This invention relates to a sealing device and more particularly to a sealing device which permits material to be continuously conveyed without leakage between adjacent regions characterized by a pressure differential.

In the processing of textile material, particularly filamentary material formed from a synthetic composition such as an acrylonitrile polymer or the like, it is often highly desirable to subject the material to fluid treatment under pressurized conditions. For instance, in the processing of "wet spun" filamentary acrylic material, a heat-relaxing or "annealing" operation is generally performed on the material preferably while it is in the form of an elongated rope or tow. As is well known, this annealing operation relieves the molecular strains in the filaments which have been introduced therein by such a filament straining operation as stretching and the like, necessary for imparting sufficient tensile strength to the filaments to render them suitable for textile end uses. Unless these molecular strains are relieved, the acrylic filaments are prone to "fibrillate" or split off into "fibrils" when subjected to abrasion and in fabric form these "fibrils" cause the fabric to assume a light color at the point of abrasion, giving the illusion of wear.

In one arrangement for carrying out such an annealing treatment, a bath-type operation is employed in which the material is loaded into autoclaves or similar pressure vessels wherein it is subjected to a pressurized heating medium such as steam for an extended period of time while in a relaxed condition. It can be understood that such a bath-type annealing operation is time consuming and is generally expensive both from the standpoint of time and labor expended as well as the initial investment in the bulky apparatus required. As such filamentary material is generally spun in continuous rope or tow form, it lends itself readily to a continuous type of annealing operation. However, conveying the tow continuously between a high pressure region such as required for carrying out the annealing treatment and a region of low or atmospheric pressure presents serious problems in equipment design. With the relatively high steam temperatures and pressures required in the annealing operation, steam leakage from the high pressure region at the point in the wall of a pressurized chamber through which the tow is passing has been extremely difficult, if not impossible, to prevent. Even with the use of available steam sealing devices, leakage often occurs to an undesirable extent. Furthermore, prior sealing devices have been subject to rapid deterioration and frequent breakdown increasing the maintenance and operating costs to an unreasonable extent.

Accordingly, a primary object of this invention is to provide a new and novel device for eliminating leakage from a pressurized region through which continuously moving material is conveyed.

Another object of this invention is to provide a new and novel sealing device for eliminating leakage from a pressurized chamber in the interior of which an annealing operation is to be carried out on a continuously moving tow of synthetic material.

A further object of this invention is to provide a new and novel sealing device which permits the movement of a filamentary tow composed of synthetic material such as that formed from acrylonitrile polymers or the like through a pressurized region with substantially no attendant decrease in its pressure level.

This invention further contemplates the provision of a new and novel apparatus for continuously moving a filamentary tow through a pressurized chamber with virtually no reduction in chamber pressure due to leakage at the points of entrance and exit.

A still further object of this invention is to provide a new and novel sealing device which may be positioned adjacent the material entrance or exit openings in the wall of a pressurized chamber and which responds to the pressure in the chamber by moving into pressure sealing engagement with continuously moving belts between which a tow of synthetic filamentary material is sandwiched to prevent leakage through the wall openings from said chamber.

A still further object of this invention is to provide a new and novel pressure sealing device which is simple in construction, inexpensive to manufacture, and which gives uninterrupted service over extended periods of time without the danger of breakdown.

Other objects and advantages of the invention will become apparent from the following description taken in connection with the accompanying drawings.

In general, the objects of the invention are accomplished by providing a sealing device comprising a pair of sealing members which are arranged to be positioned within a region of high pressure such as the interior of a pressurized chamber, vessel, or the like. Means are also provided for supporting the sealing members in their passage forming relationship on the inner surface of a wall defining the high pressure region or chamber with the passage communicating with a material-admitting opening in the wall whereby a pressure differential is produced between the passage and the high pressure region. During the movement of the tow, the passage of the sealing members yieldingly opens against the pressure in said high pressure region and intimately engages the tow passing therethrough so that leakage of pressure from the high pressure region through the passage and wall opening is substantially eliminated.

The novel features which are believed to be characteristic of the invention are set forth with particularity in the appended claim. The invention itself, however, both as to its organization and method of operation, may be best understood by reference to the following description taken in conjunction with the accompanying drawings:

Figure 1 is a side view, partially in section, of material advancing apparatus with which the invention is incorporated;

Figure 2 is an exploded perspective view of a portion of the supporting means incorporated in the invention;

Figure 3 is an enlarged end view of the invention in its operating position; and

Figure 4 is a plan view of the device of Figure 3.

