer from the problems associated with liners including a foil layer. The liner ply according to the invention is thinner and does not require an anaconda fold seam. In addition, the liner ply is adhered to the paperboard without a separate adhesive application step and without the need to precoat the paperboard for adhesion. The liner ply is prebonded to the paperboard and thus does not suffer from stretching or creasing when wound onto the mandrel.

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BRIEF DESCRIPTION OF THE DRAWINGS

Some of the objects and advantages of the present invention having been stated, others will appear as the description proceeds when taken in conjunction with the accompanying drawings, which are not necessarily drawn to scale, wherein;

Figure 1 is an exploded perspective view of a tubular container according to the present invention;

Figure 2 is a fragmentary and enlarged sectional view of an end of the tubular container taken along lines 2-2 of Figure 1;

Figure 3 is an enlarged sectional view of a paperboard body ply and a polymeric liner ply taken along lines 3-3 of Figure 1;

Figure 4 is a fragmentary and enlarged sectional view of an anaconda fold seam according to the prior art;

Figure 5 is an enlarged sectional view of the anaconda fold seam of the prior art taken along lines 5-5 of Figure 4;

Figure 6 is a plan view of an apparatus according to the present invention for making a tubular container;

Figure 7 is an enlarged plan view of a section of the apparatus illustrating the alignment of the liner ply relative to the body ply;

Figure 8 is a perspective view of a section of the apparatus illustrating the winding of the body and liner plies onto a mandrel;

Figure 9A is an enlarged sectional view of the body ply taken along lines 9A-9A of Figure 6;

Figure 9B is an enlarged sectional view of the body ply illustrating the heating thereof taken along lines 9B-9B of Figure 6;

Figure 9C is an enlarged sectional view of the body ply and the polymeric liner ply adhered thereto and taken along lines 9C-9C of Figure 6;

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Figure 9D is a fragmentary and enlarged sectional view of one edge of the body ply illustrating the application of a skived edge adhesive taken along lines 9D-9D of Figure 6;

5 Figure 9E is a fragmentary and enlarged sectional view illustrating the application of infrared heat to the edge of the body ply taken along lines 9E-9E of Figure 6;

10 Figure 9F is a fragmentary and enlarged sectional view of the body ply illustrating the application of forced air heat to the edge of the body ply taken along lines 9F-9F of Figure 6;

15 Figure 10A is a fragmentary and enlarged sectional view of the edge of the body ply opposite the edge illustrated in Figures 9A-9F illustrating the application of forced air heat and taken along lines 10A-10A of Figure 6;

20 Figure 10B is a fragmentary and enlarged sectional view of adjacent body and liner plies illustrating the seams between the plies;

Figure 11 is a schematic elevational view of an apparatus for manufacturing a tubular container having two body plies according to another embodiment of the invention;

25 Figure 12 is a fragmentary and enlarged sectional view of one edge of the body plies adhered together in the apparatus of Figure 11;

30 Figure 13 is a greatly enlarged sectional view of a liner ply according to the invention adhered to the body ply; and

Figure 14 is a greatly enlarged sectional view of a liner ply of another embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

35 The present invention now will be described more fully hereinafter with reference to the

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accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

10 A tubular container 10 according to the present invention is illustrated in Figure 1. Although illustrated as having a circular cross section, the tube may have any cross sectional shape which can be formed by wrapping the tube around an appropriately shaped mandrel. One example is a generally rectangular shaped tube having rounded corners.

15 The embodiment illustrated in Figure 1 is particularly advantageous for packaging potato crisps and includes a flexible foil seal 11 and a reusable plastic end cap 12 over the seal. Various other end closures may be used, however, depending upon the type of food product which is to be packaged such as, for example, dough.

25 As illustrated in more detail in Figure 2, the tubular container 10 includes a wall having a body ply 13 which is preferably formed of paperboard and a liner ply 14 which is preferably formed of a polymeric material adhered to the inner surface of the body ply 13. The upper end of the tubular container 10 is rolled over so as to form a bead 15 or flange and the foil seal 11 is hermetically sealed to the top of the bead with an adhesive sealant 16. The end cap 12 is then snapped over the bead 15 and may be reused after the foil seal 11 has been removed. A metal closure (not illustrated) can be secured to the opposite end of the container 10.

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The seams where the various plies are joined together are illustrated in Figure 3. The paperboard body ply 13 is made of a relatively thick and stiff paperboard. Accordingly, the edges are first skived and then joined together during the tube forming process with an adhesive 20 to create a strong seam. The liner ply 14 is adhered to the inner surface of the body ply 13 and the overlapping edges of the liner ply are adhered together to ensure that the container 10 is completely sealed. A label ply 22 is preferably adhered to the outer surface of the body ply 13 having various indicia printed thereon regarding the product within the container.

Figures 4 and 5 illustrate conventional tubular containers which include a liner having an aluminum foil layer 23 for providing strength and barrier properties to the liner. As discussed above, because conventional wet adhesives have been unable to adhere to aluminum foil, a kraft paper layer 24 is preadhered to the aluminum foil layer 23.

The kraft paper layer 24 cannot be exposed to the interior of the container because liquids and gasses could pass through the porous and absorbent kraft paper layer. For example, if a straight lap seam, such as that shown in Figure 3, were employed at the edges of the liner 14, one edge of the kraft paper layer 24 would be exposed and would cause liquids in the container to wick through the kraft paper layer and leak from the container. Accordingly, an anaconda fold must be used at the seam wherein an overlying edge portion 25 of the liner is folded back on itself and then sealed to an underlying edge portion 26 of the liner as illustrated in Figure 5. The overlying liner edge portion 25 may be adhered to the underlying liner edge portion 26 by way of a hot melt adhesive (not shown). Alternatively, the aluminum foil layer 23 most often includes a thin polymeric layer (not shown) on

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the surface thereof facing the interior of the container which can be heat sealed to itself at the point where the overlying liner edge portion 25 contacts the underlying liner edge portion 26.

5 One disadvantage of such a liner arises at the point where the anaconda fold seam extends over the bead 15 as illustrated in Figure 4. Specifically, the thick anaconda fold seam creates a pair of step discontinuities 30 along the periphery of the bead 15. 10 This presents difficulties when sealing the foil seal 11 to the bead 15 and is typically overcome by applying extra adhesive sealant 16 to the foil seal or the bead to fill the discontinuities 30. The use of this added adhesive sealant 16 is disadvantageous because of the 15 expense of the extra material used and the complexity of applying added sealant to those areas.

 An apparatus for making tubular containers which overcomes the disadvantages of conventional tubular containers is illustrated in Figure 6. A 20 continuous strip of paperboard body ply material 13 is supplied to the apparatus and is first passed through a pair of opposed edge skivers 31. As illustrated in Figure 9A, the edge skivers remove part of the square edge of the body ply 13 to create first 32 and second 25 33 edges having a beveled configuration.

 If desired, the body ply 13 may then be advanced through an adhesive applicator (not shown) which applies an aqueous adhesive to the upper surface of the body ply 13. An advantageous tubular container 30 incorporating an aqueous adhesive and methods and apparatus for manufacturing the same, are disclosed in U.S. Patent No. 5,829,669 filed concurrently herewith, which is assigned to the assignee of the present invention. In the present invention, however, the 35 separate application of a liquid adhesive is obviated.

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The body ply 13 is then passed underneath a heater 35. The heater 35 is preferably an infrared heater which supplies a sufficient amount of heat to the body ply 13 to activate an adhesive layer 63 in the liner ply 14 when the plies are nipped together, as discussed below. An infrared heater capable of generating a heat flux of at least about 200,000 W/m² has been determined to be sufficient at line speeds of about 50 ft./min. although line speeds up to 400 ft./min. are contemplated. It will be understood by one of ordinary skill in the art, however, that the various other heat sources, e.g., forced air heating or the like can be used and that the appropriate amount of heat can vary depending on various factors including the efficiency of the heat source, the speed of the body ply and the type of adhesive used.

After the heater 35, the body ply 13 is then advanced into a pair of opposed nip rollers 36. A continuous strip of liner ply material 14 is fed from a reel 40 and is also advanced into the nip adjacent to the body ply 13. Heat is transferred from the heated body ply 13 to the liner ply 14 and the adhesive layer 63 is activated so that the liner ply 14 becomes adhered to the body ply 13.

A preferred liner construction is illustrated in Figures 13 and 14 and includes a seal layer 60, a moisture barrier layer 61 and the adhesive layer 63. The moisture barrier layer 61 is resistant to the passage of liquids and preferably also gasses such as oxygen. If a barrier is required for both liquids and gasses, a preferred barrier material is polyester. Some food products, however, do not require a gas barrier, such as various juices, and other barrier materials may be used (although the barrier may also be generally resistant to the passage of gasses). It will be understood that various barrier materials or

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properties could be employed depending upon the item being packaged.

