United States Patent [19]

Stadler et al.

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[45] **Apr. 17, 1973**

[54] **JOINT FOR ENDLESS BELTS**

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[22] Filed: **Nov. 30, 1970**

[21] Appl. No.: **93,538**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 693,889, Dec. 27, 1967, abandoned.

[52] **U.S. Cl.** .....**425/471,** 74/231 J, 74/231 M

[51] **Int. Cl.** **B28b 1/00**

[58] **Field of Search** .....18/2 J, 5 A, 12 TB, 18/15 R, 15 F, 15 S, 6 E; 425/471; 74/231 J, 231 M, 232

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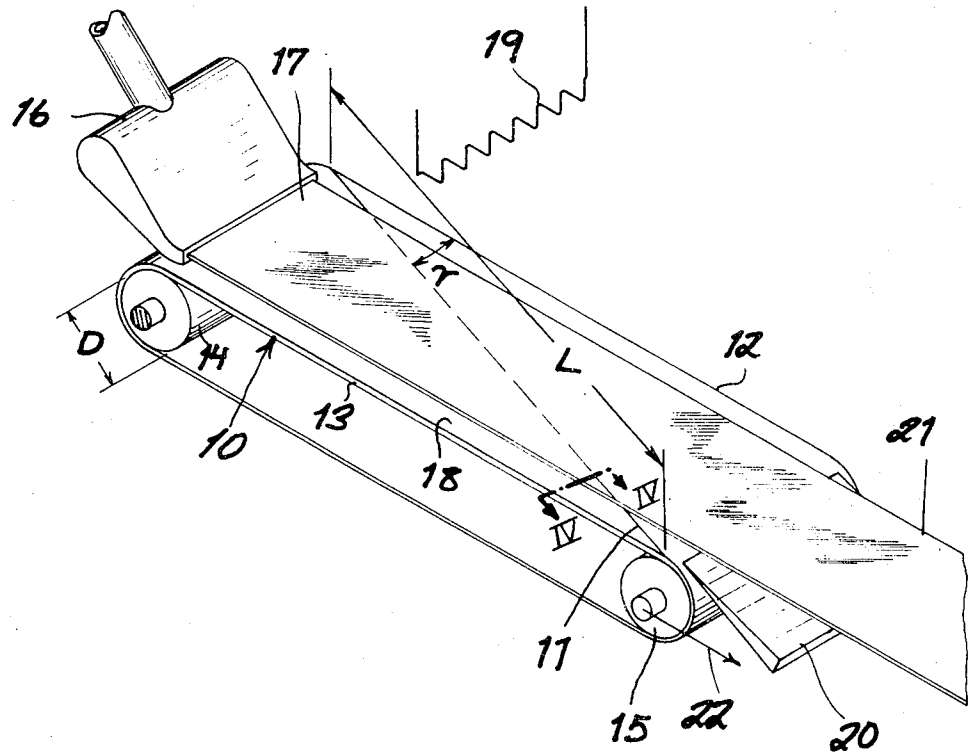
[57] **ABSTRACT**

A film-casting belt is composed of flexible metal of high hardness, especially stainless steel but possibly ordinary steel, copper and nickel, and has a thickness up to about 1 mm. The belt joint is made by butt-welding the ends of the band and a bias such that the weld seam runs at an angle to the direction of movement to the belt which ranges between 2° and 45° but preferably is between 2° and 15°. The weld seam is ground flush with the surface of the belt which has a tolerance ± 3 μ. The curvature of the band, which is maintained under tensions up to 200 tons, may be reversed to facilitate stripping of the synthetic-resin or cellulosic film from the surface.