Referring now to Figure 1, there is shown a pressure sealing device constructed in accordance with the invention and designated generally by the numeral 11. Although this device 11 is readily adaptable for handling material of any desired type, it is particularly adaptable for use with a filamentary material of synthetic material such as that formed from acrylonitrile polymers or the like.

As generally illustrative of the invention, the sealing device 11 is used in conveying tow 12 between a region...
of low or atmospheric pressure designated generally by the numeral 13, and a high pressure region designated generally by the numeral 14. In the specific embodiment illustrated, the region 14 is preferably the interior of a pressure chamber or vessel (not shown) having a wall, a portion of which has been designated by the numeral 16. This chamber is of a type which may be conveniently used to carry out an "annealing" operation on synthetic filamentary material such as "spun" acrylic tow in a manner to be explained hereinafter. An example of an annealing chamber with which the sealing device of the invention may be satisfactorily employed is disclosed and claimed in the copending joint patent application of the present inventor and Robert C. Jackson, Serial No. 728,460, filed April 14, 1958.

As specifically illustrative of the invention, the sealing device 11 comprises a pair of sealing members 17 which, in the preferred embodiment, are composed of a resilient or deformable material such as neoprene rubber or the like. The sealing members 17 are preferably identical in construction and are of substantially planar shape in their natural or unstressed condition.

As shown best in Figures 3, 4, means have been provided for positioning the sealing members 17 so that their portions 17a are located in overlying relationship to form a normally closed passage or slit 18 (Figure 3) through which the filamentary tow 12 may pass.

More specifically, the positioning means include a pair of support frames, designated generally by the numeral 19, one of which is shown in Figure 2. It will be understood that the pair of support frames 19 are substantially identical in construction as are the sealing members 17 and for the purpose of clarity only one of such frames and sealing members will be described hereinafter.

Referring now to Figure 2, the support frame 19, which is preferably rectangular in shape to define an open central space 21, comprises a pair of substantially parallel spacers 22, 23, at each of the corresponding ends of which are fixed an end bracket designated generally by the numeral 24. As shown in Figure 2, spacer 23 is preferably of reduced height relative to spacer 22 in order to simplify the construction of the sealng device 11.

Each of the end brackets 24 comprises a bottom plate 26 and an upstanding, centrally arranged plate 27 which is suitably secured by means such as welding or the like to the ends of the spacers 22, 23.

In order to position the sealing members 17 with their portions 17a in the overlying relationship described above, the sealing members 17 are arranged in the overlying relationship of Figure 3 to form passage 18 and each of the members 17 are oppositely folded around the outer surfaces of the spacers 22, 23 on their associated support frame 19. The sealing members 17 are maintained in the relationship of Figure 3 by suitably clamping the opposed bottom plates 26 of the end brackets 24 together by means such as bolts 28 or the like (Figure 4). It will be noted in Figure 2 that the spacers 22, 23, or the end brackets bottom plates 26 are grooved or slotted in any suitable manner at their junction point so that a longitudinally extending clearance 29 is provided between the lower edges of spacers 22, 23, and the underside of the bottom plates 26. Thus, the sealing member portions 17a are positioned adjacent the open space 21 of the support frames 19 in a relatively unrestrained condition so that they can flex freely being restrained only by the gripping action of the end brackets bottom plates 26 on the marginal portions of the sealing members.

The wall 16 which defines the interior 14 of the pressurized chamber, is provided with a plurality of openings 30, three of such openings being employed in the embodiment illustrated, which are suitably dimensioned so as to accommodate the filamentary tow 12, and means have been provided for supporting the frames 19, together with the sealing members 17, on the inner surface of wall 16 with the passage 18 in communication with the wall opening 30 as shown in Figures 1, 3.

More specifically, each of the spacer plates 22 is provided with a plurality of openings 31 for accommodating bolts 32 which are inserted through openings 33 in the sealing members 17 and into suitably threaded recesses 34 in the wall 16 in order to secure the support frames 19 and one end of the sealing members 17 in the position of Figure 4. In this position, the opposite end portion of the sealing members is initially loose and, therefore, means have also been provided for securing this sealing member end portion on the outer surface of spacer plate 23.

More specifically, openings 36 are provided in spacer plate 23 for accommodating bolts 37 which are inserted through openings 38 into longitudinally extending reinforcing bars 39 so that the sealing member end portion is sandwiched and fixedly held between the spacer plate 23 and the reinforcing bar 39.