Alternative barrier materials include nylon, EVOH (ethylene vinyl alcohol polymer and copolymer), polyvinylidene chloride, polyethylene and polypropylene and the like as will be apparent to the skilled artisan. One surface of the barrier layer 61 may include a thin metallized coating 62 to provide a metallic appearance and also to enhance the barrier properties. The metallized coating 62, which may be formed of aluminum, is significantly thinner than a foil layer, however, and is not necessary for strength or barrier properties in certain applications. Thus, a thick and expensive foil sheet layer is advantageously eliminated. The liner ply 14 preferably has a total thickness less than about 3 mils and is more preferably closer to 1 mil in thickness.

The liner ply 14 is aligned through the nip with the body ply 13 such that a first marginal edge portion 41 of the liner ply extends beyond the first edge 32 of the body ply. The liner ply 14 may have the same width as the body ply 13 and thus the opposite second marginal edge portion 42 of the liner ply does not extend all the way to the second edge 33 of the body ply. Alternatively, the liner ply 14 may be wider or narrower than the body ply 13 depending on the amount of liner overlap which is desired. This configuration can be seen in the plan view of Figure 7 and the sectional view of Figure 9C.

After the nip rollers 36, the body ply 13/liner ply 14 laminate is passed under a skive adhesive applicator 43 which applies the skive adhesive 20 to the beveled surface of the skived second edge 33 of the body ply 13. The skive adhesive 20 is preferably a hot melt adhesive of the type which is conventional in the art although could also be an other polymeric-type adhesive. The skive adhesive 20 helps provide a

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stronger body ply bond especially for single body ply containers.

5 The surface of the liner ply 14 may then be coated with lubricant from a roller 44 which allows the liner 14 to slide smoothly during the winding operation. If making the embodiment of the container discussed below, however, the lubricant can be advantageously eliminated or greatly reduced.

10 The laminate is then passed under an infrared heater 45 which heats the second marginal edge portion 42 of the liner ply 14 and also may heat the second edge 33 of the body ply 13, as can be seen in Figure 9E. An infrared heater capable of generating a heat flux of at least about 83,000 W/m² has been determined to be sufficient. After the infrared heater 45, the second marginal edge portion 42 of the liner ply 14 is then passed under at least one forced air heater 46.

20 The body ply 13/liner ply 14 laminate is then wrapped around a shaping mandrel 47. The laminate is first wrapped under the mandrel 47 and then back over the top in a helical fashion with the liner ply 14 wound against the surface of the mandrel. The first marginal edge portion 41 of the liner ply 14 is exposed on the mandrel 47 and is subjected to heat from a second forced air heater 50 as can be seen in Figures 8 and 10A. As the laminate is further wrapped and the first edge 32 of the body ply 13 advances back under the mandrel 47 after one complete revolution, it is brought into contact with the second edge 33 of the ensuing portion of the body ply 13 which is first coming into contact with the mandrel. The skived edges 32,33 become abutted together and the skive adhesive 20 adheres the edges together to form a spirally wound tube which advances along the mandrel 47. With regard to the liner ply 14, the first marginal edge portion 41 is brought into an overlapping relationship with the second marginal edge portion 42 to create a sealed

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straight lap seam as illustrated in Figure 10B. The present invention thus eliminates the disadvantages associated with anaconda fold seams and uses a straight overlapping seam instead.

5 An adhesive layer 63 is below the metallized coating 62 and defines the outer surface of the liner ply 14. The adhesive layer 63 includes a non-aqueous polymeric adhesive which is activated at a predetermined activation temperature. Such adhesives, 10 which are also known as "dry-bond" adhesives, can include one or more of the following polymers or modified copolymers thereof; ethylene vinyl acetate, ethylene acrylic acid, ethylene methacrylic acid, ethylene methyl acrylate and blends with each other or 15 lower cost polyolefins. A preferred embodiment is illustrated in Figure 14 and includes an adhesive layer having two sublayers 63a,b which are coextruded together. The inner sublayer 63a is preferably ethylene acrylic acid which adheres well to the 20 polyester barrier layer 61 and the outer sublayer 63b is preferably ethylene methyl acrylate which adheres well to the paperboard body ply 13.

 A seal layer 60 may also form a part of the liner ply 14 and defines the inner surface of the liner 25 ply. The seal layer 60 provides a surface against which the adhesive layer 63 is adhered when the first marginal edge portion 41 of the liner ply 14 is brought into an overlapping relationship with the second marginal edge portion 42. The seal layer 60 includes a 30 polyolefin polymer which is preferably high density polyethylene.

 One advantageous feature of the seal layer 60 is that it has a higher melting temperature than the adhesive layer 63. As noted above, the first marginal 35 portion 41 of the liner ply 14 is raised to a temperature (whether heated before reaching the mandrel 47 or while on the mandrel 47) such that the adhesive

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layer 63 is activated. However, if the seal layer 60 was made of the same polymer as the adhesive layer 63 or had a melting temperature equal to or less than the melting temperature of the adhesive layer, the seal layer would be melted and inclined to stick to the mandrel 47, which would greatly impede the winding process. This problem would be especially acute with the apparatus according to the present invention because the mandrel 47 is preferably heated to minimize heat loss from the liner ply 14 to the mandrel. The present invention does not suffer from this problem, however, because the seal layer 60 has a melting temperature higher than the activation temperature of the adhesive layer 63.

The tube is then advanced down the mandrel 47 by a conventional winding belt 51 which extends around a pair of opposed pulleys 52. The winding belt 51 not only rotates and advances the tube, but also applies pressure to the overlapping edges of the body ply 13 and liner ply 14 to ensure a secure bond between the respective ply edges.

An outer label ply 22 is then preferably passed over an adhesive applicator 53 and wrapped around the body ply 13. The label ply 22 could be applied before the winding belt 51. A conventional adhesive may be used as illustrated or, optionally, the label ply 22 could be formed having an adhesive layer and a seal layer and be applied to the outer surface of the body ply 13 without a separate liquid adhesive in accordance with the method discussed herein used to apply the liner ply. At a cutting station 54, the continuous tube is cut into discrete lengths and removed from the mandrel 47.

The ends of the containers 10 are then rolled outwardly to form the bead 15 or a flange. Another advantageous feature of the polymeric liner ply according to the present invention is that the

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elasticity of the polymer causes the bead 15 to be locked in place once rolled. Conventional inelastic foil liners may have a tendency to unroll the bead 15 or crack which can present a problem when sealing the ends.

After being filled with the food product, a foil seal 11 preferably is sealed on one or both ends of the container 10. The unsupported liner ply 14 according to the present invention is significantly thinner than conventional foil liners and a straight lap seam can be used instead of an anaconda fold seam. Accordingly, much smaller discontinuities are presented at the point where the seam crosses the bead, and the foil seal 11 can be cheaply and easily sealed to the bead 15 with a minimum amount of adhesive sealant 16. An end cap 12 can then be placed over the seal 11.

Another advantageous feature of the present invention is the wrinkled or "matte" surface of the liner ply 14 which can be seen in Figures 1 and 2. The wrinkled surface is provided by the method and apparatus according to the present invention which causes equal lengths of the body ply 13 and liner ply 14 to adhere together before being wrapped around the mandrel 47. As the plies are wrapped around the mandrel 47, the much stiffer body ply 13 causes the liner ply 14 to become compressed. In other words, the body ply 13 initially defines a circumferential length corresponding to one revolution around the mandrel 47 and the liner ply 14 has an initial length per revolution equal to that of the body ply 13. However, when wrapped, the liner ply 14 is forced into a circular section having a slightly smaller radius than the radius of the circle defined by the body ply 13. As such, the liner ply 14 is circumferentially compressed relative to the body ply 13.

The circumferential compression is advantageous if certain types of liner ply 14 are used

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because the compression may cause an initially smooth liner ply to have a wrinkled or matte surface once wrapped. The wrinkled surface finish has an "alligator skin" type appearance caused by many small peaks and valleys in the surface of the liner ply 14. The wrinkled surface is highly advantageous because it dramatically decreases the amount of winding friction between the liner ply 14 and mandrel 47. While not wishing to be bound by theory, it is believed that the decreased friction is due to the decreased surface area of the liner ply 14 (caused by the peaks and valleys thereof) which is in frictional contact with the mandrel 47. The friction is decreased so much that the lubricant and lubricant roller 44 can preferably be eliminated. One preferred material for the liner ply 14 includes a polyester barrier layer 61 which becomes wrinkled with circumferential compression.

