APPARATUS FOR THE CONTINUOUS TREATMENT OF SHEET MATERIAL

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ABSTRACT

Apparatus for supporting and continuously transporting a sheet material, e.g., in the treatment of endless films or foils of a thermoplastic polymer, including a plurality of aligned rolls or drums having rectangular grooves adjacent their outer edges which receive two pairs of sheet clamping belts, each individual belt extending in a continuous loop path under tension and only one belt of each pair riding flush within the rectangular grooves to hold the sheet material firmly in its transported position on the rolls and between adjacent rolls.

3 Claims, 2 Drawing Figures
APPARATUS FOR THE CONTINUOUS TREATMENT OF SHEET MATERIAL

This invention is generally directed to an apparatus or device designed for the continuous treatment of sheet materials, especially thermoplastic films or foils, wherein the sheet material is transported on rotating rolls or drums and wherein some provision must be made to tightly hold the sheet material on the edges or rims of the rolls and thereby tightly press the entire sheet material onto a portion of the outer circumferential surface of each roll. This type of apparatus is generally applicable to the continuous treatment of all types of sheet materials, including fabrics, paper, fleeces or similar porous non-woven webs, thermoplastic or elastomeric films or sheets and the like. Thus, it is often necessary to subject a sheet material to various continuous operations including forming, coating, laminating, embossing or the like, in such a manner that the relatively thin and flexible sheet material being treated during its continuous transport is not warped, shrunk or otherwise distorted.

One device is already known in which the edges of the sheet material are pressed by cables or cords against a roll provided with circumferential grooves, for example, to prevent a shrinkage of the sheet material on the roll. The proposed construction for this apparatus, however, is very expensive and also always brings about a distortion of the edges of the sheet material. In another known device, the edges of the sheet material are punctured by needles arranged around the outer circumference of the roll. The sheet material is thereby severely damaged along its edges, and the danger exists that cuts or tears will form which will then extend into the center or middle portion of the sheet material.

One object of the present invention is to provide a very simply and economically constructed apparatus including transport rolls which can be used for the continuous treatment of sheet materials without influencing the essential appearance and quality of such sheet materials. Another object of the invention is to provide a sheet transporting apparatus in which the sheet material can be very firmly clamped in a non-distorted manner while being carried around a portion of the circumference of a number of adjacent rolls or drums. Still another object of the invention is to provide apparatus of the type described in which a wide variety of sheet materials, but especially sensitive thermoplastic films or foils, can be rapidly and easily handled without damage to the sheet material. These and other objects and advantages of the invention will become more apparent upon consideration of the following detailed disclosure.

It has now been found, in accordance with the invention, that the foregoing objects can be achieved with an apparatus for the continuous treatment of a sheet material which includes a plurality of rotatably mounted cylindrical rolls aligned sequentially on parallel axes of rotation, each roll containing in alignment along each of its outer edges a circumferential groove of approximately rectangular cross-section, two pairs of flat belts, each of which is arranged to ride in the aligned grooves while partially encircling each successive roll in opposite directions of rotation, the individual belts of each pair being placed in parallel facing contact to hold the sheet material being transported therebetween and only one of said individual belts being received within each of said aligned grooves such that the contacting faces of the individual belts are substantially level with the outer circumferential surfaces of the rolls, means to guide each individual belt in a continuous loop from the last of the partially encircled rolls to the first roll, said guide means including at least one tensioning roller to maintain the individual belts of each pair in tightly clamped relationship. One embodiment of the invention is illustrated in the accompanying drawing in which:

FIG. 1 is partly schematic side elevational view with certain elements shown partially in cross-section, in order to illustrate the assembly of two individual belts as they are paired in riding contact with the circumferential grooves of the transporting rolls or drums; and FIG. 2 is a longitudinal section along the axis of rotation of one of the cylindrical rolls or drums shown in FIG. 1.

Referring to both FIGS. 1 and 2, each individual roll or drum 1 is substantially identical in its construction and is rotatably mounted by means of an axle or hub 1a, so that at least one of the rolls can be positively driven by any suitable drive means such as a motor and drive belt 1b. All of the rolls or drums 1 revolve at the same rate, and although it would be feasible for the special transporting belt pairs of the invention to be used for rotation of the rolls, this would tend to interfere with their function of transporting the sheet material, so that it is especially preferred to positively drive at least one of the rolls 1 by an external means 1h at a predetermined speed of revolution. The individual belts 2 and 3 of each pair of transporting belts lie in facing contact one above the other as they pass around each succeeding roll 1 in such a manner that the rolls rotate alternately in opposite directions. The particular sheet material 4, e.g., a thermoplastic film, is received from any suitable feed source such as the supporting shelf or platform 11, a suitable pair of feed rolls or the like. This sheet material 4 is then drawn between the oppositely facing belts of an individual pair of belts 2 and 3 along or adjacent to the two edges or rims of the first roll arranged in sequence on their parallel axes of rotation.

As shown more clearly in FIG. 2, one of the individual belts 3 is received in the circumferential rectangular groove 10 near the outer edge of each end of the roll 1 so as to be flush or on a level with the outer circumferential surface of the roll 1. The sheet material 4 is then clamped between this lower groove-contacting belt 3 and the upper facing belt 2 which remains in close clamping relationship with the lower belt. In passing from one drum or roll to the next, the upper belt 2 becomes the lower belt and is received in the correspondingly aligned rectangular grooves of the next roll. In each case, however, it is essential that the facing surfaces of the two individual belts in each pair are level with the outer circumferential surface of the roll 1.

Each individual belt 2 and 3 is directed in a continuous loop path so as to return from the last roll in the direction of transport back to the first roll, the individual looped belts being suitably guided by means of a number of guide rollers 5. There should also be provided at least one tensioning roller 6 in each continuous
loop path of an individual belt 2 or 3 so that the individual belts will be tightly clamped together on either side of the sheet material 4 as these belts are conducted with the sheet material around the sequentially arranged rolls 1. The amount of tension must be sufficient to seat each individual belt in its corresponding circumferential groove on the various rolls, i.e., so that its flush relationship with the outer circumference of the roll is fully maintained throughout the entire operation.

Each of the individual rolls 1 can be provided with an internal heating means 7, using any conventional heating device such as electrical resistance heating, steam heating or the like. Various heating assemblies for the internal heating of a transporting roll are quite well known in this art. In addition to or in place of such internal heating, it is also possible to arrange suitable infrared radiators 8 or similar heating devices above or below the individual rolls 1 so that heat is directed onto the transported sheet, film or the like. As the sheet material 4 is discharged at the exit end of the apparatus, it is also possible to arrange a conventional cooling roller 9 in order to lead the sheet material from the heated apparatus into subsequent operations or onto a take-up reel where the sheet material is finally collected.

With the apparatus according to the invention, the sheet material is essentially conducted and carried along between both circulating pairs of flat belts and is tightly pressed by these belt pairs onto the circumferential outer surface of each rotating roll or drum, i.e., so as to alternately apply one side or face of the sheet material and then the other side or face to a revolving roll or drum surface. This provides a very uniform and controlled treatment of the sheet material, for example where it is desirable to subject a film or foil to a heat sealing treatment or for the purpose of adhering combination films or foils together into a laminated or multi-layer film. These and similar heating treatments are easily accomplished with special embodiments of the invention in which heating means are readily combined with the rolls to supply heat onto at least one of the cylindrical roll surfaces, either from an internal or an external source.

The breadth or axial length of the individual rolls is generally about 500 to 3,000 mm. with a diameter amounting to about 150 to 400 mm. in order to handle films or foils having approximately the same breadth as the rolls. Depending upon the particular sheet material and the required treatment, the rolls are usually rotated at a circumferential velocity of about 2 to 100 meters/minute.

The grooved openings for each pair of flat belts are preferably located at an interval of about 25 to 100 mm. inwardly from the edges or rims of the rolls and generally so as to receive and press the sheet material fairly close to its outer edges. The base portion of the groove 10 as shown in FIG. 2 is preferably flat to exactly receive one of the individual flat rectangular belts. It is feasible, however, to slightly profile this base portion to receive a correspondingly profiled belt, i.e., where each individual belt may have its side facing away from the sheet material slightly profiled in order to be easily centered as it rides in the groove, i.e., in cooperation with the sides of the approximately rectangular groove.

In order to achieve an especially good pressure of the sheet material onto the rollers and to avoid any possible displacement of the sheet, it is quite advantageous in a special embodiment of the invention to emboss or roughen the individual belt surfaces which face the sheet material, i.e., so as to make them slip-resistant, for example by providing them with a large number of shallow burls or grooves. This slightly roughened surface of the facing sides of the belts permits a very firm grip even on smooth or glossy sheet materials without causing any significant damage or distortion along the edges of the sheet.