6 Claims, 8 Drawing Figures



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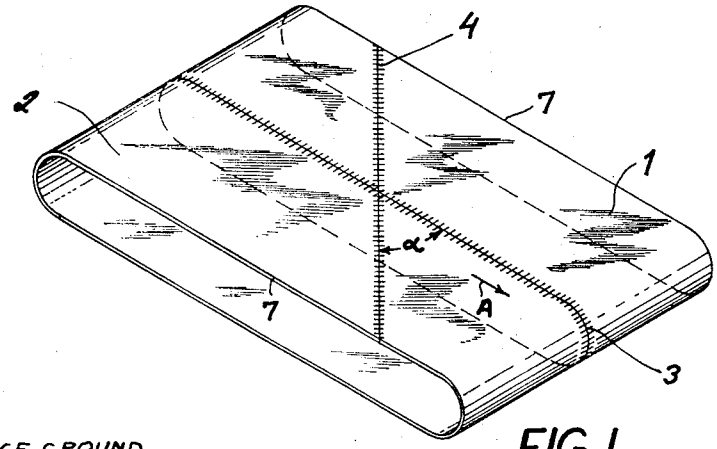

FIG. 1

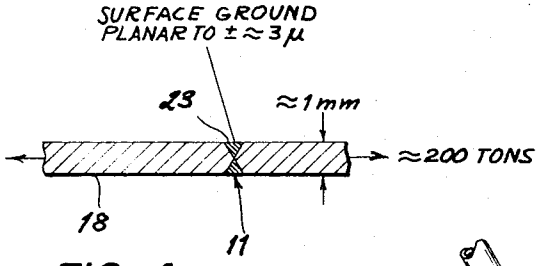

FIG. 4

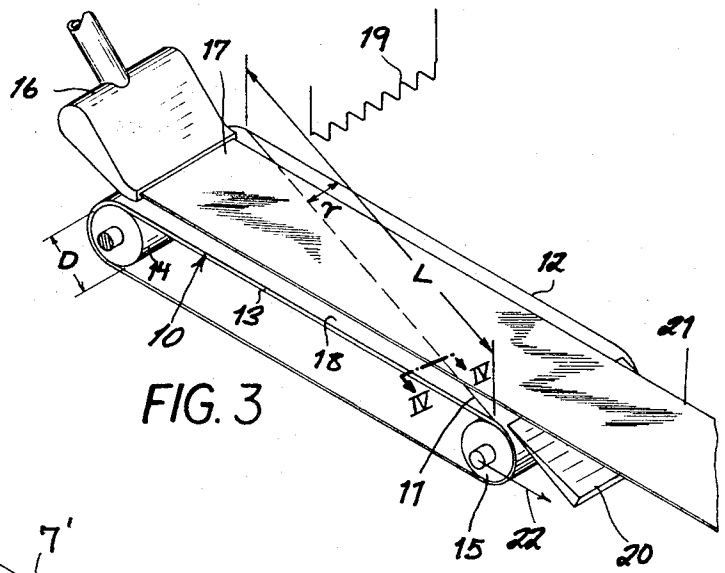

FIG. 3

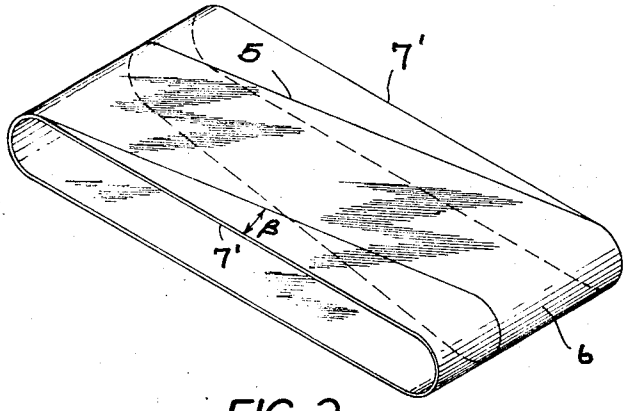

FIG. 2

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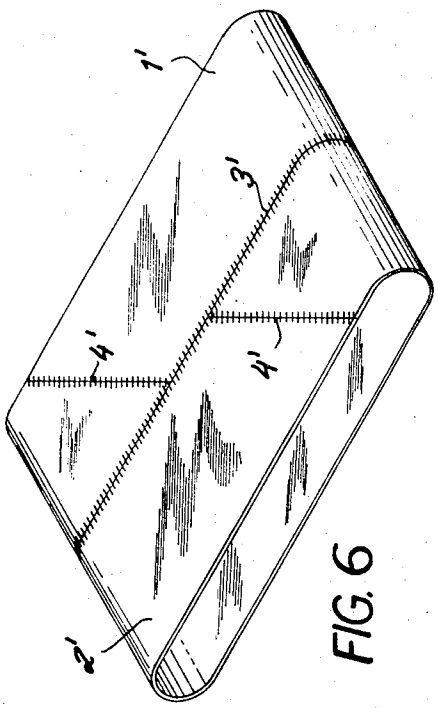