An alternative embodiment of the tubular container 10 according to the present invention is illustrated in Figure 12 and includes two overlying body plies 13a, 13b. This embodiment is advantageous if additional strength is necessary. A first body ply 13a is adhered to the liner 14 in the fashion discussed above and passed through the pair of nip rollers 36. A second body ply 13b is coated with a wet adhesive and then brought into engagement with the underside of the first body ply 13a so that they will be adhered together.

Many modifications and other embodiments of the invention will come to mind to one skilled in the art to which this invention pertains having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is to be understood that the invention is not to be limited to the specific embodiments disclosed and that modifications and other embodiments are intended to be included within the scope of the appended claims. For

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example, the tubular containers according to the present invention are not necessarily helically wound but may instead be longitudinally wrapped to create a "convolute" tube having an axially extending seam. In addition, although the tubular containers according to the present invention have been described primarily in connection with food products, it is to be understood that the containers could be used in connection with other products where the liner ply is advantageous such as, for example, ink or caulk. Although specific terms are employed herein, they are used in a generic and descriptive sense only and not for purposes of limitation.

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CLAIMS:

1. A method of manufacturing multi-ply tubular containers for products comprising the steps of:

5 advancing a continuous body ply formed of paperboard towards a shaping mandrel;

 advancing a continuous polymeric liner ply adjacent to one surface of the paperboard body ply, the liner ply having a moisture barrier layer and an
10 adhesive layer defining one surface of the liner ply, wherein the adhesive layer includes a polymeric adhesive which is activated at a predetermined activation temperature;

 passing the liner ply and the body ply in
15 face-to-face contact through a pair of nip rollers with the adhesive layer of the liner ply adjacent to the body ply;

 heating at least a portion of the adhesive layer to a temperature above the activation temperature
20 of the adhesive so that the liner ply becomes adhered to the body ply; and then

 wrapping the body ply and adhered liner ply around the mandrel to create a tubular shape.

2. A method of manufacturing containers as
25 defined in Claim 1 wherein said heating step further comprises heating the paperboard body ply with a heat source and then passing the liner ply and body ply through the nip rollers so that heat is transferred from the body ply to the liner ply to activate the
30 adhesive.

3. A method of manufacturing multi-ply tubular containers for products comprising the steps of:

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advancing a continuous body ply formed of paperboard having first and second side edges towards a shaping mandrel;

5 advancing a continuous polymeric liner ply having first and second marginal edge portions adjacent to one surface of the paperboard body ply, the liner ply having a moisture barrier layer and an adhesive layer defining one surface of the liner ply, wherein the adhesive layer includes a polymeric adhesive which
10 is activated at a predetermined activation temperature;

 passing the liner ply and the body ply in face-to-face contact through a pair of nip rollers with the adhesive layer of the liner ply adjacent to the body ply, said passing step including aligning the
15 liner ply and the body ply such that the first marginal edge portion of the liner ply extends beyond the first side edge of the body ply;

 heating the portion of the adhesive layer contacting the body ply to a temperature above the
20 activation temperature of the adhesive so that the liner ply becomes adhered to the body ply; and

 wrapping the body ply and adhered liner ply around the shaping mandrel so that the second edge of the body ply engages the first edge of the body ply and
25 so that the second marginal edge portion of the liner ply engages the first marginal edge portion of the liner ply.

4. A method of manufacturing containers as defined in Claim 3 further comprising the step of
30 heating the first marginal edge portion of the liner ply to a temperature above the activation temperature of the adhesive so that the first marginal edge portion of the liner ply becomes adhered to the second marginal edge portion.

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5. A method of manufacturing containers as defined in Claim 4 wherein said step of heating the first marginal edge portion of the liner ply comprises heating the first marginal edge portion while the liner ply is wrapped on the mandrel.

6. A multi-ply tubular container for products comprising:

at least one body ply formed of a fibrous paperboard, said body ply being wrapped into a tubular shape having an inner surface; and

a polymeric liner ply having an inner surface facing the interior of the container and an outer surface adhered to the inner surface of said paperboard body ply, wherein said liner ply comprises;

a polymeric moisture barrier layer; and

an adhesive layer defining the outer surface of said liner ply, wherein said adhesive layer includes a heat-activatable polymeric adhesive which is adhered directly to the fibers of said body ply prior to said body ply being wrapped.

7. A tubular container as defined in Claim 6 wherein the inner surface of said fibrous paperboard body ply is an uncoated surface prior to being adhered to said liner ply so that the fibers are generally exposed and the adhesive adheres thereto.

8. A tubular container as defined in Claim 6 wherein said liner ply further comprises a polymeric seal layer defining the inner surface of said liner ply, and wherein said seal layer has a melting temperature higher than the temperature at which said adhesive becomes activated.

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9. A tubular container as defined in Claim 6 wherein the adhesive layer includes a polymer from the group consisting of ethylene vinyl acetate, ethylene acrylic acid, ethylene methacrylic acid, ethylene methyl acrylate and blends thereof.

10. A tubular container as defined in Claim 6 wherein said body ply and said liner ply are rolled outwardly at an end of the tubular container to form a bead, and wherein said liner layer is elastically deformable and prevents said bead from unrolling.

11. A tubular container as defined in Claim 6, wherein said adhesive layer comprises inner and outer sublayers each having a heat-activatable polymeric adhesive, said inner sublayer having an adhesive which is adhered to said barrier layer and said outer sublayer having a different adhesive which is adhered directly to the fibers of said body ply.

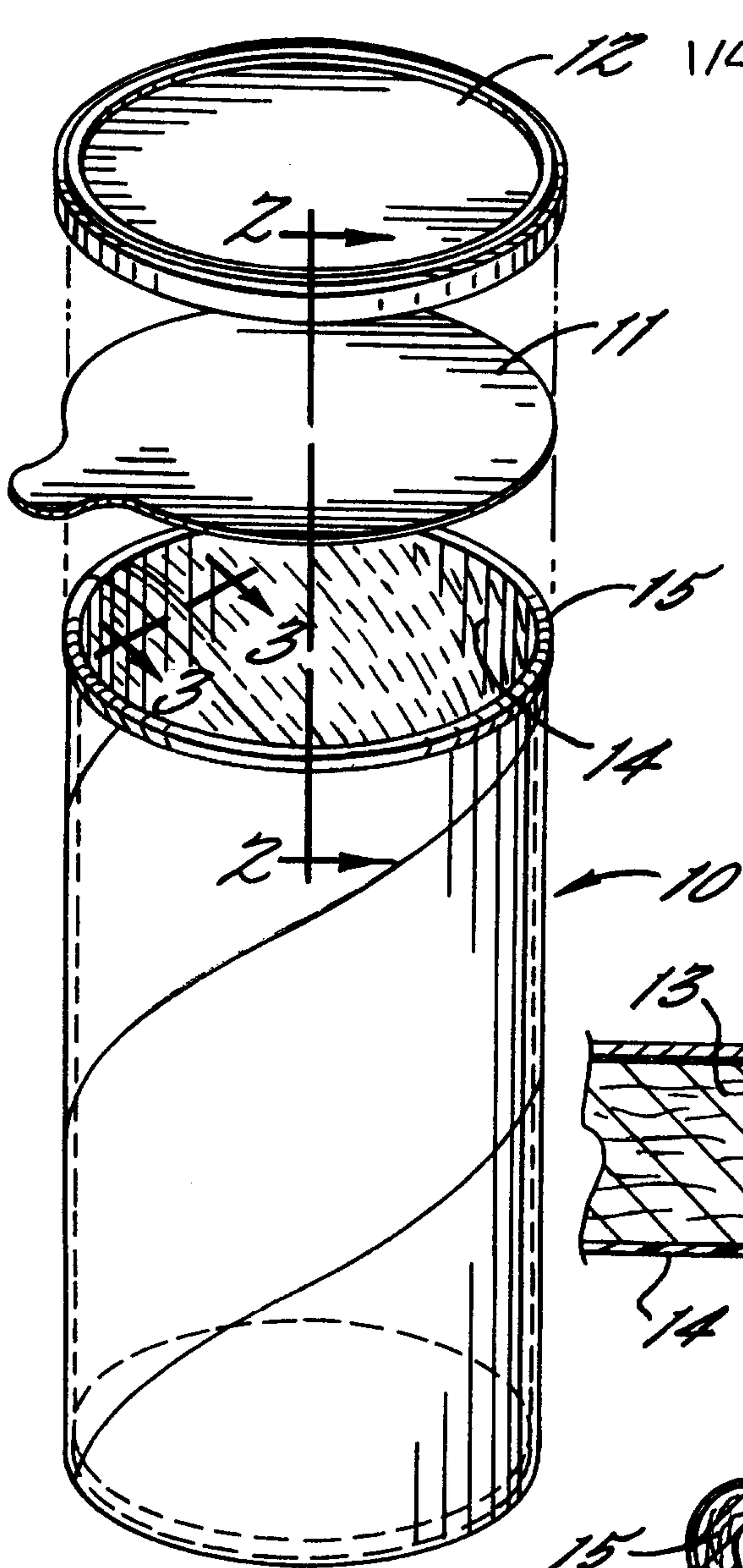


FIG. 1.