Thus, all of the marginal portions of the sealing members 17 are held securely so that the relatively unrestrained, overlying portions 17a of the sealing members may flex to a limited extent as previously described, and admit through passage 18 a belt or a three-ply assembly consisting of a pair of belts with a tow sandwiched therebetween. It should be understood that any suitable seal such as an elastomeric plug or the like (not shown) is preferably positioned within each end of the V-shaped lateral opening 41 shown in Figure 3 formed by the sealing members 17 and the inner surface of wall 16 so as to prevent leakage of pressure from the chamber interior 14, past the sealing device 11 and through the wall opening 30.

As previously discussed, the filamentary tow 12 may be continuously conveyed through wall opening 30 and the normally closed passage 18 of the sealing members 17 by any suitable means. For example, the tow 12 alone may be pulled or advanced through the sealing device 11 by any conventional tow advancing means and, in the specific embodiment, the tow advancing means includes a pair of continuous belts 42, 43, which are preferably formed of relatively thin material such as sheet steel or the like, and are sufficiently wide to be snugly accommodated within the passage 18 as shown in Figure 5. In this instance, the belts may be approxi- mately 6 inches wide and are preferably between 0.005 and 0.030 inch in thickness so as to flex freely.

In order to drive belts 42, 43, each belt is associated with a pair of rolls or pulleys which are positioned on the opposite sides of the wall 16. More specifically, belt 42 is positioned on rolls 44, 46 rotatably mounted on shafts 45, 47, and belt 43 is positioned on rolls 49, 51, rotatably mounted on shafts 52, 53, respectively. Both of the rolls associated with each belt may be driven, if desired, but preferably only one is driven by any suitable means (not shown) and the driven rolls in each belt are suitably connected for simultaneous rotation so that the belts 42, 43 will travel at the same speed.

As can be seen in the specific construction illustrated in Figure 1, the belts 42, 43 are arranged to travel in the direction of arrow H and move together into the pressurized chamber interior 14 through the centermost wall opening 30. Each belt subsequently moves out of the chamber interior 14 through one of the remote wall openings 30 spaced along the wall 16 from the centermost opening. As previously described, in order to prevent leakage of pressurized fluid such as steam through the chamber interior 14, a pressure sealing device 11 is also supported on wall 16 adjacent each of the remote openings 30, each of which accommodates one of the belts 42, 43 during its movement from the chamber interior 14.

In the operation of the apparatus shown in Figure 1, the tow 12 is fed to the nip of rolls 44, 46 and moves subsequently into sandwiched relationship with belts 42, 43 in a three-ply assembly. This three-ply
assembly is conveyed in the direction of arrow H into the chamber interior 14 through the normally closed passage 18 of the sealing device 11 which yieldingly opens as a result of the flexing action of the unrestrained sealing members portions 17a into the space 21. The tow subsequently emerges from the belts as they separate adjacent the nip of the rolls 46, 51, and each belt returns to the exterior 13 through a similar sealing device 11 positioned adjacent each of the remote openings 30 as shown in Figure 1.

When the apparatus of Figure 1 is employed in the annealing of a filamentary tow composed of "wet spun" acrylic filaments, it is desirable to subject this tow to steam under pressure (preferably steam at a temperature of between 135° to 155° C. and at a pressure of between 35 to 50 pounds per square inch) and the sealing device 11 is particularly adaptable for facilitating the conveying of such a tow into the chamber interior 14 which is supplied with pressurized steam in any suitable manner.

As is well known, the tow is generally maintained in a relaxed or tension-free condition while in the region 14 by any suitable means in order to obtain the desired annealing action in which the molecular strains in the tow filaments are relieved.

The passage of the three- ply assembly consisting of the two belts 42, 43, and the tow 12 through the passage 18 of the centermost sealing device 11, forces the passage 18 to yieldingly open as shown in Figure 3. The opposed surfaces of the relatively thin flexible belts 42, 43 move in close, confining relationship with the filaments in tow 12 with a minimum of free space therebetween and the yielding inner wall of passage 18 thereby surrounds the outer surface of the belts. As previously described, the belt material and thickness is selected so as to permit the belts to flex sufficiently and fill any voids or valleys which might be present in the tow between the filaments.

The close-fitting, intimate relationship between the contacting surfaces of the sealing member portions 17a which form the passage 18 and the belts 42, 43 together with the similar intimate relationship between the belts 42, 43 and the tow 12 provide a substantial amount of sealing action in sealing device 11 so as to prevent leakage of pressure from the chamber interior 14 through the wall opening 30.