The individual rolls are normally provided with a smooth outer surface, but is also feasible for certain processing operations, e.g., for stamping or embossing the sheet material itself, to employ a correspondingly embossed outer cylindrical surface on the roll.

The apparatus according to the invention must have at least two of the rolls or drums as described and illustrated herein. In the most usual operations, three rolls are sufficient to provide an adequate treatment of an endless or continuous sheet material, but in some operations it may be desirable to provide four, five or even more rolls which are aligned sequentially in the same manner as illustrated in FIG. 1, i.e., so as to alternately rotate in opposite directions. This of course requires a corresponding increase in the number of guide rollers and/or tensioning rollers as well as an enlarged continuous loop path for each of the individual flat belts. The axes of rotation of the rolls can lie in the same plane as shown in FIG. 1 or may also be arranged alternately above and below a common plane in parallel relationship.

The individual flat belts are conducted in the return loop from the last to the first roll by a minimum of three guide rollers, at least one of which serves as a tensioning roller to hold each belt under a certain tension such that both flat belts positioned opposite each other as a pair of belts riding in the grooved rolls are pressed tightly together. The tensioning rollers can be constructed in a conventional manner, e.g., so as to be spring-loaded or weighted to provide a predetermined and preferably an adjustable tension.

The width of each individual flat belt preferably amounts to about 10 to 40 mm., depending upon the dimensions of the sheet material and also the supporting rolls. The rectangular grooves on the circumference of the rolls are preferably carefully fitted to the width of the belts, i.e., with a close tolerance so that the sheet material lies on an unbroken surface as it spans one of the belts riding in a groove. If desired, the width of the groove can be made adjustable by providing an outer annular ring with an outer diameter corresponding to that required for the roll and an inner diameter corresponding to the depth of the groove, and this annular ring can be partially threaded or otherwise moved axially into a fixed position on a slightly modified roll wherein both ends carry a cylindrical projection of reduced diameter as indicated by the dotted lines 12 in FIG. 2.

The apparatus of the invention is not only readily combined with external heating means such as infrared radiating devices to apply heat to the sheet material in its path around the rolls, but it is also easily combined with other auxiliary apparatus such as spray devices or other coating or wetting devices, embossing or stamp-
ing rolls, cooling apparatus and the like. Thus, the cooling roller at the point where the sheet material is withdrawn from the last roll and released by the belt pairs is useful for cooling a heated film or foil back to room temperature. These and other variations or combinations using the apparatus of the invention will be readily suggested to those skilled in this art.

The apparatus of the invention is especially advantageous in that it is very economically constructed and can be widely used with easily manipulated continuous processing operations for subjecting an endless single or multiple layer sheet material to embossing, heat-sealing, shaping, coating, laminating or the like. At the same time, the sheet material is not perforated, distorted, torn or in any way damaged along its edges or in its central portion during these operations. Also, undesirable contraction or shrinkage of the sheet material is avoided, especially when handling relatively heat-sensitive thermoplastic films or foils. Such results are achieved even though the sheet material is transferred from roll to roll by the two pairs of belts carrying the sheet material clamped therebetween.

The invention is hereby claimed as follows:

1. Apparatus for supporting and continuously transporting a sheet material which comprises:
   a plurality of rotatably mounted cylindrical rolls
   aligned sequentially on parallel axes of rotation,
   each roll containing in alignment along each of its outer edges a circumferential groove of approxi-
   mately rectangular cross-section;
two pairs of flat belts, each of which is arranged to ride in the aligned grooves while partially encircling each successive roll in opposite directions of rotation, the individual belts of each pair being placed in parallel facing contact one above the other on each groove to hold the sheet material being transported therebetween and only one of said individual belts being received within each of said aligned grooves such that the mutually contacting faces of the individual belts are substantially level with the circumferential sheet carrying surfaces of the rolls to firmly hold said sheet material transversely between said two pairs of belts in tightly clamped contact against said circumferential surfaces of the cylindrical rolls;
means to guide each individual belt in a continuous loop from the last of the partially encircled rolls to the first roll, said guide means including at least one tensioning roller to maintain the individual belts of each pair in tightly clamped relationship.

2. Apparatus as claimed in claim 1 including means to supply heat onto at least one of the cylindrical roll surfaces.

3. Apparatus as claimed in claim 1 wherein the facing surfaces of the individual belts are embossed to provide a firm grip on sheet material being transported therebetween.

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