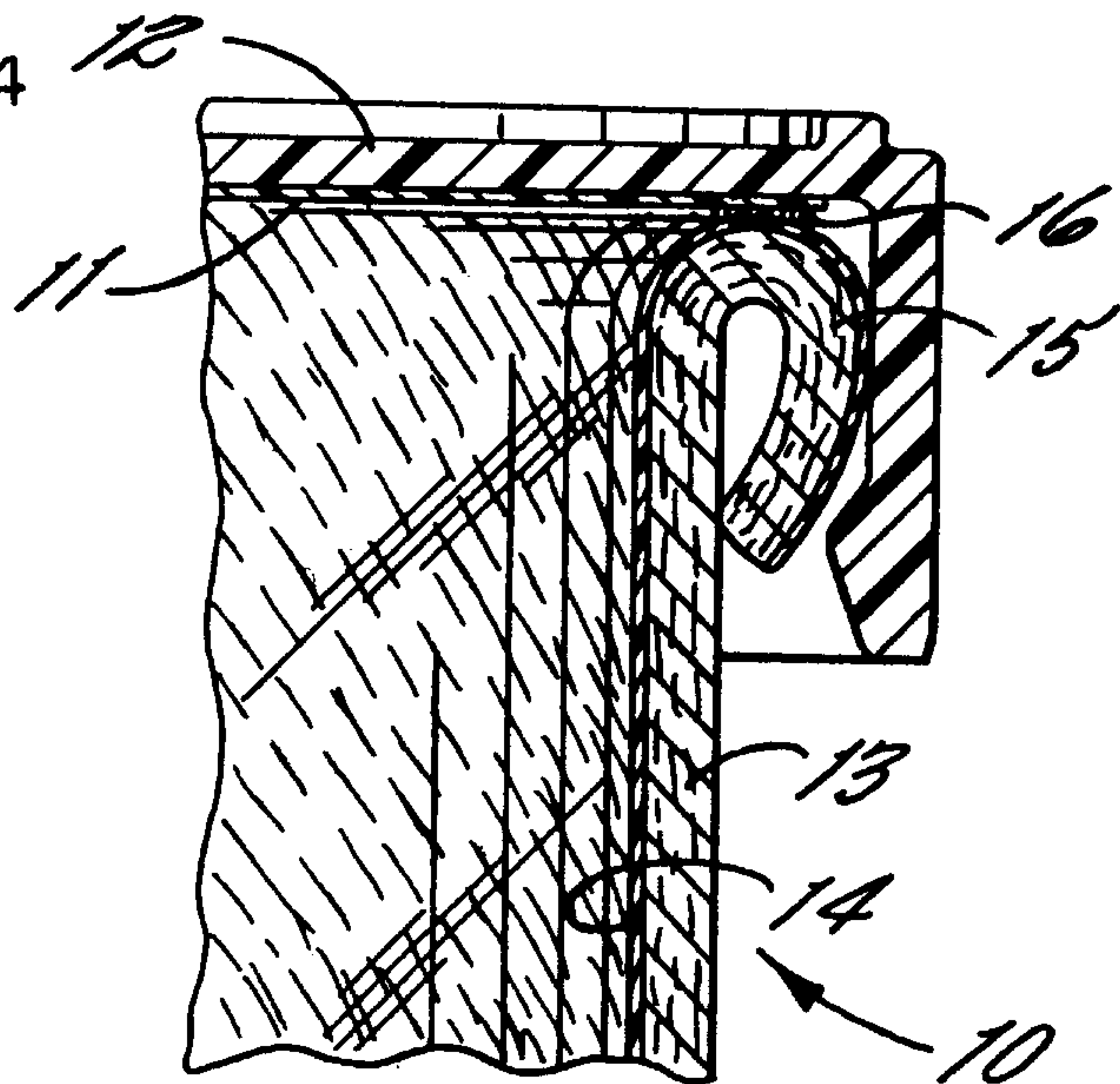


FIG. 2.

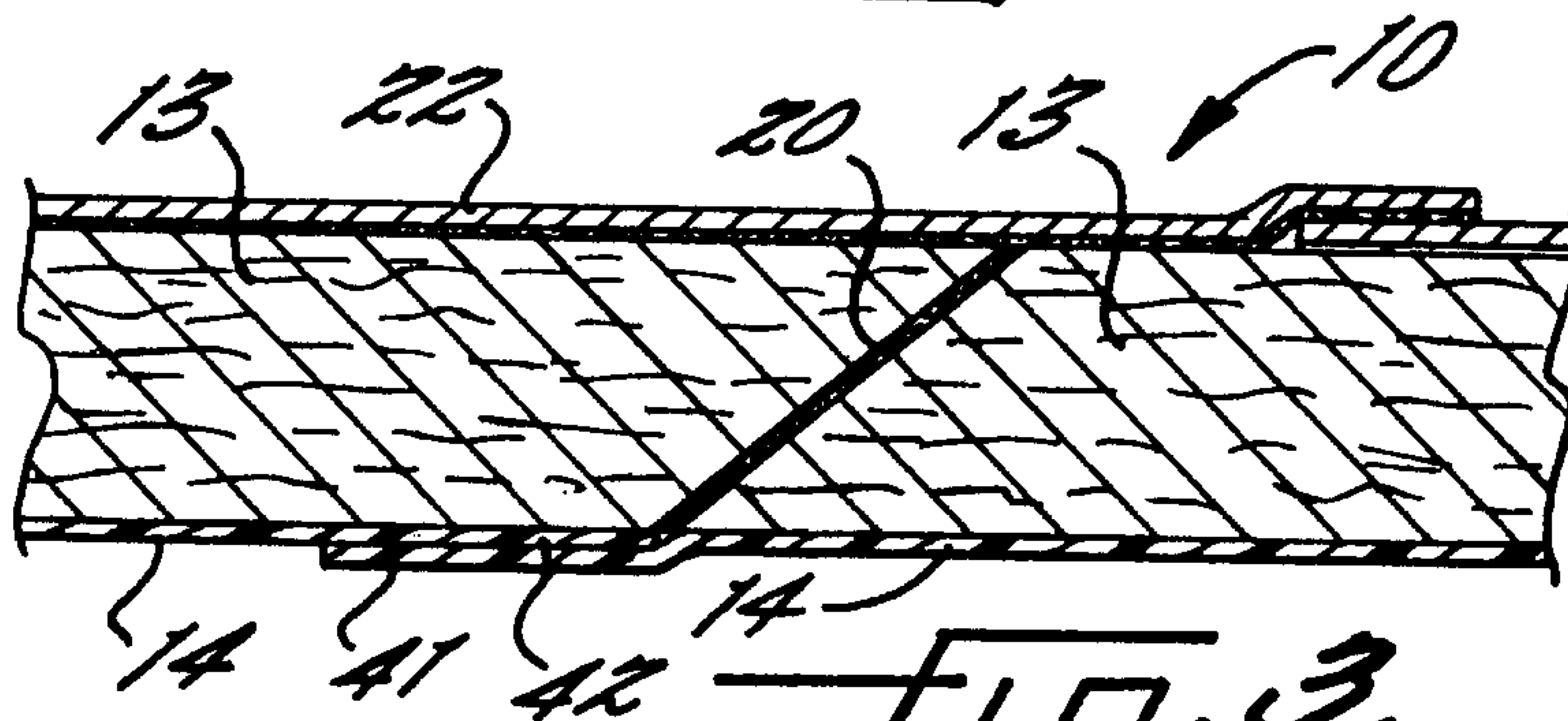


FIG. 3.

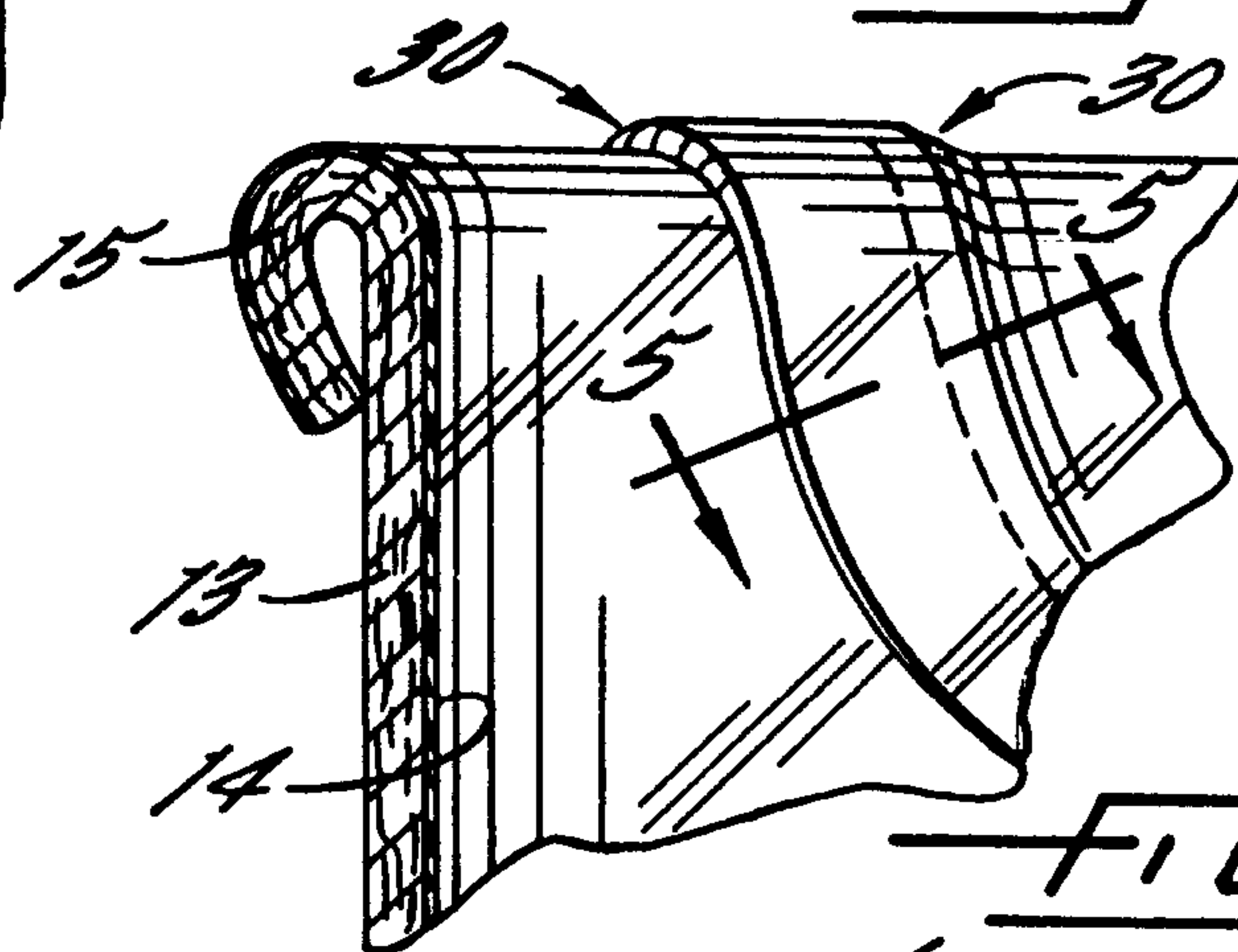


FIG. 4.
(PRIOR ART)

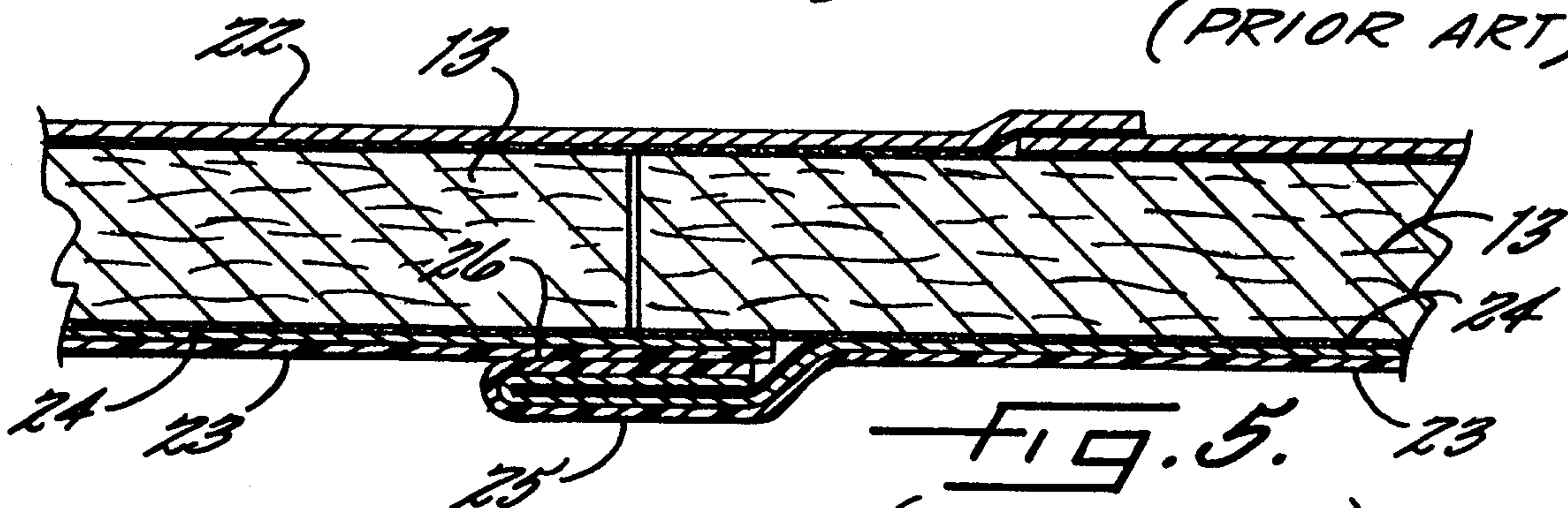
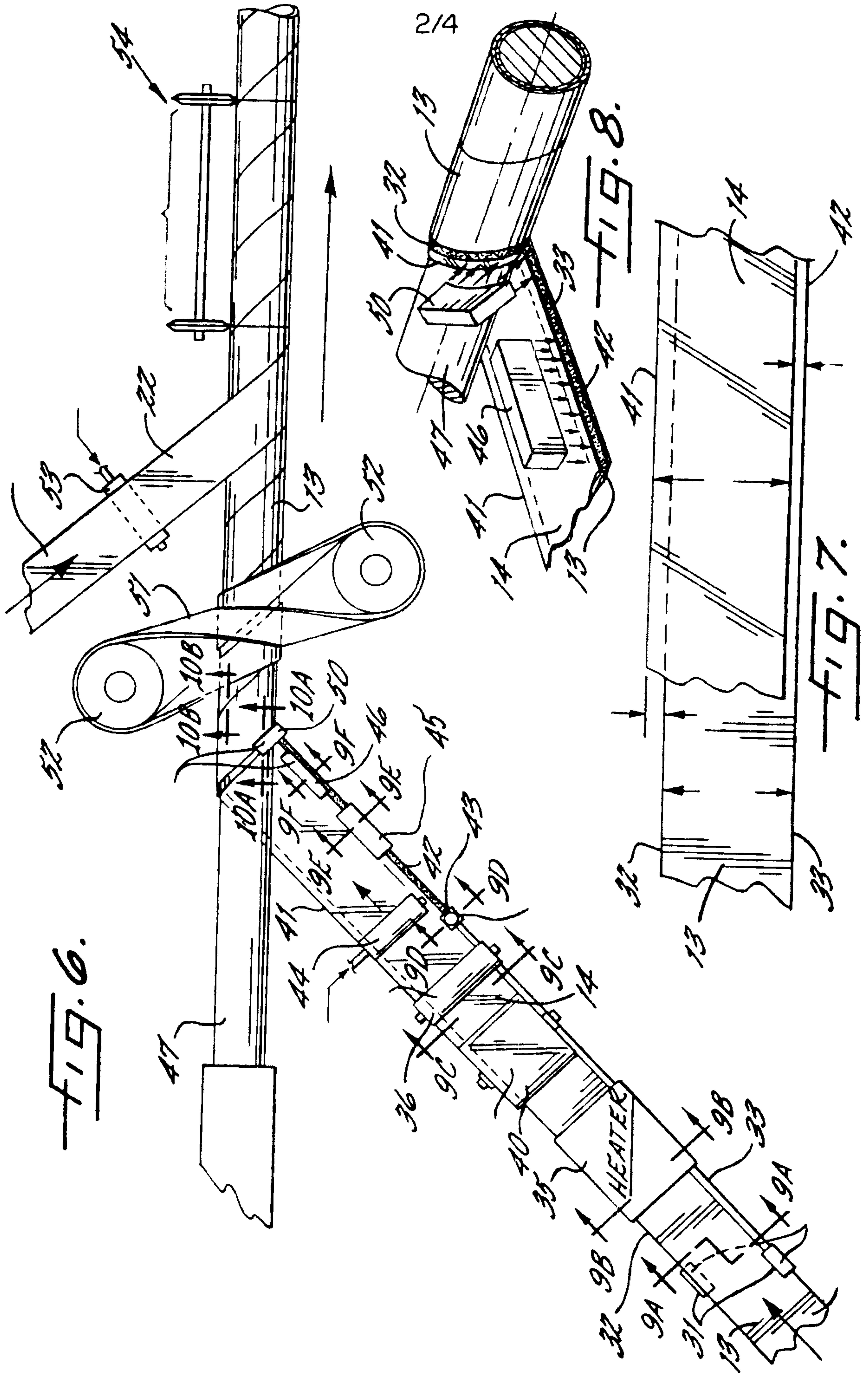
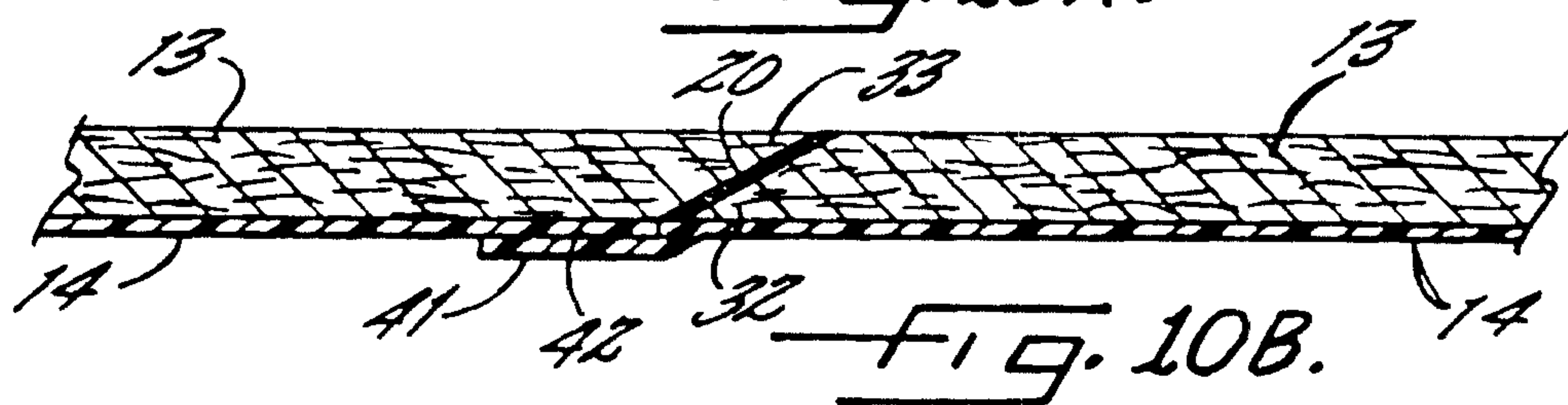
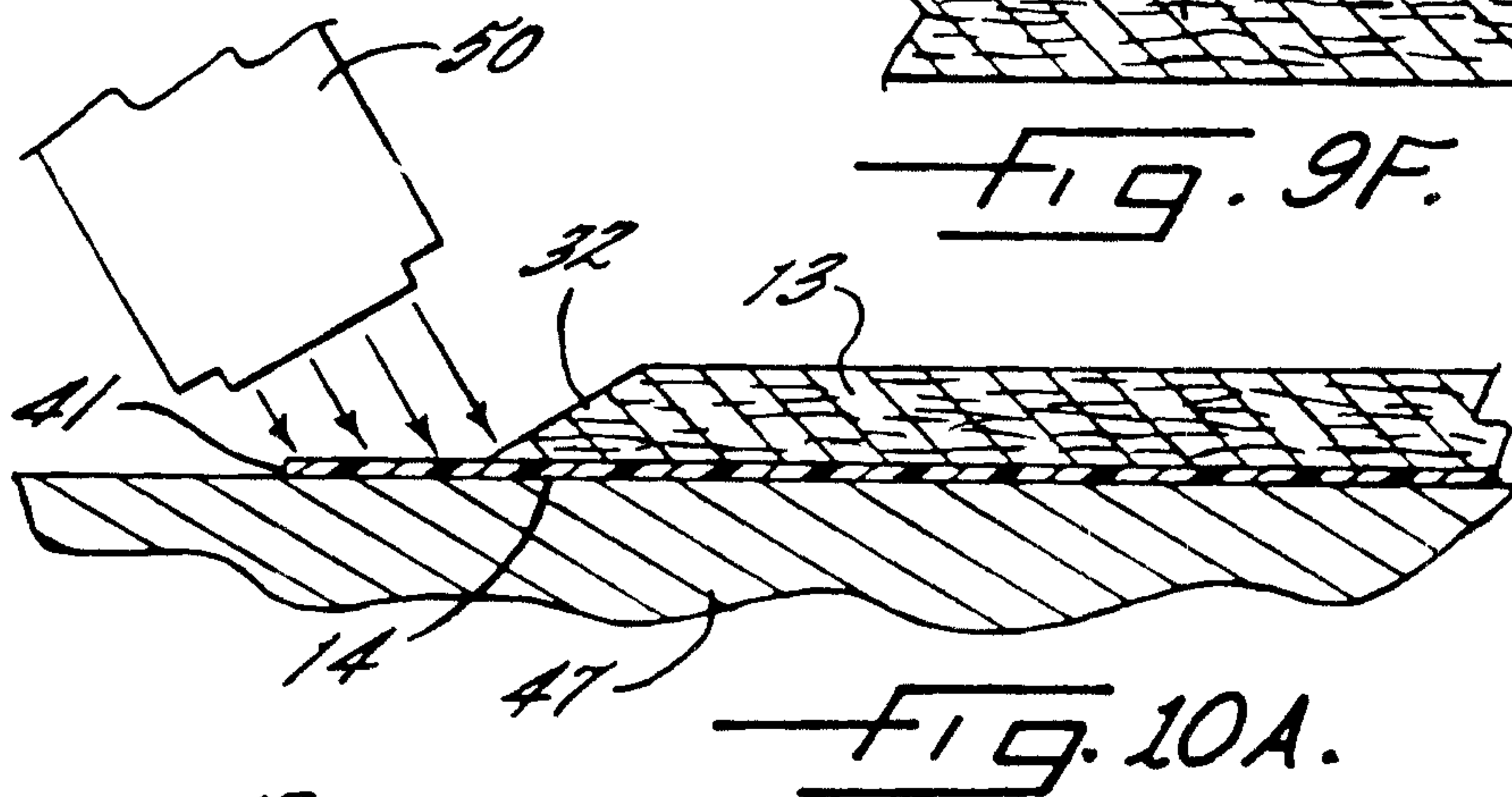
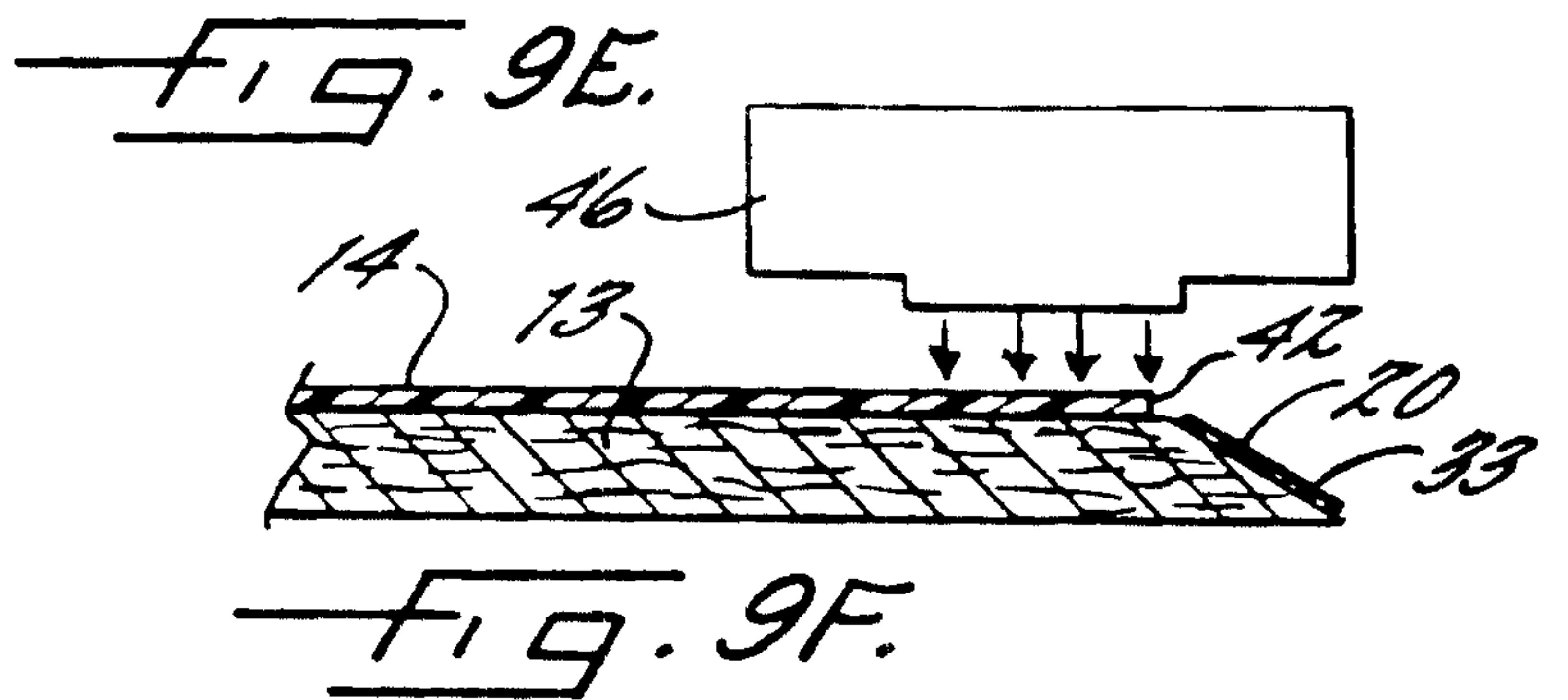
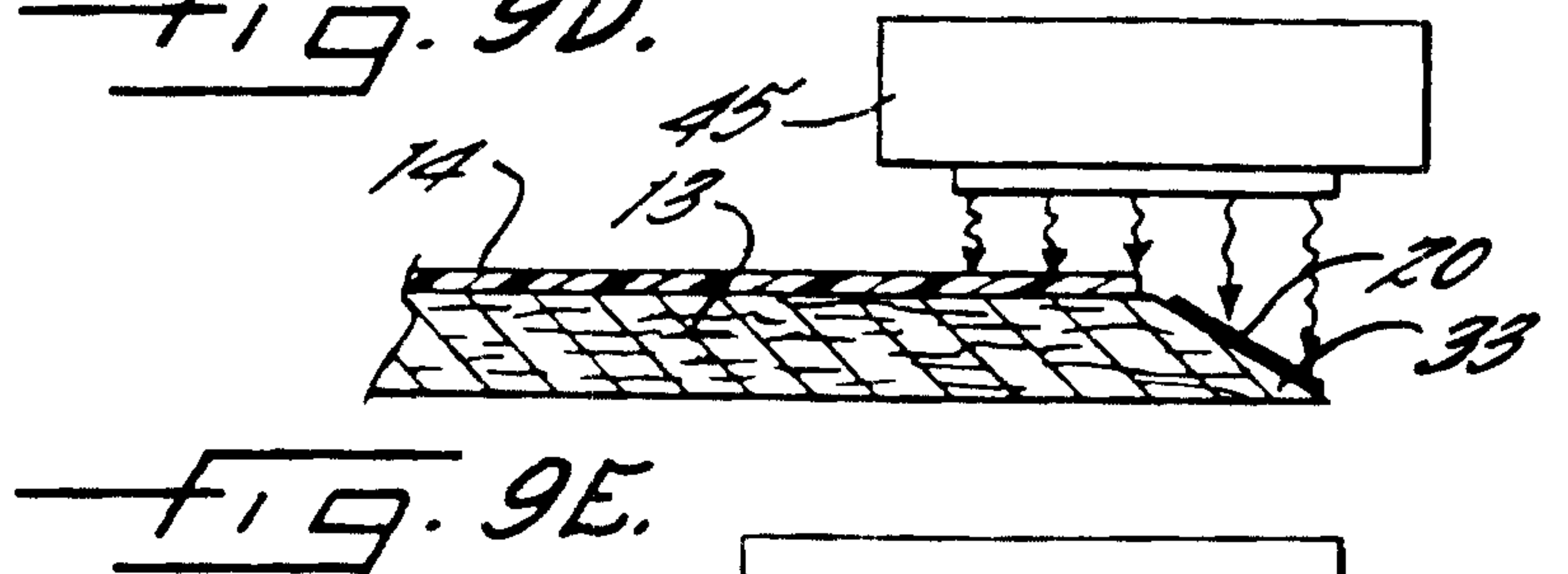
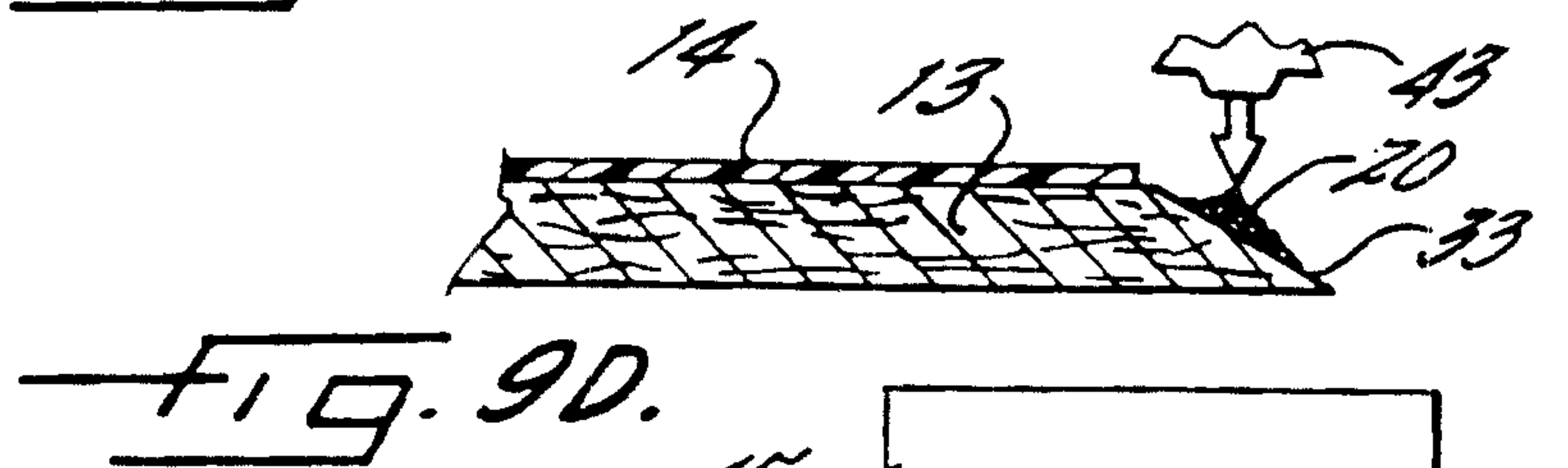
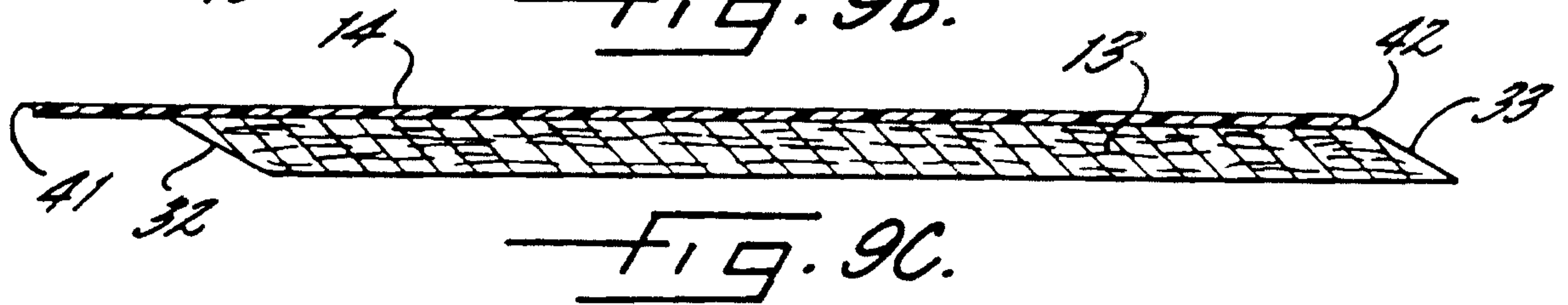
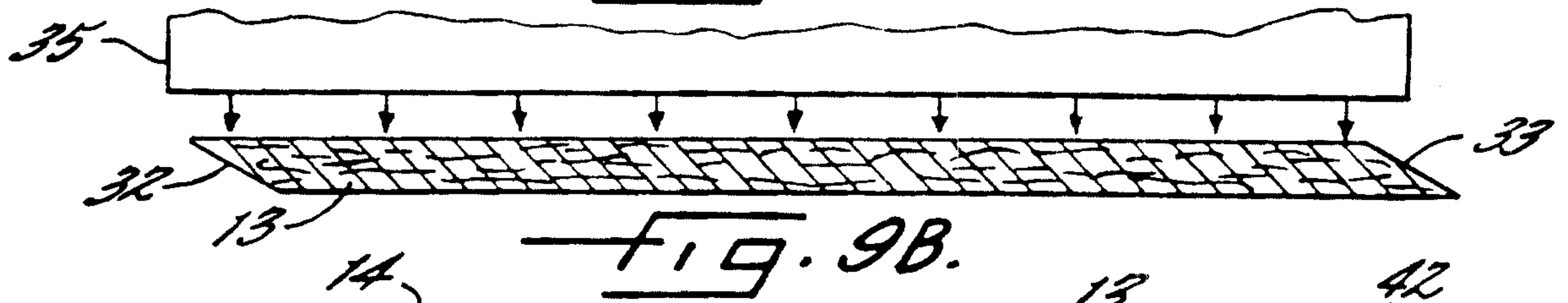
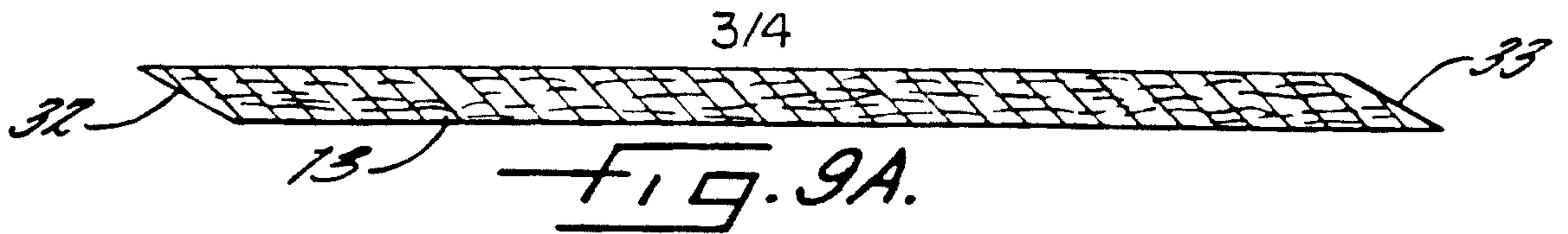