However, an even more outstanding sealing action for a belt or for the three- ply assembly consisting of the two belts and the tow is obtained by means of the novel construction of the sealing device 11. As has been previously described, the sealing device 11 is supported on the rollers 47 and 48 with the passage 18 in communication with the wall opening 30. Thus, when the passage 18 is passing either a belt or the belts and tow assembly an initial slight or negligible flow of pressurized fluid or steam into the passage 18 from region 14 will occur. This negligible passage of steam into passage 18 results in a throttling action and, consequently, a pressure drop through the passage.

Thus, a pressure differential is created between the interior of passage 18 and the high pressure region 14 which produces a constricting or squeezing action by the relatively unrestrained portions 17a of the sealing members 17 and consequently around the belts 42, 43 and tow 12 or a belt alone. As this constricting action occurs, the throttling action, and therefore the pressure drop in passage 18, is increased to add further to the constricting forces developed. The outer surfaces of portions 17a are exposed to the high pressure region as a result of the novel construction for the sealing members 17 shown best in Figure 2. Thus, an unusually high sealing action is obtained to provide a virtually leakproof sealing device, and the forward end portions of the sealing members 17 between spacer 22 and wall 16 cooperate with the inner surface of wall 16 to prevent any leakage directly through the opening 30 from the interior 14. Similarly, a sealing action is produced in the sealing devices 11 ad-

jacent the remote wall openings 30 through which the individual belts pass as they return to the exterior 13 and the high pressure chamber interior 14 is maintained in a sealed condition while the belts 42, 43 together with tow 12 move continuously between the regions 13, 14. It should be understood, however, that although a movement of the tow 12 into the high pressure region 14 has been shown, the sealing device of the invention is equally useful for removing tow from such a region through the chamber wall. In the preferred use of the sealing device 11, it is employed with suitably arranged belts to continuously convey a tow of indefinite length through a pressurized chamber in which an annealing operation is performed.

Through the novel construction of the invention there has been provided a sealing device which enables material to be continuously conveyed between regions of high and low pressure while maintaining the high pressure region in a sealed condition. The sealing device provided is of simple and inexpensive construction and is readily adaptable to not only many conventional conveying means such as belts, tubes, sheets and the like, but also may be used for conveying the material alone through the high pressure region without affecting the efficient sealing action of the device. Although the sealing device of the invention is particularly useful in the annealing or stream treatment of fibers, it may also be formed from a synthetic composition such as acrylic or nylon polymers or the like, any suitable pressurized fluid may be satisfactorily handled by material conveying apparatus employing the sealing device of the invention. Furthermore, it can be seen that the pressure regions 13, 14 may be at any pressure level as long as the region 14 in which the sealing device 11 is located is at a higher pressure than region 13. For instance, a vacuum might be imposed on region 13 with region 14 at atmospheric pressure.

While there has been described what at present is considered to be the preferred embodiment of the invention, it will be understood by those skilled in the art that various changes and modifications may be made therein without departing from the invention and, therefore, it is the aim of the appended claim to cover all such changes and modifications as fall within the true spirit and scope of the invention.

Having thus described the invention, what is claimed is:

A sealing device for passing a continuous length of elongated material between a high and a low pressure region having a wall therebetween comprising, in combination, an opening in said wall for admitting said material therethrough, a pair of substantially identical sheets of resilient material, a pair of substantially rectangular support frames defining a central space, a pair of end brackets on each of said support frames, means on said end brackets for rigidly clamping said support frames in assembled relationship with said pair of sheets sandwiched therebetween whereby overlying portions of said sandwiched sheets are maintained in a relatively unrestrained contacting condition adjacent said central space and form a normally closed passage for said material, means for fixedly mounting said clamped support frames and said sandwiched sheets on said wall with said normally closed passage communicating with said wall opening whereby a pressure differential is produced between said passage and said high pressure region, said normally closed passage being arranged to yieldingly open against the pressure in said high pressure region and pass continuously moving material therethrough in intimate sealing relationship therewith.

References Cited in the file of this patent

UNITED STATES PATENTS

1,819,051 Wilson Oct. 1, 1931
2,522,071 Tall Sept. 12, 1950
2,756,632 Blu Feb. 28, 1956
UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,932,183

April 12, 1960

James P. Richeson

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 2, line 68, after "such as" insert -- a laterally spread tow 12 which may be composed of continuous filaments of synthetic material such as --.

Signed and sealed this 11th day of October 1960.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents