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(54) **CONTINUOUS PLATFORM CUTTING APPARATUS AND METHOD**

VORRICHTUNG UND VERFAHREN ZUM KONTINUIERLICHEN PLATTFORMSCHNEIDEN

APPAREIL DE DECOUPE A PLATE-FORME CONTINUE ET PROCEDE

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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to an apparatus and a continuous method for shaping the surface of a slab of compressible or cellular polymer material, such as polyurethane foam as per the preambles of claims 1 and 8. An example of such a method and apparatus is disclosed by WO-A-99/04941.

[0002] Several methods and apparatus for cutting slabs of cellular polymer materials have been disclosed in the prior art. For example, U.S. Patent No. 4,700,447 to Spann discloses convolute-cutting slabs of polyurethane foam by compressing a slab or pad of foam between a pair of rolls with opposed spaced projecting fingers arranged in a pattern and cutting the foam with a saw blade transversely just as it emerges from the rolls. The cut slab is then separated into two pads each with convotute-cut surfaces forming a series of peaks separated by valleys. The valleys formed on one pad are formed by slicing away foam which becomes a mating peak or projection on the other pad. Spann then shaves the peaks to form a more planar top surface. As noted in Spann, convolute cutting alone produces only rounded peaks and rounded valleys, and it is difficult, if not impossible, to produce a cut surface with peaks having substantially flat top surfaces or with recesses having substantially straight side walls. The convolute usually is intended to form the classic symmetrical and repeating "egg crate" pattern of peaks and valleys. To achieve a planar upper surface at other than the recessed portions, the tops of the peaks must be cut or shaped in a second step.

[0003] Compressible cellular polymer materials may also be cut using a hot wire cutter. A slab of such material is cut by moving the slab relative to one or more hot wires as shown, for example, in U.S. Patent No. 4,683,791 (Demont). Only straight cuts in regular or symmetrical patterns may be formed using a hot wire cutter. See also U.S. Patent No. 4,915,000 (MacFarlane) and U.S. Patent No. 5,573,350 (Stegall).

[0004] Shapes may be cut into the surface of a slab of cellular polymer material using a punch cutting apparatus, such as disclosed in U.S. Patent No. 5,299,483 (Ber-Fong). A block of the cellular material is pressed against a template so that a portion of the material is forced through an opening in the template. The exposed material is then cut by a blade and removed, leaving a recess or cavity in the slab. This method cuts one block of material at a time, and only one surface at a time.

[0005] U.S. Patent No. 4,351,211 (Azzolini) compresses a block of foam material against a template or die having an aperture therein using a pair of plates with concave and convex portions. The compressed foam is transversely cut along the template as it is held between the plates. More complex cut regions may be obtained than when using a template without the plates with raised and depressed portions, but only one block is cut at a time. Other template or pattern cutting methods are shown in U.S. Patent No. 3,800,650 (Schroder) and U.S. Patent No. 3,653,291 (Babcock).

[0006] The surface of a cellular polymer material may be shaped by molding or embossing, as opposed to cutting. U.S. Patent No. 4,383,342 (Forster), for example, discloses injecting the foam-forming composition in a mold cavity. After sufficient curing time, the individual foamed article is removed from the mold. Other one-shot molding techniques are known to persons of skill in the art. The molded cellular polymer product generally forms a tough skin at the surfaces that were in contact with the mold.

[0007] Continuous and semi-continuous molding processes are also known. These processes have the same drawbacks associated with one-shot molding techniques. For example, U.S. Patent Nos. 4,128,369 and 4,290,248 (Kemerer, et al.) disclose an apparatus and method for impression molding thermoplastic products. The thermoplastic material in a liquid state is injected between compressed traveling belt molds. As the belt molds travel away from the point of introduction of the thermoplastic, they are cooled, which in turns cools the thermoplastic material. The hardened molded thermoplastic material is removed from between the belts to form the finished product. Kemerer does not show a method for cutting or shaping a cellular polymer material, such as polyurethane foam.

[0008] A method of embossing a foam surface using a patterned metallic embossing belt or band is shown in U.S. Patent 4,740,258 (Breitscheidel). The foam is heated and then pressed against the embossing belt The belt is removed after the foam surface cools. The embossed surface by design has a hardened skin. No method for cutting or shaping the foam is disclosed.

[0009] U.S. Patent No. 5,534,208 (Barr) discloses a continuous rotary method for surface shaping synthetic foams in which the foam is compressed between a compression roller and a die roller having raised and recessed portions. The portions of the foam extruded into the recesses in the die roller are cut away. The compressed foam portions return to an uncompressed state after passing through the rollers. As a result, a mirror-image pattern to the pattern on the surface of the die roller is cut on the surface of the foam. The diameter of the die roller limits the length of the shaped foam article that may be formed.

[0010] Patent application WO99/04940 discloses a method for shaping cellular polymer materials by cutting portions of the material from one surface as per the preamble of claim 1. The cellular polymer material travels on a moving patterned platform defining at least one recess. The platform is interposed between a compression roller and a cooperating surface. When the polymer material is compressed between the compression roller and the cooperating surface, a portion of the material fills the recess or recesses. The said portion is then cut from the

surface of the material with a blade just as the slab emerges from between the compression roller and the cooperating surface. This prior art does not disclose neither an apparatus nor a continuous method for shaping a compressible or cellular polymer material wherein the slab of material is more smoothly compressed before being passed between a compression roller and a moving patterned platform and after which it is cut with a blade.

SUMMARY OF THE INVENTION

[0011] The present invention is related to a method for shaping polymer material according to the features of claim 1. The invention also relates to an apparatus according to the features of claim 9. A continuous method for shaping a compressible or cellular polymer material, such as polyurethane foam, by cutting and removing portions of the material is disclosed. A slab of cellular polymer material is compressed between a compression roller and a surface of a moving patterned platform. The moving patterned platform is interposed between the compression roller and a cooperating surface, such as the surface of a drive roller. In order to more smoothly flatten the slab before compressing it between the compression roller and the moving patterned platform, the slab is passed through an upstream narrowing gap defined between a belt and the moving patterned platform. The said belt travels in a circuit defined by the compression roller and a follower roller. In a preferred embodiment, idler rollers are positioned between the compression roller and the follower roller. Consequently the narrowing gap is widest between the follower roller and the moving patterned platform and progressively narrows between the idlers rollers and the moving patterned platform. As the slab passes through the progressively narrowing gap, the polymer material is compressed to a greater degree until the greatest compression force is exerted in the predetermined gap (between the compression roller and the cooperating surface). Because the moving patterned platform may be formed from a flexible material, the compression force preferably is applied at a region where the platform is adjacent to a solid surface of the drive roller. In a less preferred embodiment, the moving patterned platform is interposed between the compression roller and a follower roller and the compression force is applied at a region where the platform is adjacent to a solid surface of the follower roller. A knife blade is positioned downstream from the compression roller and the point at which the compression force is applied, preferably with the blade interposed between the compression roller and the patterned platform. The slab surface is cut transversely by the blade just as the slab emerges from between the compression roller and the moving patterned platform, thus trimming off portions of the cellular material that filled the recesses in the patterned platform. In an alternate embodiment, the blade is positioned so that it shaves a fine scrim layer of foam from the slab surface, and makes deeper cuts into the slab in the regions in which the polymer material has filled the recesses in the patterned platform. If the patterned platform defines upstanding projections, instead of or in addition to recesses, the projections force a portion of the foam material away from the blade and less material is cut from the slab surface in those regions.

[0012] The patterned platform may be an endless belt or a series of movable panels or plates or any other structure that may travel in a continuous circuit or path. Where the patterned platform is an endless belt, the belt is placed over a series of rollers wherein at least one such roller is driven by a motor. The belt may be engaged to the roller with interconnecting gears or ribs so that the rotation of the drive roller causes the belt to travel. Where the patterned platform is formed by a series of interconnected panels, such as metal plates, the panels preferably are connected movably to a chain and sprocket drive system. Thus when the sprocket is driven, such as by a motor, the sprocket drives the chain and the panels interconnected to the chain.

[0013] The patterned platform may define at least one recess, which may be a hole or void through the platform, but preferably is a cut-out portion that does not pass through the entire thickness of the platform. The recess may be provided as a simple or complex geometric shape. Where more than one recess is defined in the platform, the recesses may be of the same or different shapes, may be interconnected or separated, may be symmetrical or non-symmetrical, and may be repeating or non-repeating on the patterned surface of the patterned platform. The recesses may be cut to different depths in the platform. Several separate series of different recesses may be provided on one patterned platform.

[0014] The patterned platform may define at least one upstanding projection. The projection may be provided as a simple or complex geometric shape. Where more than one projection is defined on the platform, the projections may be of the same or different shapes, may be inter-connected or separated, may be symmetrical or non-symmetrical and may be repeating or non-repeating the patterned surface of the patterned platform. The projections may have different heights. The patterned platform may include a combination of recesses and upstanding projections.

[0015] As the slab travels with the patterned platform and is compressed between the compression roller and patterned platform (with recesses), a portion of the cellular material fills the recesses in the patterned platform. Greater amounts of cellular material are cut from the slab in regions that have been compressed into the recesses in the patterned platform because this material has been forced to one side of the cutting edge of the blade in these regions. The cut portions are removed from the slab after it passes the knife. The resulting profile cut product has on its cut face a series of cut regions that substantially correspond in pattern and shape in mirror image to the recesses provided in the patterned platform. The cut regions in the slab are also cut deeper in those regions that

correspond to the deeper recesses in the patterned platform. However, due to the varying compression factors for cellular polymer materials, the depth of cut of the cut regions usually is not identical to the depth of the recesses within the patterned platform.

[0016] Also disclosed is an apparatus for continuously shaping a compressible or cellular polymer material, such as polyurethane foam, by cutting and removing portions of the material. A compression roller and a cooperating surface, such as the surface of a driver roller, compress a slab of cellular polymer material. A surface of the moving patterned platform, interposed between the compression roller and the cooperating support surface, defines one or more recesses that hold a portion of the cellular material as it is compressed. In order to compress more smoothly the slab, at least one follower roller idler rollers and a belt are provided. The said belt travels In a circuit defined by the compression roller and the follower roller and is interposed between the compression roller and the moving patterned platform. In a preferred embodiment, the cooperating surface is the solid surface of a drive roller. In a less preferred embodiment, the moving patterned platform is interposed between the compression roller and a follower roller and the compression force is applied at a region where the platform is adjacent to a solid surface of the follower roller. Preferably, the compression roller is motor driven. The patterned platform is also preferably motor driven.

[0017] A knife blade is positioned downstream from the compression roller and the point at which the compression force is applied, preferably with the blade interposed between the compression roller and the patterned platform. The slab surface is cut transversely by the blade just as the slab emerges from between the compression roller and the moving patterned platform, thus trimming offthose portions of the cellular material that filled the recesses in the patterned platform. In an alternate embodiment, the blade is positioned so that it shaves a fine scrim layer of material (*e.g.,* foam) from the slab surface, and makes deeper cuts into the slab in the regions in which the polymer material has filled the recesses, but preferably the blade cuts away foam material only from those portions of the surface at which it is intended that voids or recesses be formed. If the patterned platform defines upstanding projections, instead of or in addition to recesses, the projections force a portion of the material (*e.g.,* foam) away from the blade and less material is cut from the slab surface in those regions.

[0018] The cut foam product has a series of recesses or projections defined in its surface. If the drive roller drives the patterned platform at one speed and the compression roller is driven at a different speed, the blade cuts the foam material to form angled side walls that are greater than or less than 90° as measured from the base of a cut recess or the top surface of a projection formed on the surface of the cut foam slab. The difference in platform speed as compared to the compression roller speed causes one surface of the slab to enter the predetermined gap prior to the other surface of the slab.

[0019] Using the apparatus and method according to the invention, a profile cut cellular product in which portions have been cut from both the upper and lower surface may be formed by feeding the slab through the apparatus twice. First, one surface is cut, then the cut product is inverted and fed through the apparatus a second time to cut its opposite surface.

DESCRIPTION OF THE FIGURES

[0020] Numerous other objects, features and advantages of the invention shall become apparent upon reading the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a schematic perspective view of a prior art continuous platform cutting apparatus;
FIG. 2 is a cross-sectional view taken along line 2-2 of FIG. 1;
FIG. 3 is a side elevational view of the apparatus shown in FIG. 1;
FIG 4 is a schematic perspective view of an alternate prior art moving platform for a continuous platform cutting apparatus that may be used to practice the invention;
FIG. 5 is a fragmental side elevational view of a cellular polymer underlayment mat defining patterned recesses that have been cut into the mat using the continuous platform cutting apparatus and method of the invention;
FIG. 5A is a fragmental side elevational view in cross-section taken along line 5-5 of FIG 5;
FIG. 6 is a top plan view of the mat of FIG. 5;
FIG. 7 is a schematic side elevational view in partial cross-section showing a prior art continuous platform cutting apparatus;
FIG. 8 is a partial schematic side elevational view in partial cross-section showing an apparatus according to the invention; and
FIG. 9 is a partial schematic side elevational view in partial cross-section showing a continuous platform cutting apparatus not covered by the scope of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Referring first to the apparatus as shown in FIGS. 1-3, a continuous platform profile cutting apparatus for compressible or cellular polymer materials **10** is supported on a first frame structure **12** and second frame structure **22.** A shaft **14** is mounted for rotation to the first frame structure **12,** preferably with bearings. A motor **16** drives the shaft **14.** A drive roller **18** is mounted on shaft **14.** The outer surface of the drive roller **18** may be covered or coated with a slip resistant material, such as urethane. Ribs or gear teeth **20** are provided around the

outer end or peripheral end surfaces of the first drive roller **18.** Alternatively, separate gears with suitable gear teeth may be provided at each end of the first drive roller **18.**

[0022] Shaft **24** is mounted for rotation to the second frame structure **22,** preferably using bearings. A first follower roller **28** is mounted on shaft **24.** The outer surface of the first follower roller **28** may be covered or coated with a slip resistant material, such as urethane.

[0023] A patterned platform, such as endless patterned belt **32,** has a patterned facing surface **34** and an opposite surface **38.** Belt **32** is mounted around the drive roller **18** and first follower roller **28.** The belt facing surface **34** defines recesses **36,** which may be simple or complex shapes, simple geometric patterns, complex patterns, symmetrical or repeating patterns or non-symmetrical and non-repeating patterns. Rectangular **36** and circular **37** recesses are shown by way of example in FIG. 1. The recesses may be provided at various depths as discussed in more detail below.

[0024] Mating ribbed sections **39** on the outer edges of the belt opposite surface **38** mate with or engage the ribs or gear teeth **20** provided on the drive roller **18.** When the servo motor **16** drives shaft **14,** which in turn rotates drive roller **18,** the endless belt **32** travels around the drive roller **18** and the first follower roller **28.** The mated ribbed sections **39** and ribs **20** and the frictional engagement between the contacting surfaces of the belt with the rollers keep the belt centered and aligned with the rollers as it travels a path around the rollers.

[0025] First idler roller **40** is mounted for rotation on shaft **42** which is held by a portion **44** of the frame **12.** First idler roller **40** is positioned at a point between the drive roller **18** and the first follower roller **28** to stabilize the movement of the endless belt **32.**

[0026] Compression roller **46** is provided at a point between the drive roller **18** and the first follower roller **28.** The compression roller **46** is mounted for rotation on shaft **48.** The shaft **48** is held in a bearing recess within a frame **52.** Tension adjusting means **54,** such as a fluid cylinder or spring or series of springs, may act on frame **52** to adjust the compression force applied.

[0027] The outer surface **47** of the compression roller **46** contacts the opposite surface **38** of the belt **32** on which the ribbed portions **39** are provided. The outer surface **47** of the compression roller **46** may be covered or coated with a slip resistant material, such as urethane. As shown best in FIG. 2, the surface **47** of the compression roller **46** does not extend to the full outer periphery of the roller, leaving a recess into which the ribbed portions **39** extend so that the surface **47** of the roller **46** contacts the surface **38** of the belt **32.** Greater slip resistance results when the amount of surface engagement between the belts **32** and the roller compression surface **47** is increased.

[0028] Compression roller **56** with outer compression surface **60** is mounted for rotation on shaft **58.** The shaft **58** is held within frame **62.** A motor **57** drives shaft **58.** The roller **56** is separated from compression roller **46,** leaving a space or gap through which the endless belt **32** travels between the compression surfaces of the rollers. The arrow **64** in FIG. 2 indicates the force applied against the frame **62** to urge roller **56** to toward roller **46.**

[0029] Referring to FIG. 3, knife blade **76** is held within casing **74.** The blade **76** must have a sharp tip that is sufficiently sharp to cut cellular polymer materials, such as polyurethane foams. Because the blade **76** construction is known and understood by persons of skill in the art of cutting cellular polymer materials, such as polyurethane foams, it will not be described in detail.

[0030] The blade **76** is positioned adjacent to the compression rollers **46, 56** so that the sharp tip of the blade is adjacent to or just beyond the point at which the outer surfaces **47, 60** of the compression rollers **46, 56** act to their greatest extent to compress material that is placed between the rollers (i.e. the predetermined gap). The blade **76** is also positioned between the compression surface **60** of compression roller **56** and the patterned facing surface **34** of endless belt **32** so that the blade tip is close to tangential contact with the facing surface **34.** The blade **76** should be positioned so that it will not cut the compression surface **60** of the roller **56** or the patterned facing surface **34** of the belt **32.** The blade **76** should not interfere with the rotation of the rollers **46, 56** or the movement of the belt **32.** Blade orientation may be adjusted so that the tip of the blade is moved closer or farther from the nip between roller **46** and roller **56.**

[0031] In one embodiment as shown best in FIGS. 2 and 3, as a slab **80** of cellular material, such as polyurethane foam, is fed between the compression surface **60** of compression roller **56** and the patterned facing surface **34** of the endless belt **32,** the slab **80** is compressed by the rollers **46, 56.** When the slab **80** travels into the nip or space or predetermined gap between the rollers **46, 56,** portions of the compressed slab material are held within the recesses **36** defined within the facing surface **34** of the belt **32.**

[0032] Knife blade **76** cuts transversely portions of the slab **80** just as the slab **80** emerges from between the compression rollers **46, 56.** As shown in FIG. 3, the cuts into the slab **80** are made in the regions corresponding to those regions in which slab material had been compressed within recesses **36** defined in the facing surface **34** of the belt **32.** A portion of the material that was held within a recess in the belt is cut away from the slab before the compressed cellular material is able to recover to its uncompressed state as it emerges from the compression rollers. Portions of the slab surface not compressed into the recesses or voids in the facing surface **34** of the belt **32** may or may not be cut, depending upon the position of the blade **76.**

[0033] After the slab is cut as it emerges from the rollers, the cut-away portions **88** are removed as waste, leaving a resulting profiled cellular material **90.** The resulting product **90** has recesses **92** substantially corresponding in shape to the recesses **36** provided in the patterned

face surface **34** of the endless belt **32.** Slabs of cellular material may thus be provided with profiled surfaces with an endless array of patterns, whether symmetrical or non-symmetrical, simple or complex, or repeating or non-repeating. For example, alternatively the cut-away portion **88** might be a separate profiled cellular material product **90.**

[0034] Preferably, only portions of the slab that have been compressed into recesses are cut away, resulting in less waste to remove from the surface of the slab as it emerges from the cutting apparatus. The waste material does not fall away and contaminate the apparatus, but is carried away by the belt **32.** The waste may then be swept or vacuumed off the belt as it continues to travel along its path defined by the position of the rollers **18, 28.**

[0035] Long slabs of cellular material may be continuously fed into and shaped by the continuous platform cutting apparatus. The method may be used to cut multiple products continuously from a single slab of material. The recesses and/or projections formed in a single patterned platform may be arranged in separate configurations for different products. Alternately, repeating recess patterns may be formed in the patterned platform. In addition, patterned platforms of different lengths may be used to form finished cut products of different lengths.

[0036] An example of a profile-cut product **300** made according to the invention is shown in FIGS. 5 and 6. The profile cut product **300** represents a cellular polymer insulating barrier or underlayment that will be installed in the interior of a motor vehicle between the floor surface and the carpeting. The upper surface **310** of the underlayment has been cut to provide complex patterns of recesses. As shown in FIG. 6, generally rectangular-shaped recesses **312** have been cut into the surface of the product **300.** In addition, more complex shaped recesses, such as interconnecting generally oval shaped recesses **314** and interconnecting straight-edged and curved-edged recesses **316,** may be cut into the cellular material. For the underlayment for a motor vehicle, preferably one surface, here what has been referred to as the upper surface **310,** is cut and the opposite surface remains uncut The cut surface of the underlayment is placed adjacent to the motor vehicle surface so that the voids and recesses in the underlayment mate with shaped portions projecting from the vehicle surface. In this manner, the underlayment may be provided so as to match the contour of the vehicle interior surface. Once the underlayment is installed in the vehicle, carpet or other covering may be installed adjacent to the uncut and generally smooth surface of the underlayment.

[0037] The depth of the recesses **36, 37** of the belt **32** are typically a small fraction of the depth of the corresponding cuts to be made in the surface of the foam material **80.** Because of the compression factor of the foam against the pattern belt **32,** a shallow depression **36, 37** in the pattern belt **32** yields a much deeper depression in the foam. For example, a 1.6 cm (5/8 inch)thick sheet of foam material compressed against a depression **36** of 0.05 cm (20 thousands of an inch) in the patterned belt, in the apparatus **10** described above, yielded approximately 1.3 cm (½ inch) deep depression in the foam sheet **80.** The spacing between the belt surface **34** and the roller surface **56,** if all other factors are equal, determines the compression factor of the foam and consequently, the ratio of patterned belt depth to foam cut depth. The depth of cut in the foam can be reduced for a given pattern belt recess depth or projection height by increasing the spacing between the roller surface **56** and the belt surface **34,** thus reducing the compression factor.

[0038] Where the belt **32** is driven at the same speed as the roller **56,** the cut product has recesses (or projections) formed with sidewalls substantially perpendicular (90°) to the top surface of the product. The angle of the cut sidewalls may be varied by driving the belt **32** at a different speed than the speed roller **56** is driven. When different drive speeds are used one surface of the slab **80** will enter the predetermined gap before the other surface. The drive speed may be adjusted continually as the foam material slab **80** is introduced into the gap. In this way, side wall angles may be the same or different in different regions of the cut product. Referring to FIG 5A, the recess is cut with substantially perpendicular (90°) sidewalls **340,** but there is shown in phantom outline a recess cut with angled sidewalls **342.** When the compression roller is driven at 7.62 meters (25 feet) per minute surface speed and the patterned platform runs at 10.67 meters (35 feet) per minute surface speed, the cut product has recesses with side walls cut at an angle of about 110° to 115°. However, the cut angle is about 90° when both surfaces are driven at the same speed.

[0039] For certain applications, it may be desired to cut both the upper and lower surfaces of a slab of cellular material. If the apparatus shown in FIGS. 1-3 is used for this purpose, once the slab has been fed between the compression rollers and cut on one side, the slab may then be inverted and fed between the compression rollers so that it may be profile-cut on the opposite surface.

[0040] The endless belt **32** preferably is formed from a flexible material such as rubber or silicone rubber or urethane. The belt **32** is thick enough to withstand the compressive forces, preferably about 0.95 cm (0.375 inches) or more, and has a durometer of about 35 or higher, preferably 75 or higher, most preferably at least 90. Alternatively, the belt may be formed of fiberglass reinforced polyurethane or other composite materials suitable for endless belts with such thickness and durometer.

[0041] As shown in FIG. 4, rather than using an endless belt, the patterned platform **200** may be constructed as a continuous or endless series of inter-linked panels driven by chain and sprocket. The series of plates **208,** preferably formed from metal or other sturdy substrate, are mounted on shafts **210.** The shafts **210** are held for rotation within bearing sleeves **212.** Y-shaped follower bars **214** are connected at one end to the shafts **210** and at the other two ends to members **204** holding together the

links **202** of a chain. The chain links **202** are driven by sprockets (not shown), which in turn are driven by motors (not shown).

[0042] The plates **208** may define one or more recesses **216,** or portions of recesses **216a.** The recesses may be cut through a portion or through the entire thickness of a plate. The recesses may be formed in rectangular, circular or other geometric shape. The recesses may be cut in non-uniform, non-symmetrical and not repeating shapes. The recesses need not be contained wholly within a single plate. Rather, a recess defined by one plate may complement the recess defined by an adjacent plate to form larger or more complex recess shapes.

[0043] When a series of plates are used as the patterned platform, the slab of cellular material will be pressed against the plates by a compression roller (not shown in FIG. 4) so that a portion of the material is compressed into the recesses in the plates and is cut away from the slab by a knife blade just as the cellular material emerges from the compression roller. A support platform **222** is provided below the plates **208** to support the plates when compression forces are exerted on them by the compression roller.

[0044] Like reference numerals in FIG. 7 refer to like elements as shown in FIGS. 1-3 because the apparatus **300** in FIG. 7 is similar to the apparatus **10** shown in FIGS. 1-3. There is provided a drive roller **18** that travels in the direction indicated by the arrow **302.** The outer surface of the drive roller **18** is provided with teeth **20.** The apparatus also includes follower roller **28.**

[0045] A belt **32** has a patterned surface **34** with one or more recesses **36** and has an opposite surface **38.** Mating ribs or teeth **39** are proved on the opposite surface **38** of the belt. The teeth **39** engage the teeth **20** provided on the drive roller **18.** As the belt travels along a path around the drive roller **18** and follower roller **28,** it also contacts the outer surfaces of first and second idler rollers **40, 40'.**

[0046] A compression roller **56** mounted on a shaft **58** is provided with an outer surface **60.** In this apparatus **300,** the compression roller **56** is positioned close to the outer surface of the drive roller **18** to define a predetermined gap between the outer surface **60** and the roller **18.** The roller **56** position is adjustable, such that the outer surface **60** of the roller may be closer or farther from the outer surface of the drive roller **18** to change the gap. The belt **32** travels between the outer surface **60** of the compression roller **56** and the outer surface of the drive roller **18.**

[0047] A slab of compressible material **80** is fed into the gap between the patterned surface **34** of the belt **32** and the outer surface **60** of the compression roller **56.** The gap is set to a distance that causes the compressible material to be compressed between the outer surface **60** of the compression roller **56** and the patterned surface **34** of the belt **32.** Portions of the compressible material are forced into the recesses **36** formed into the patterned surface **34** of the belt **32.**

[0048] A knife blade **76** held within knife casing **74** is positioned just downstream from the gap. Just as the compressible material **80** passes through the gap, portions of the slab **80** held within the recess **36** are cut by the blade **76.** The cut slab emerges with a profile-cut surface with recesses. The cut-away portions **88** are separated from the slab **80** and are carried away by the belt **32** to be removed, either by falling away, by manual removal or by vacuum.

[0049] The apparatus in FIG. 8 shows a preferred embodiment of the invention. To more smoothly compress the slab **80** of compressible material between the compression roller **56** and the moving patterned endless belt **32,** idler rollers **304** and **306,** and a follower roller **308** are provided. A belt **310** travels in a circuit defined by the compression roller **56** and the follower roller **308** and idler rollers **304, 306.** A narrowing gap is defined between the belt **308** and the belt **32.** The gap is widest between the follower roller **308** and the belt **32** and progressively narrows or closes between the idler roller **306** and the belt **32** and between the idler roller **304** and the belt **32.** As the slab **80** passes between the belt **32** and the belt **308** and through the progressively narrowing gap, the compressible material is compressed to a greater degree, until the greatest compression in the predetermined gap between the compression roller **56** and the belt **32.**

[0050] FIG. 9 shows a belt **32'** modified to include raised projections **320** projecting from the patterned surface **34'.** Some cut products are formed by cutting away a scrim or thin layer from the surface along the entire length of the slab **80.** With projections **320** provided on the belt **32',** cut products can be formed without cutting away material where portions of the slab passing through the predetermined gap are held to one side of the blade **76** by the projections **320.**

[0051] The apparatus and method according to this invention might be used to make profile cut products for a variety of end uses. In addition to motor vehicle carpet systems, profile cut products might be made for other vehicle interior applications, such as head liners, side panels and dash panels. Profile cut products might also be used for mattresses, mattress pads, pillows, furniture cushions, filters, sports equipment, footwear components and packaging. The above list is intended to be representative and not exhaustive as to all the possible applications for the invention.

[0052] While a preferred embodiments (Fig. 7) of the invention has been described and illustrated here, various changes, substitutions and modifications to the described embodiment will become apparent to those of ordinary skill in the art without thereby departing from the scope of the invention as defined by the claims.

Claims

1. A method for shaping a cellular polymer material (10) by cutting portions (92) from a surface of the material

in which a predetermined gap is established between a compression roller (56) and a cooperating surface and a continuous patterned platform is interposed in the predetermined gap between the compression roller (56) and the cooperating surface, and wherein a slab (80) of the cellular polymer material (10) is continuously fed through the gap between the compression roller (56) and the cooperating surface so that the slab (80) is compressed while a surface of the slab is adjacent to the moving continuous patterned platform (32) and a fraction of the portion of the cellular polymer material is transversely cut from the slab (80) with a blade (76) as the slab emerges from the gap between the compression roller (56) and the cooperating surface wherein the slab (80) is passed through a progressively narrowing gap, formed between a belt (310) and the platfonn (32), before it is compressed in the predetermined gap, **characterized by** said belt traveling along a path forming the progressively narrowing gap defined by the compression roller (56), a series of idler rollers (304, 306) spaced apart from the platform (32) at varying distances and a follower roller (308) positioned upsteam to the predermined gap.

2. The method according to claim 1, **characterized in that** the belt (310) is driven by the compression roller (56).

3. The method according to claim 1 or 2, **characterized in that** the moving patterned platform (32) defines at least one recess (36).

4. The method according to any one of claims 1 to 2, **characterized in that** the moving patterned platform (32) defines at least one projection (320).

5. The method according to any one of the preceding claims, **characterized in that** the cooperating surface is a drive roller (18).

6. The method according to any one of the preceding claims, daaracterized in that the patterned platform (32) is an endless flexible belt.

7. The method according to any one of the preceding claims, **characterized in that** the compression roller (56) is driven and the moving continuous patterned platform (32) is driven and **in that** the compression roller (56) is driven at a surface speed different from the speed at which the moving continuous patterned platform (32) is driven.

8. An apparatus for shaping a slab (80) of cellular polymer material (10) by cutting portions of material (10) from an outer surface of the slab (80) in which a compression roller (56) is rotatable on an axis and has its outer surface (60) spaced apart from a cooperating surface (46) to define a predetermined gap therebetween so that the roller (56) exerts a compressive force against the slab (80) of cellular polymer material (10) as said slab (80) is passed through said gap between the compression roller (56) and the cooperating surface, and having a moving continuous patterned platform (32) interposed in the predetermined gap between the compression roller (56) and the cooperating surface (46) and movable with relation thereto, and further having a blade (76) for cutting the cellular polymer material (10) as the slab (80) emerges from the predetermined gap between the compression roller (56) and the cooperating surface (46), said blade (76) positioned in substantially tangent closely adjacent relationship with the outer surface of the patterned platform (32) to cut a portion of the cellular polymer material (10) from the slab (80), **characterised in that** the apparatus further comprises at least one follower roller (308) positioned upstream from the predetermined gap, a series of idler rollers spaced apart from the platform (32) at varying distances a belt (310) interposed between the compression roller (56) and the outer surface of the patterned platform (32), the belt (310) travelling in a progressively narrowing gap circuit defined by the compression roller (56), the follower roller (308) and the idler rollers (304, 306) so that the slab of cellular polymer material (10) is progressively compressed between the belt (310) and the moving patterned platform (32) before it enters the predetermined gap.

9. The apparatus according to claim 8, **characterized in that** the belt (310) is driven by the compression roller (56).

10. The apparatus according to claim 8 or 9, **characterized in that** the moving patterned platform (32) defines at least one recess (36).

11. The apparatus according to claim 8 or 9, **characterized in that** the moving patterned platform (32) defines at least one projection (320).

12. The apparatus according to any one of claims 8 to 11, **characterized in that** the patterned platform (32) is an endless flexible belt.

13. The apparatus according to any one of claims 8 to 12, **characterized in that** the cooperating surface is a drive roller (18).

14. The apparatus according to claim 13, **characterized in that** a motor (16) drives the drive roller (18) and the drive roller (18) causes the platform (32) to travel at a speed synchronized with the speed at which the outer surface of the drive roller (18) is driven.

15. The apparatus according to claim 13, **characterized in that** a motor (16) drives the drive roller (18) and the drive roller (18) causes the platform (32) to travel at a speed different from the speed at which the outer surface of the compression roller (56) is driven.

Patentansprüche

1. Verfahren zum Formen eines Zellpolymermaterials (10) durch Schneiden von Abschnitten (92) von einer Fläche des Materials, wobei ein vorgegebener Spalt zwischen einer Kompressionswalze (56) und einer zusammenwirkenden Fläche hergestellt wird und eine kontinuierliche gemusterte Plattform in dem vorgegebenen Spalt zwischen der Kompressionswalze (56) und der zusammenwirkenden Fläche angeordnet wird, und wobei ein tafelförmiger Abschnitt (80) des Zellpolymermaterials (10) kontinuierlich durch den Spalt zwischen der Kompressionswalze (56) und der zusammenwirkenden Fläche dergestalt zugeführt wird, dass der tafelförmige Abschnitt (80) zusammengedrückt wird, während sich eine Fläche des tafelförmigen Abschnitts neben der sich bewegenden kontinuierlichen gemusterten Plattform (32) befindet, und ein Bruchteil des Abschnitts des Zellpolymermaterials quer mittels eines Messers (76) von dem tafelförmigen Abschnitt (80) abgeschnitten wird, wenn der tafelförmige Abschnitt aus dem Spalt zwischen der Kompressionswalze (56) und der zusammenwirkenden Fläche hervortritt, wobei der tafelförmige Abschnitt (80) durch einen zunehmend schmaler werdenden Spalt, der zwischen einem Band (310) und der Plattform (32) gebildet wird, geführt wird, bevor er in dem vorgegebenen Spalt zusammengedrückt wird, **dadurch gekennzeichnet, dass** sich das Band entlang eines Pfades bewegt, der den zunehmend schmaler werdenden Spalt bildet, welcher durch die Kompressionswalze (56), eine Reihe von Mitläuferwalzen (304, 306), die von der Plattform (32) in variierenden Abständen beabstandet sind, und eine Nachläuferwalze (308), die stromaufwärts von dem vorgegebenen Spalt angeordnet ist, definiert wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** das Band (310) durch die Kompressionswalze (56) angetrieben wird.

3. Verfahren nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die sich bewegende gemusterte Plattform (32) wenigstens eine Ausnehmung (36) definiert.

4. Verfahren nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die sich bewegende gemusterte Plattform (32) wenigstens einen Vorsprung (320) definiert.

5. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich bei der zusammenwirkenden Fläche um eine Antriebswalze (18) handelt.

6. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich bei der gemusterten Plattform (32) um ein flexibles Endlosband handelt.

7. Verfahren nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** die Kompressionswalze (56) angetrieben wird und die sich bewegende kontinuierliche gemusterte Plattform (32) angetrieben wird und dass die Kompressionswalze (56) mit einer Oberflächengeschwindigkeit angetrieben wird, die sich von der Geschwindigkeit unterscheidet, mit der die sich bewegende kontinuierliche gemusterte Plattform (32) angetrieben wird.

8. Vorrichtung zum Formen eines tafelförmigen Abschnitts (80) eines Zellpolymermaterials (10) durch Schneiden von Abschnitten des Materials (10) von einer Außenfläche des tafelförmigen Abschnitts (80), wobei eine Kompressionswalze (56) auf einer Achse drehbar ist und wobei die Außenfläche (60) der Kompressionswalze (56) von einer zusammenwirkenden Fläche (46) dergestalt beabstandet ist, dass dazwischen ein vorgegebener Spalt gebildet wird, dergestalt, dass die Walze (56) eine Druckkraft gegen den tafelförmigen Abschnitt (80) des Zellpolymermaterials (10) ausübt, wenn der tafelförmige Abschnitt (80) durch den Spalt zwischen der Kompressionswalze (56) und der zusammenwirkenden Fläche geführt wird, und eine sich bewegende kontinuierliche gemusterte Plattform (32) aufweist, die in dem vorgegebenen Spalt zwischen der Kompressionswalze (56) und der zusammenwirkenden Fläche (46) angeordnet ist und sich relativ dazu bewegen kann, und des Weiteren ein Messer (76) aufweist, das zum Schneiden des Zellpolymermaterials (10) dient, wenn der tafelförmige Abschnitt (80) aus dem vorgegebenen Spalt zwischen der Kompressionswalze (56) und der zusammenwirkenden Fläche (46) hervortritt, wobei das Messer (76) in einer im Wesentlichen tangentialen, dicht benachbarten Beziehung zu der Außenfläche der gemusterten Plattform (32) angeordnet ist, um einen Abschnitt des Zellpolymermaterials (10) von dem tafelförmigen Abschnitt (80) zu schneiden, **dadurch gekennzeichnet, dass** die Vorrichtung des Weiteren wenigstens eine Nachläuferwalze (308), die stromaufwärts von dem vorgegebenen Spalt angeordnet ist, eine Reihe von Mitläuferwalzen, die von der Plattform (32) in variierenden Abständen beabstandet sind, und ein Band (310), das zwischen der Kompressionswalze (56) und der Außenfläche der gemusterten Plattform (32) angeordnet ist, aufweist,

wobei sich das Band (310) in einem Kreislauf durch einem zunehmend schmaler werdenden Spalt bewegt, welcher durch die Kompressionswalze (56), die Nachläuferwalze (308) und die Mitläuferwalzen (304, 306) definiert ist, dergestalt, dass der tafelförmige Abschnitt des Zellpolymermaterials (10) zunehmend zwischen dem Band (310) und der sich bewegenden gemusterten Plattform (32) zusammengedrückt wird, bevor er in den vorgegebenen Spalt eintritt.

9. Vorrichtung nach Anspruch 8, **dadurch gekennzeichnet, dass** das Band (310) durch die Kompressionswalze (56) angetrieben wird.

10. Vorrichtung nach Anspruch 8 oder 9, **dadurch gekennzeichnet, dass** die sich bewegende gemusterte Plattform (32) wenigstens eine Ausnehmung (36) definiert.

11. Vorrichtung nach Anspruch 8 oder 9, **dadurch gekennzeichnet, dass** die sich bewegende gemusterte Plattform (32) wenigstens einen Vorsprung (320) definiert.

12. Vorrichtung nach einem der Ansprüche 8 bis 11, **dadurch gekennzeichnet, dass** es sich bei der gemusterten Plattform (32) um ein flexibles Endlosband handelt.

13. Vorrichtung nach einem der Ansprüche 8 bis 12, **dadurch gekennzeichnet, dass** es sich bei der zusammenwirkenden Fläche um eine Antriebswalze (18) handelt.

14. Vorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** ein Motor (16) die Antriebswalze (18) antreibt und die Antriebswalze (18) bewirkt, dass sich die Plattform (32) mit einer Geschwindigkeit bewegt, die mit der Geschwindigkeit synchronisiert ist, mit der die Außenfläche der Antriebswalze (18) angetrieben wird.

15. Vorrichtung nach Anspruch 13, **dadurch gekennzeichnet, dass** ein Motor (16) die Antriebswalze (18) antreibt und die Antriebswalze (18) bewirkt, dass sich die Plattform (32) mit einer anderen Geschwindigkeit bewegt als der Geschwindigkeit, mit der die Außenfläche der Kompressionswalze (56) angetrieben wird.

Revendications

1. Procédé pour façonner une matière polymère cellulaire (10) en découpant des parties (92) hors d'une surface de la matière, dans lequel on établit un espace prédéterminé entre un rouleau de compression (56) et une surface coopérante et on interpose une plate-forme structurée continue dans l'espace prédéterminé entre le rouleau de compression (56) et la surface coopérante, et dans lequel on introduit en continu une plaque (80) de la matière polymère cellulaire (10) à travers l'espace entre le rouleau de compression (56) et la surface coopérante de telle façon que la plaque (80) soit comprimée tandis qu'une surface de la plaque est adjacente à la plate-forme structurée continue en mouvement (32) et qu'une fraction de la partie de la matière polymère cellulaire soit découpée transversalement hors de la plaque (80) avec une lame (76) lorsque la plaque émerge hors de l'espace entre le rouleau de compression (56) et la surface coopérante, dans lequel on fait passer la plaque (80) à travers un espace qui se rétrécit progressivement, formé entre une courroie (310) et la plate-forme (32), avant qu'elle soit comprimée dans l'espace prédéterminé, **caractérisé en ce que** ladite courroie se déplace le long d'un chemin formant l'espace qui se rétrécit progressivement défini par le rouleau de compression (56), une série de rouleaux fous (304, 306) placés à des distances variables de la plate-forme (32) et un rouleau suiveur (308) positionné en amont de l'espace prédéterminé.

2. Procédé selon la revendication 1, **caractérisé en ce que** la courroie (310) est entraînée par le rouleau de compression (56).

3. Procédé selon la revendication 1 ou 2, **caractérisé en ce que** la plate-forme structurée en mouvement (32) définit au moins un creux (36).

4. Procédé selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** la plate-forme structurée en mouvement (32) définit au moins une saillie (320).

5. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la surface coopérante est un rouleau d'entraînement (18).

6. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** la plate-forme structurée (32) est une courroie souple sans fin.

7. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** le rouleau de compression (56) est entraîné et la plate-forme structurée continue en mouvement (32) est entraînée et **en ce que** le rouleau de compression (56) est entraîné à une vitesse superficielle différente de la vitesse à laquelle la plate-forme structurée continue en mouvement (32) est entraînée.

8. Appareil pour façonner une plaque (80) de matière

polymère cellulaire (10) en découpant des parties de matière (10) hors d'une surface extérieure de la plaque (80), dans lequel un rouleau de compression (56) peut tourner sur un axe et a sa surface extérieure (60) espacée d'une surface coopérante (46) pour définir un espace prédéterminé entre elles de telle façon que le rouleau (56) exerce une force de compression contre la plaque (80) de matière polymère cellulaire (10) lorsque ladite plaque (80) passe à travers ledit espace entre le rouleau de compression (56) et la surface coopérante, et comportant une plate-forme structurée continue en mouvement (32) interposée dans l'espace prédéterminé entre le rouleau de compression (56) et la surface coopérante (46) et mobile par rapport à ceux-ci, et comportant en outre une lame (76) pour découper la matière polymère cellulaire (10) lorsque la plaque (80) émerge hors de l'espace prédéterminé entre le rouleau de compression (56) et la surface coopérante (46), ladite lame (76) étant placée dans une position intimement adjacente et sensiblement tangente par rapport à la surface extérieure de la plate-forme structurée (32) afin de découper une partie de la matière polymère cellulaire (10) hors de la plaque (80), **caractérisé en ce que** l'appareil comprend en outre au moins un rouleau suiveur (308) positionné en amont de l'espace prédéterminé, une série de rouleaux fous placés à des distances variables de la plate-forme (32), une courroie (310) interposée entre le rouleau de compression (56) et la surface extérieure de la plate-forme structurée (32), la courroie (310) se déplaçant dans un espace qui se rétrécit progressivement selon un circuit défini par le rouleau de compression (56), le rouleau suiveur (308) et les rouleaux fous (304, 306) de telle façon que la plaque de matière polymère cellulaire (10) soit progressivement comprimée entre la courroie (310) et la plate-forme structurée en mouvement (32) avant de pénétrer dans l'espace prédéterminé.

9. Appareil selon la revendication 8, **caractérisé en ce que** la courroie (310) est entraînée par le rouleau de compression (56).

10. Appareil selon la revendication 8 ou 9, **caractérisé en ce que** la plate-forme structurée en mouvement (32) définit au moins un creux (36).

11. Appareil selon la revendication 8 ou 9, **caractérisé en ce que** la plate-forme structurée en mouvement (32) définit au moins une saillie (320).

12. Appareil selon l'une quelconque des revendications 8 à 11, **caractérisé en ce que** la plate-forme structurée (32) est une courroie souple sans fin.

13. Appareil selon l'une quelconque des revendications 8 à 12, **caractérisé en ce que** la surface coopérante est un rouleau d'entraînement (18).

14. Appareil selon la revendication 13, **caractérisé en ce qu'**un moteur (16) entraîne le rouleau d'entraînement (18) et **en ce que** le rouleau d'entraînement (18) entraîne la plate-forme (32) à se déplacer à une vitesse synchronisée avec la vitesse à laquelle la surface extérieure du rouleau d'entraînement (18) est entraînée.

15. Appareil selon la revendication 13, **caractérisé en ce qu'**un moteur (16) entraîne le rouleau d'entraînement (18) et **en ce que** le rouleau d'entraînement (18) amène la plate-forme (32) à se déplacer à une vitesse différente de la vitesse à laquelle la surface extérieure du rouleau de compression (56) est entraînée.

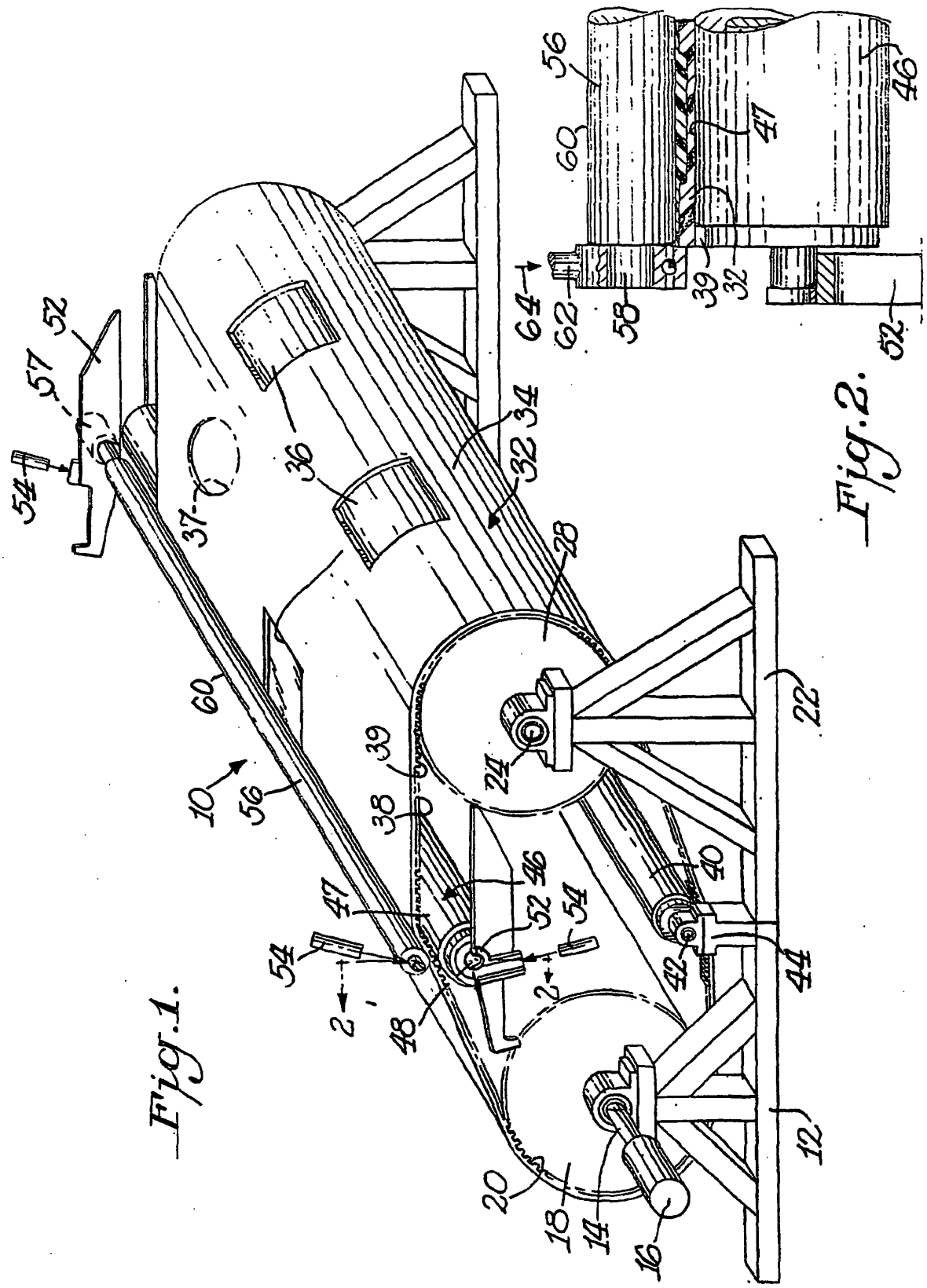

10
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36
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47
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54
56
57
60
2
2

Fig.1.

46
47
56
60
64
62
58
39
32
52

Fig.2.

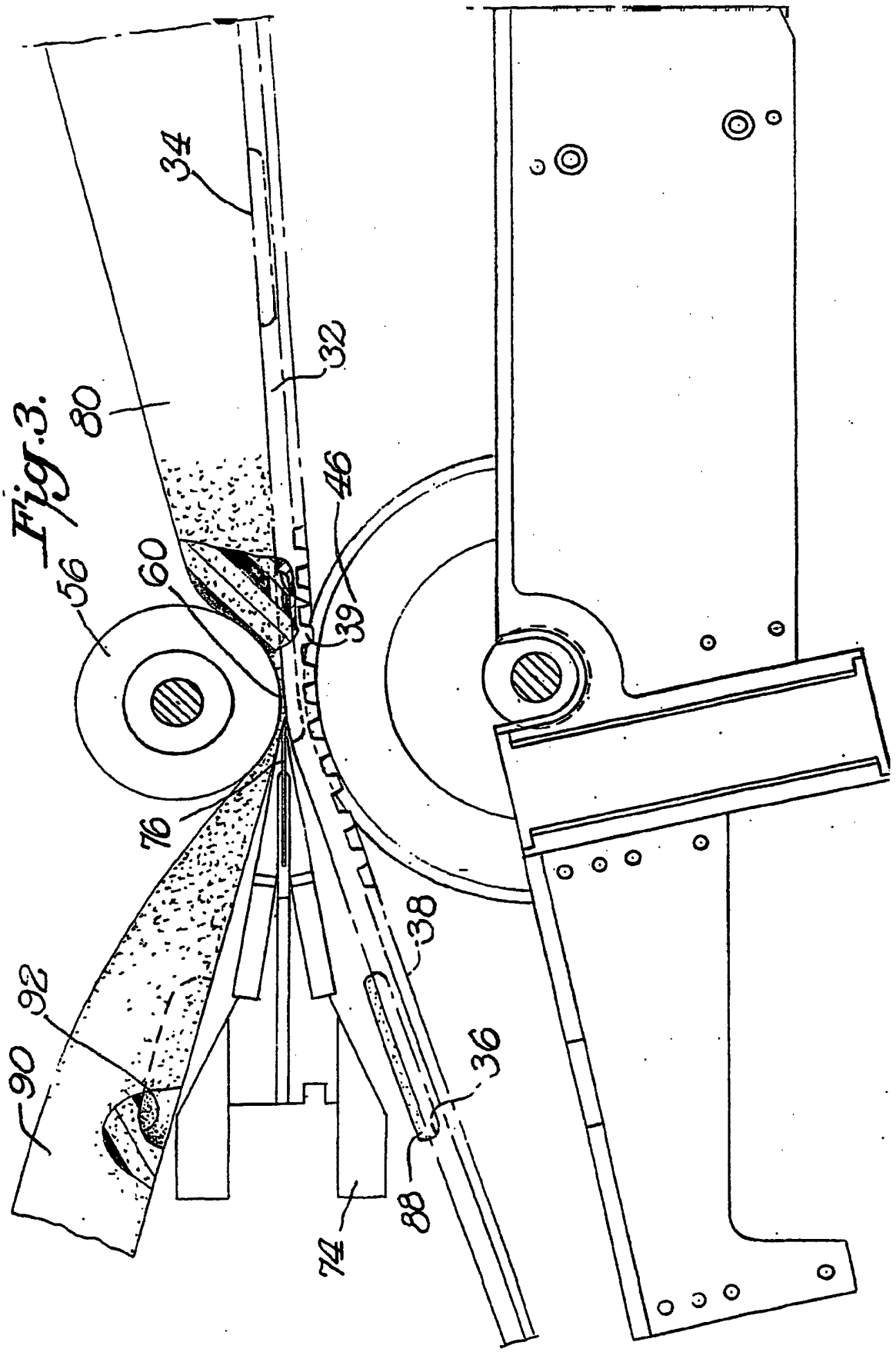


Fig.3.

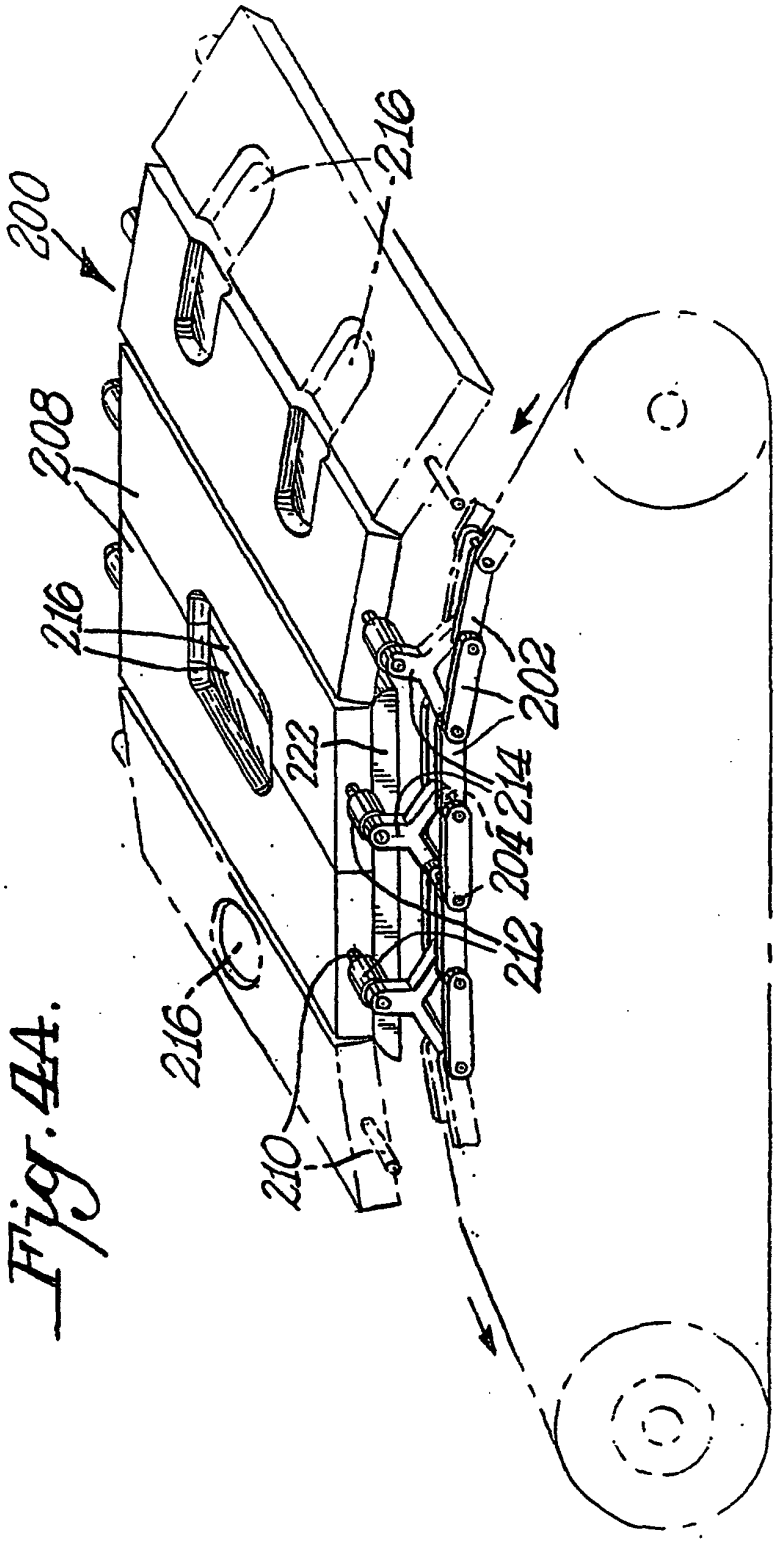


Fig. 4A.

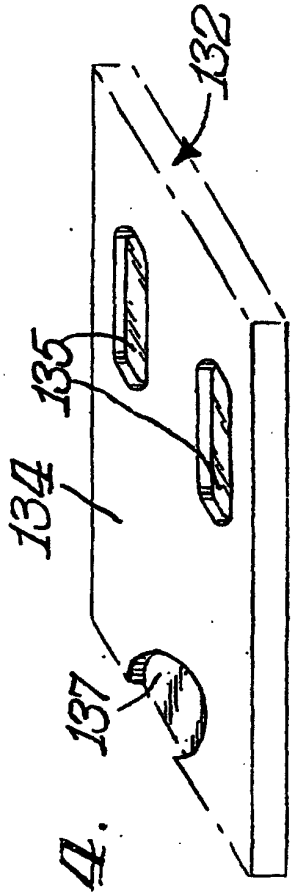


Fig. 4.

Fig.6.

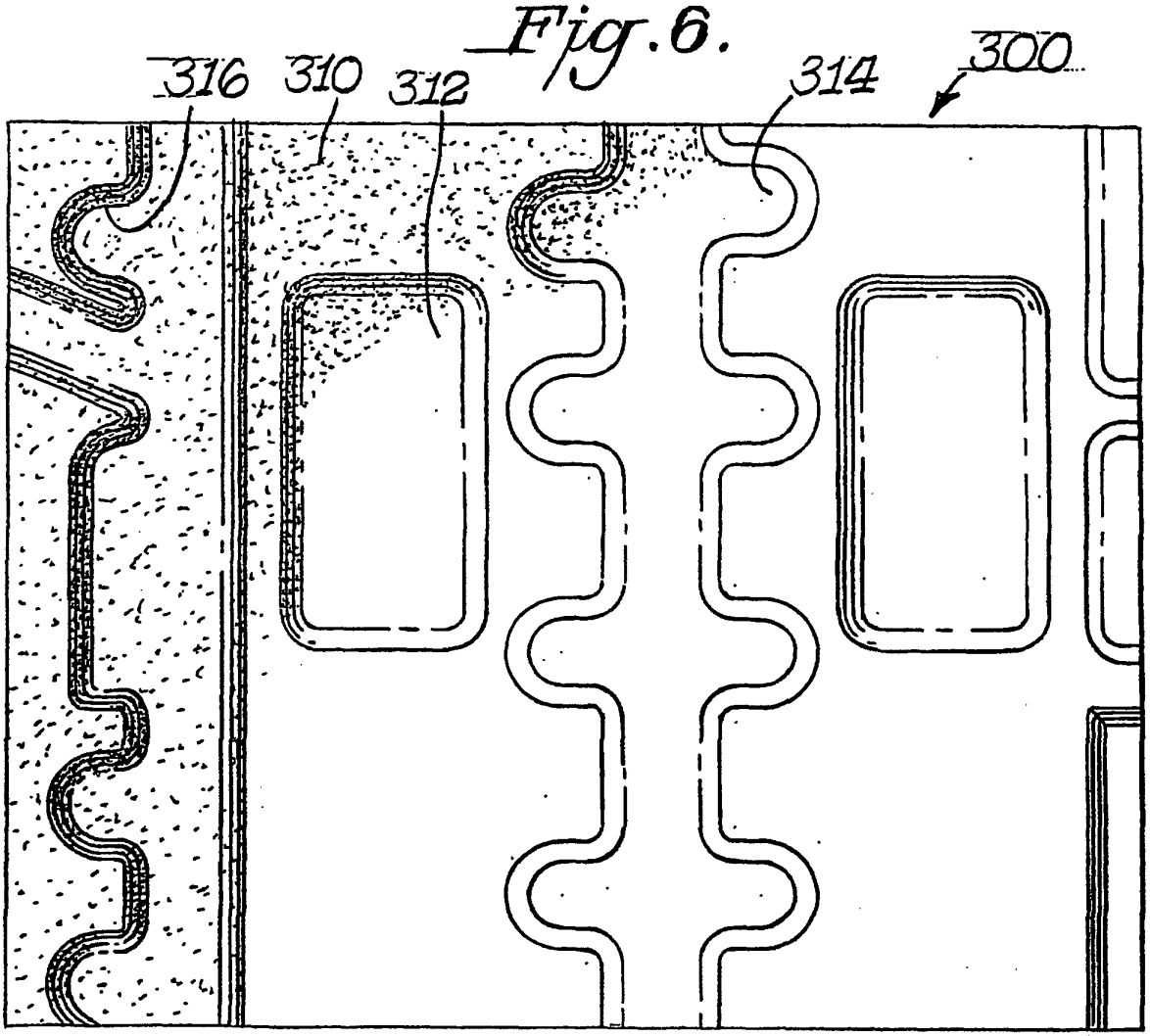


Fig.5.

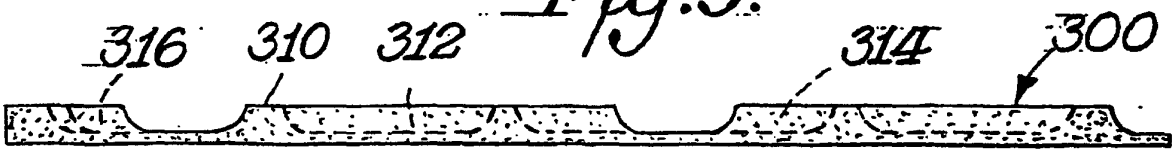
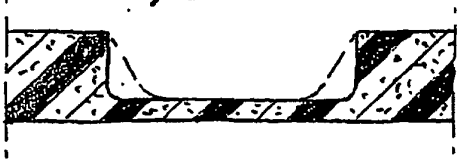


Fig.5A.



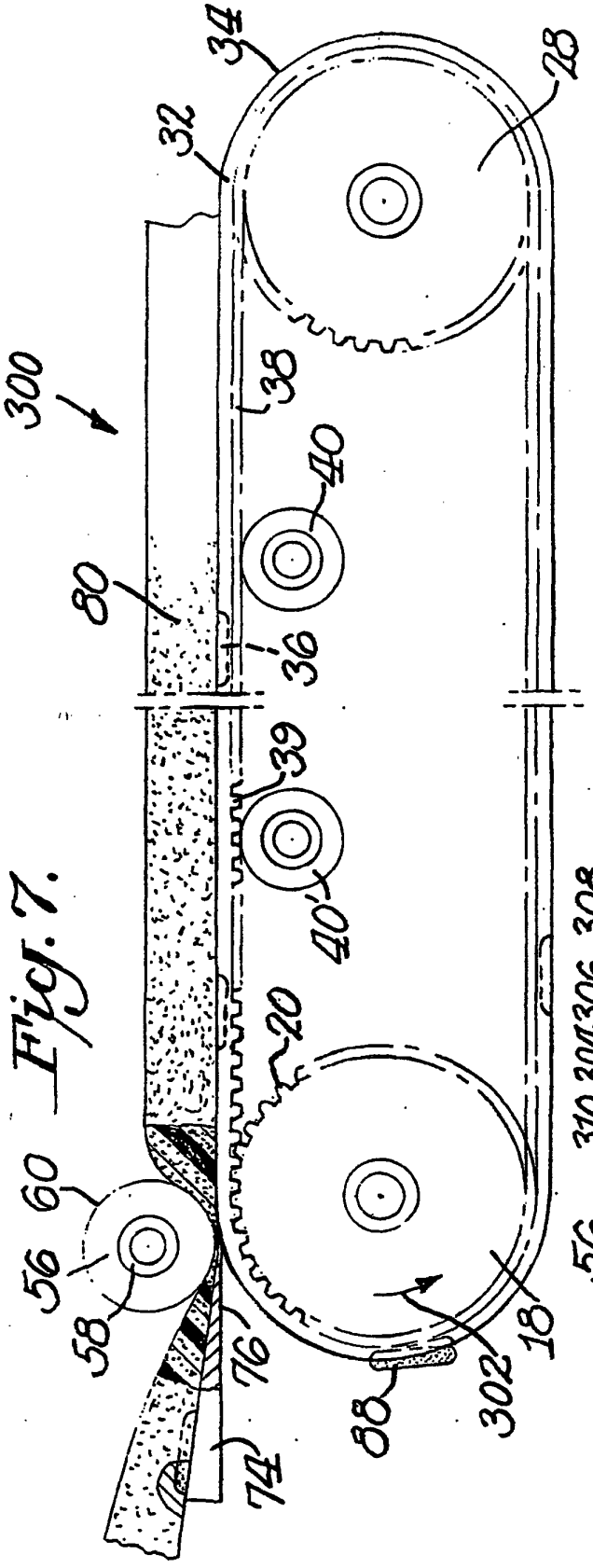

300
34
32
28
38
40
80
36
39
40'
20
56
60
58
76
74
88
302
18

Fig. 7.

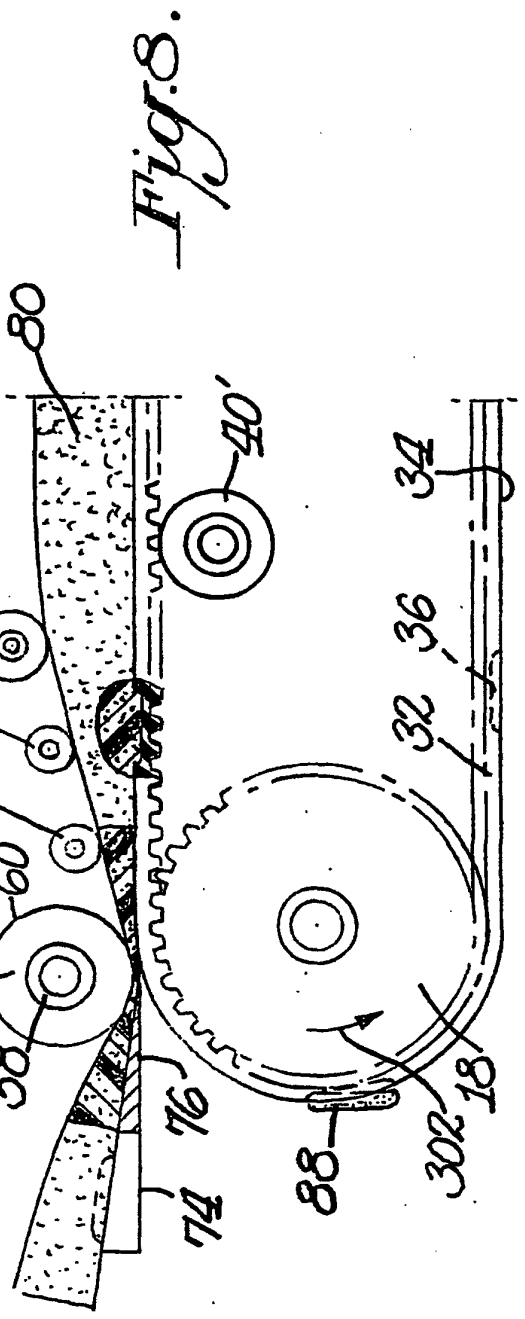

80
40'
34
36
308
306
304
310
32
60
56
58
76
74
88
302
18

Fig. 8.

Fig.9.