FIG. 5.
(PRIOR ART)





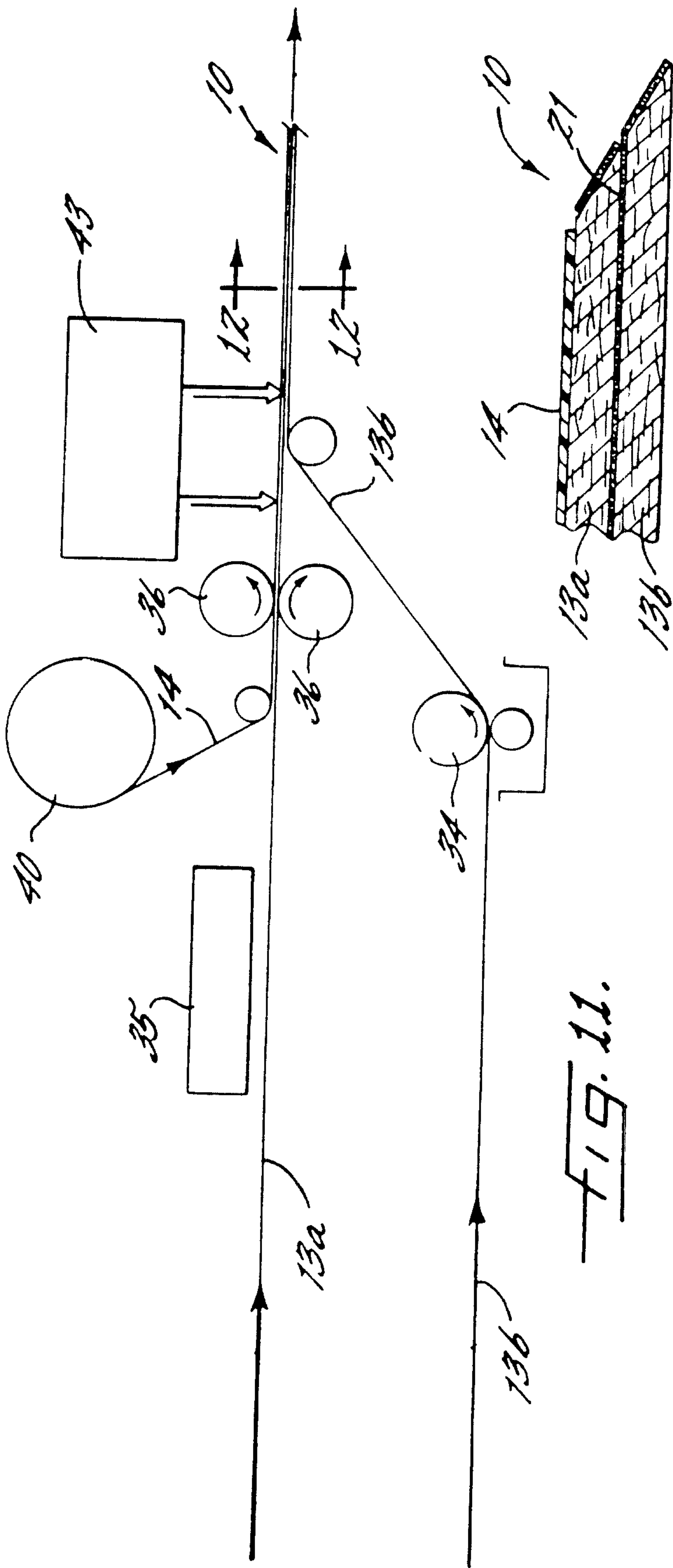


FIG. 11.

FIG. 12.

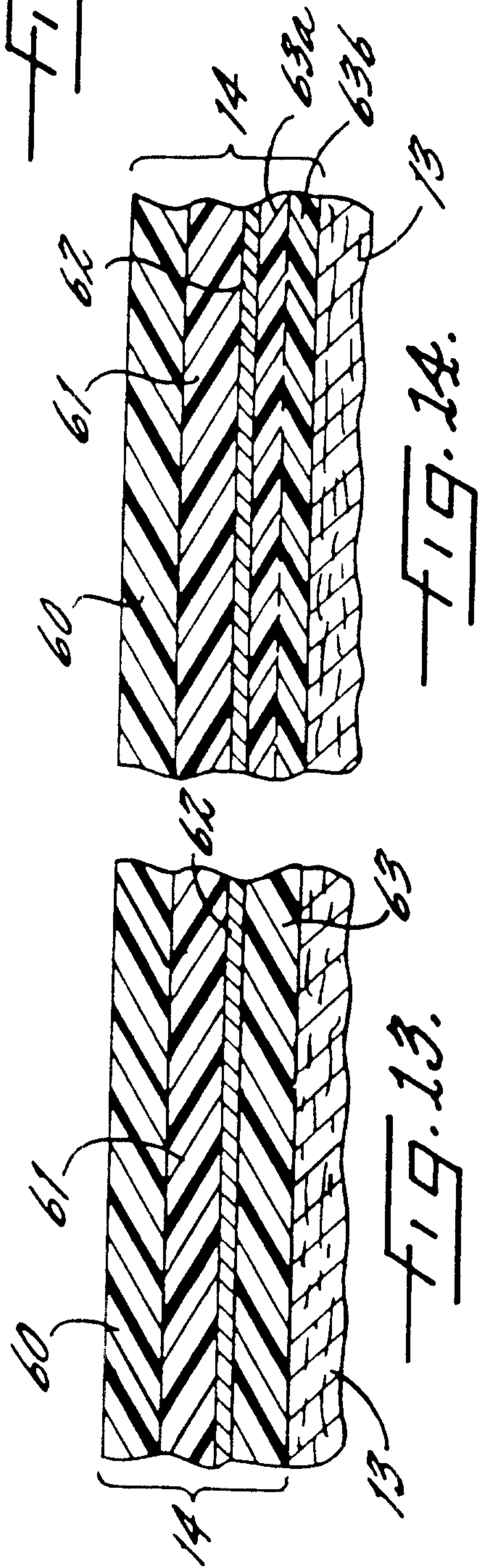


FIG. 13.

FIG. 14.