FIG. 6

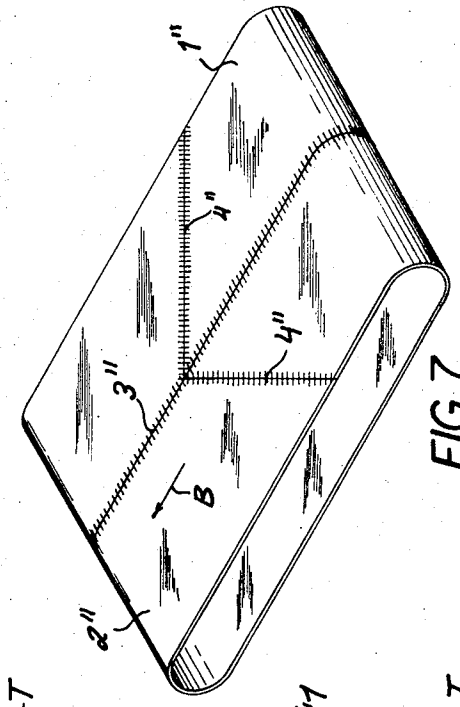

FIG. 7

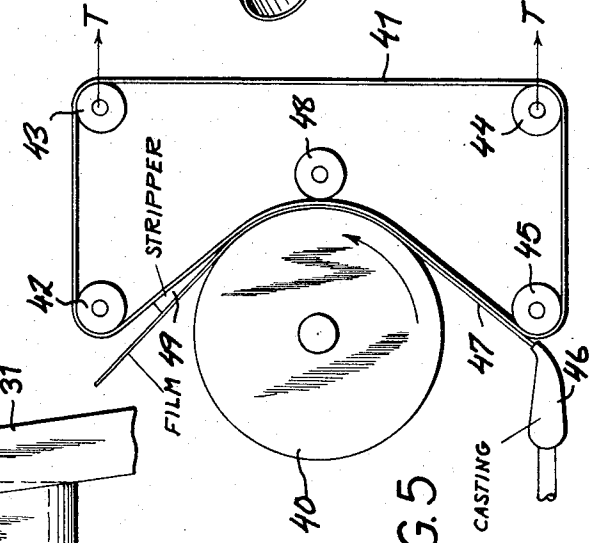

FIG. 5

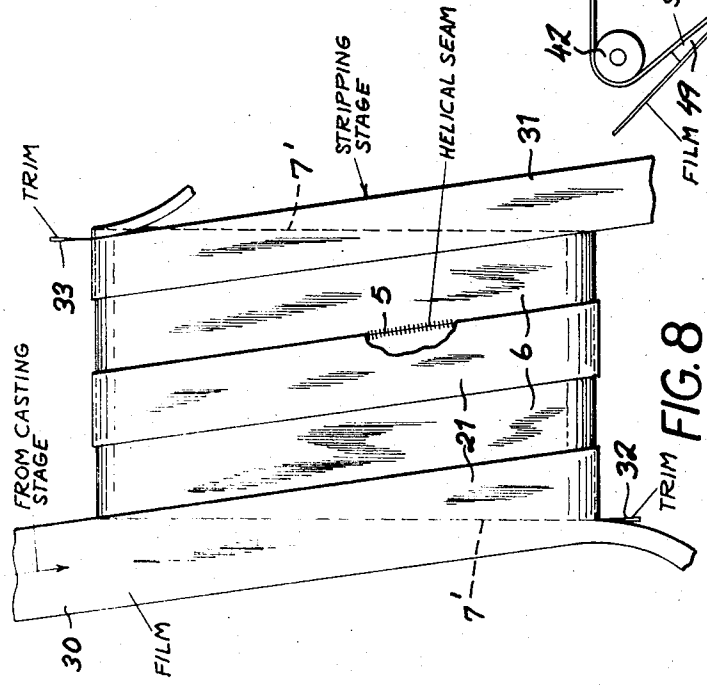

FIG. 8

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JOINT FOR ENDLESS BELTS

CROSS REFERENCE TO COPENDING APPLICATION

This application is a continuation-in-part of our application Ser. No. 693,889 filed 27 Dec. 1967 now abandoned and entitled "JOINT FOR ENDLESS BELTS".

FIELD OF THE INVENTION

Our present invention relates to a belt for the production of synthetic-resin and cellulosic film and, more particularly, to an endless belt provided with a seam for the casting of films; the invention also relates to a joint for such belts.

BACKGROUND OF THE INVENTION

In the formation of synthetic-resin or cellulosic films, it is common practice to spray or doctor the film-forming material onto a continually endless surface which carries the congealing film through a heating zone at which the solvent is dispelled and then into a stripping zone at which the film is removed from the surface.

Such belts are frequently constituted of metal and must have a hard, highly finished surface of limited dimensional tolerance. Since the belt must pass over rollers, it must be highly flexible and because any deformation of the belt will result in a corresponding defect in the film, the belt must be rigid during the casting and drying steps. Such rigidity is obtained by the application of high tension forces to the belt.

For the most part, such belts are formed by joining the ends of the belt in a carefully prepared lap weld running perpendicularly to the direction of movement of the belt. This has the disadvantage that the seam is a weak point and, indeed, prior-art belts tend to rupture at this seam. The problem is increased by the fact that, where the seam contacts the rollers, it is bent therealong and lies along a generatrix of the roller and is subjected to severe bending stress. When the band leaves the roller, it straightens, thereby bending the band at the weld seam in the opposite direction. Furthermore it may be desirable to reverse the curvature of the band to facilitate stripping as described below, whereupon an additional stress is provided. Hence the elevated tensile stress applied to the band to maintain its stiffness and the quality of its surface, the repeated bending stresses generated at the weld seam and the resulting material fatigue, cause failure of the belt, especially at the seam.

A further disadvantage, brought out in the aforedescribed copending application, is the fact that, when the seam lies perpendicular to the direction of movement of the belt, the entire seam passes at once beneath the pouring apparatus from which the film-forming material is dispensed. If a cavity is formed at the seam, e.g., by the grinding of the seam flush with the belt surface or by the tensile stresses applied at the seam, the gap between the receiving surface of the belt and the pouring apparatus will increase and the thickness of the film altered. This is, of course, a consequence of the fact that the entire seam is disposed beneath the pouring apparatus and lies along a generatrix of the support roller at once.

OBJECT OF THE INVENTION

It is the principal object of the present invention to provide a metal-foil belt for the casting of synthetic-resin and cellulosic film in which the aforementioned disadvantages are obviated.

Another object of the invention is to provide an improved joint structure for such belts.

It is also an object of our invention to provide a dimensionally stable belt for the casting of film which will yield a film of higher quality and will suffer less frequently from breakdown than theretofore.

SUMMARY OF THE INVENTION

We have now discovered, most surprisingly, that the aforementioned disadvantages can be eliminated and the listed objects gained by providing a film-casting belt which consists of metal, especially stainless steel, but possibly also ordinary steel, nickel or copper, having a seam extending generally oblique to the direction of movement of the belt, the seam being formed as a butt weld rather than as the lap-type weld current heretofore.

The important feature of the invention is that the metallic band has a thickness up to about 1 mm and that the butt-weld seam runs athwart the belt at an angle between 2° and 45° to the direction of movement of the belt. The angle of inclination of the seam is preferably 2° to 15° (to the longitudinal edge). The fact that the seam intersects the guide rollers to an angle to its generatrices insures that the stress applies only to limited regions of the seam at any time, whereby unstressed portions of the seam serve to support the stressed portions of the seam against breakage. Moreover, since only a limited portion of the seam is located in the pouring gap at any given moment, there is no sharp alteration in the gap width simultaneously across the entire length of the pouring gap and hence no material change in the thickness of the film which is obtained.

In the aforementioned copending application, we have pointed out that the prior-art drawbacks are avoided by providing connecting seams oblique with respect to the side edges. Such an arrangement enables only partial passage of the welding seam over the guide roller at a given moment so that only that part of the seam is subjected to extraordinary stress. Unevenness in the welding seam cannot have too disadvantageous an effect in this arrangement.

According to a more specific feature of the invention, the oblique weld seam may extend continuously across the entire transverse width of the belt. Alternatively, the belt may be built up of a plurality of laterally juxtaposed belt sections which are joined by a longitudinal seam, i.e. a seam extending in the direction of movement of the belt while the oblique seams of each section include angles of 10° to 45° with the longitudinal seam. In this embodiment, the oblique seams of the plurality belt sections preferably are aligned with one another, i.e. form a single continuous oblique seam. According to another embodiment of the invention, the belt is formed by winding a single band generally helically so that a correspondingly formed seam is produced, the seam having a pitch angle between about 2° and 8°.

In all cases, means may be provided for tensioning the band to about 200 tons and/or for inverting the curvature of the band to facilitate stripping of the film from the surface of the band. Since the oblique joint of the present invention has its specific importance in film-casting conveyors, the apparatus of the present invention is understood to include means for casting the film-forming material upon a surface of the belt and forming, therefore, a pouring gap therewith, means for vaporizing the solvent, and means for stripping the film from the belt upon vaporization of the solvent.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a diagrammatic perspective view showing a film-casting belt according to the present invention, made up of two belt sections in lateral juxtaposition;

FIG. 2 is a similar view of a belt formed by helical winding of a suitably shaped metal band;

FIG. 3 is a perspective view, also in diagrammatic form, of an apparatus for the casting of synthetic resin film;

FIG. 4 is a cross-sectional view taken along the line IV — IV of FIG. 3;

FIG. 5 is an end view illustrating the inversion of the curvature of the band for stripping the film thereof;

FIGS. 6 and 7 are views similar to FIG. 1 illustrating other arrangements of the oblique seam; and

FIG. 8 is an elevational view showing the utilization of the band of FIG. 2 in a film-forming apparatus.

SPECIFIC DESCRIPTION

In FIG. 1, we have shown a metal film-casting conveyor of double breadth made up of two strips of normal breadth which have been welded together laterally along their longitudinal edges in the direction of movement of the conveyor via the weld seam 3. The outer edges 7 thus constitute the longitudinal edges of the double-breadth belt produced from the two sections 1 and 2 and lie in planes perpendicular to the casting surface. The sections 1 and 2 are individually joined into endless bands by oblique seams 4 which include an angle α in the direction of advance of the belt (arrow A) ranging between 10° and 45° and preferably between 10° and 20°. In this embodiment, the oblique weld seams 4 are aligned with one another and are butt-welds as described below in connection with FIG. 4.

In the embodiment of FIG. 2, the oblique seam has been lengthened by decreasing the angle so that, for example, the angle β ranges between 2° and 8°. In this case, a central seam can be eliminated and the oblique seam formed as a helix. The band between the longitudinal edges 7' has a width greater than the width of the band from which it is formed. While only somewhat more than a single complete turn of the helix is provided in this embodiment, the band may be made up of any number of such turns or turn fractions. The result is a screw-type joint which practically functions as a longitudinal seam but serves as well to join the band in an endless configuration (see FIG. 8).

As represented in FIG. 3, only a single band section 10 need be provided and its oblique seam 11 may include an angle γ of, say, 10° with the longitudinal edges 12 and 13 of the band. The total length L of the oblique seam may be less than the length of the longitudinal edge 7. L is greater than the length of the longitudinal edge 7' in FIG. 2. L in FIG. 3 is shown to be greater than the circumference C of the guide rollers 14 and 15 over which the belt passes. The guide rollers have a diameter D so that the circumference $C = \pi D$. In FIG. 3, moreover, we show a casting nozzle 16 from which a band of film-forming synthetic resin or cellulosic material is deposited at 17 upon the surface 18 of the belt 10 for vaporization of a solvent by heating in the subsequent stretch. The heating means is represented at 19 in FIG. 3.

Beyond the heating means, a stripper 20 removes the finished film 21, preferably at a point of direction change of the belt 10 to facilitate such removal. Arrow 22 represents the tension applied to the belt which may be of 200 tons, for example. The weld seam 11 is shown in cross section in FIG. 4 from which it can be observed that the seam is a butt weld with beads of weldment 23 introduced between the edges of the belt and ground flush with the surface 18 thereof so that the surface tolerance is $\pm 3\mu$. The thickness of the metal belt is approximately 1mm and the belt is preferably composed of stainless steel. Advantageously, prior to grinding, the weld is compacted by cold or hot rolling or hammering, thereby densifying the weldment. In fact, when the surface is hammered or rolled smooth, grinding may be omitted. In addition, we must point out that the term "welding" as used herein is intended to include "soldering" in which the bead is formed by low-melting solder.

In FIG. 8, we show the use of the band of FIG. 2 in a film-forming apparatus in which it is assumed that the film has initially been produced elsewhere and is fed at 30 to the belt 6 whose helical seam 5 has a pitch angle β of 2° to 8° as previously noted. The film 30 is fed at this pitch angle and in the same pitch sense as shown in FIG. 8 so that, whenever the helical seam meets the band, it will coincide with the junction between turns of the helical strip, the latter being fed from the apparatus at 31. While the film is drying on the heated metal belt, it may be trimmed by blades 32 and 33 at the longitudinal edges 7' of the belt.

In FIG. 5, we have shown an arrangement in which a heated drum 40 or guide roller is subtended by an endless metal belt 41 which has a helical seam over a length greater than the arc length of the band in contact with the heated drum or roller 40, the latter being at a temperature of 200°C. The belt passes about idler and drive rollers 42, 43, 44 and 45, the rollers 43 and 44 being tensioned at T to apply a tensile stress of 200 tons to the belt. At the roller 45, the film is cast onto the belt 41 via a nozzle arrangement 46, the film 47 moving on the belt to contact the roller 40 for drive thereon. A pressure roller 48 may serve to calibrate the thickness of the film. The film is stripped at 49 upon its emergence from the gap between the belt and the roller 40 and as the belt 41 is deflected about the roller 42 to invert its curvature.

FIGS. 6 and 7, show that the seams 4' of the two-section belt 1', 2', joined by the longitudinal seam 3', can

be parallel to one another but staggered in the direction of movement of the belt. In the modification of FIG. 7, the oblique seams 4'' converge toward one another in the direction of belt movement (arrow B) and terminate at a common vortex of longitudinal seam 3'' of the sections 1'' and 2''. In the systems of FIGS. 5–8, of course, the seam has the same construction as already described for FIG. 4.

We claim:

1. A belt or the formation of a film strip from a film-forming material, comprising a metal-foil band having complementary edges joined together in a butt seam with metal bonding flush with the surfaces of the belt, said band being of generally flat configuration with longitudinal edges lying in planes perpendicular to the band surface, said seam extending athwart said band between said edges and obliquely thereto while including with at least one of said longitudinal edges in the direction of movement of the band, an angle ranging between 2° and 45°, said band being composed of steel, copper or nickel and having a thickness of the order of 1mm while being guided over at least two spaced-apart guide rollers, said seam having a length exceeding the circumference of said guide rollers.

2. The belt defined in claim 1 wherein said seam extends helically through at least one complete turn with a pitch angle of substantially 2° to 8°.

3. The belt defined in claim 1 wherein said band is composed of a plurality of metal-foil loops joined by such seams in endless relationship, further comprising a central longitudinal weld seam securing juxtaposed longitudinal edges of said loops together.

4. The belt defined in claim 3 wherein said oblique seams are aligned with one another.

5. The belt defined in claim 3 wherein said oblique seams are offset from one another.

6. The belt defined in claim 3 wherein said oblique seams converge toward one another in the direction of said longitudinal seam.

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