

July 31, 1962

A. C. HEALEY

3,046,773

PRESSURE SEAL

Filed Dec. 18, 1961

4 Sheets-Sheet 1

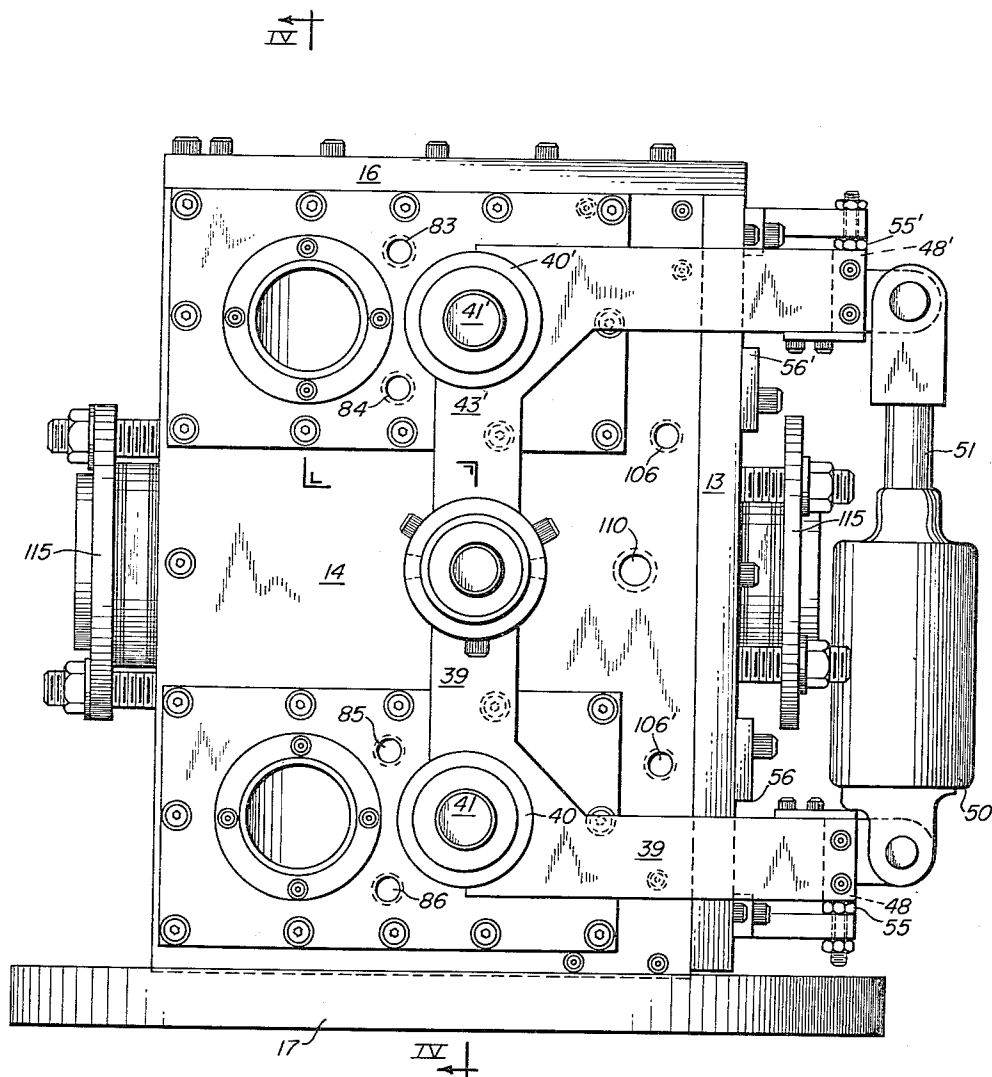


Fig. 1

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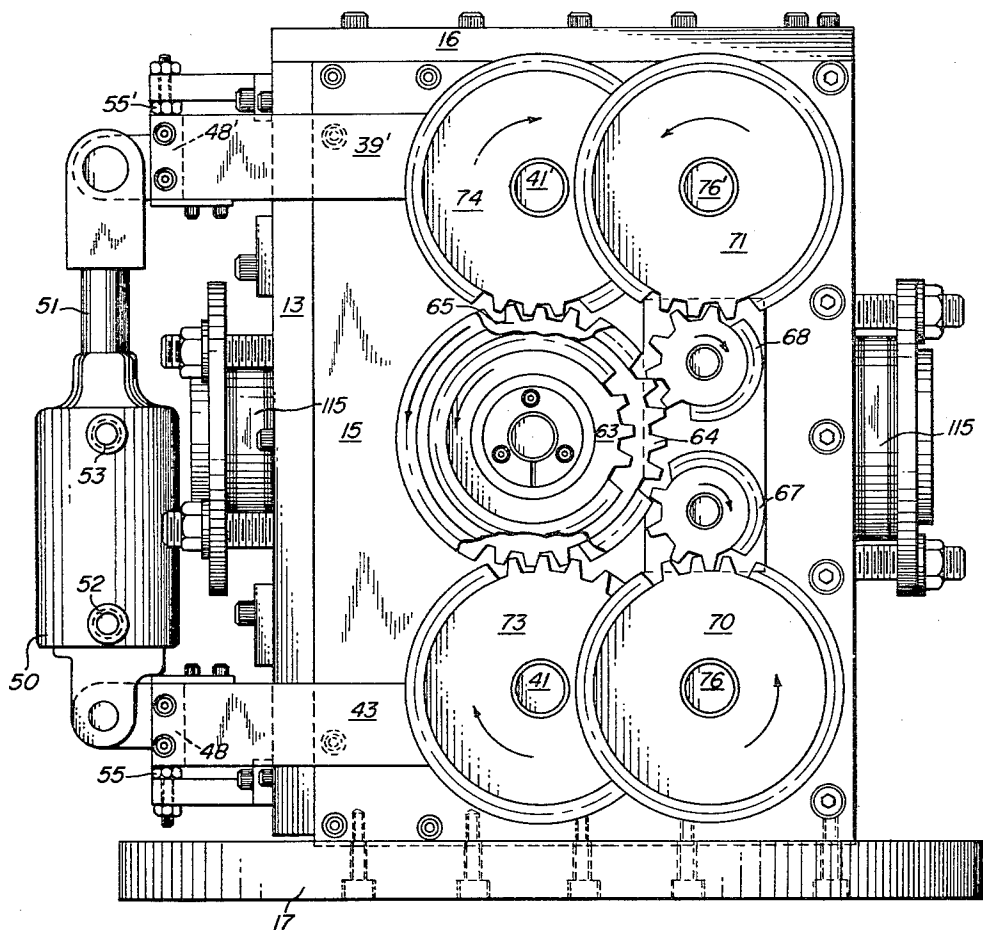


FIG. 2

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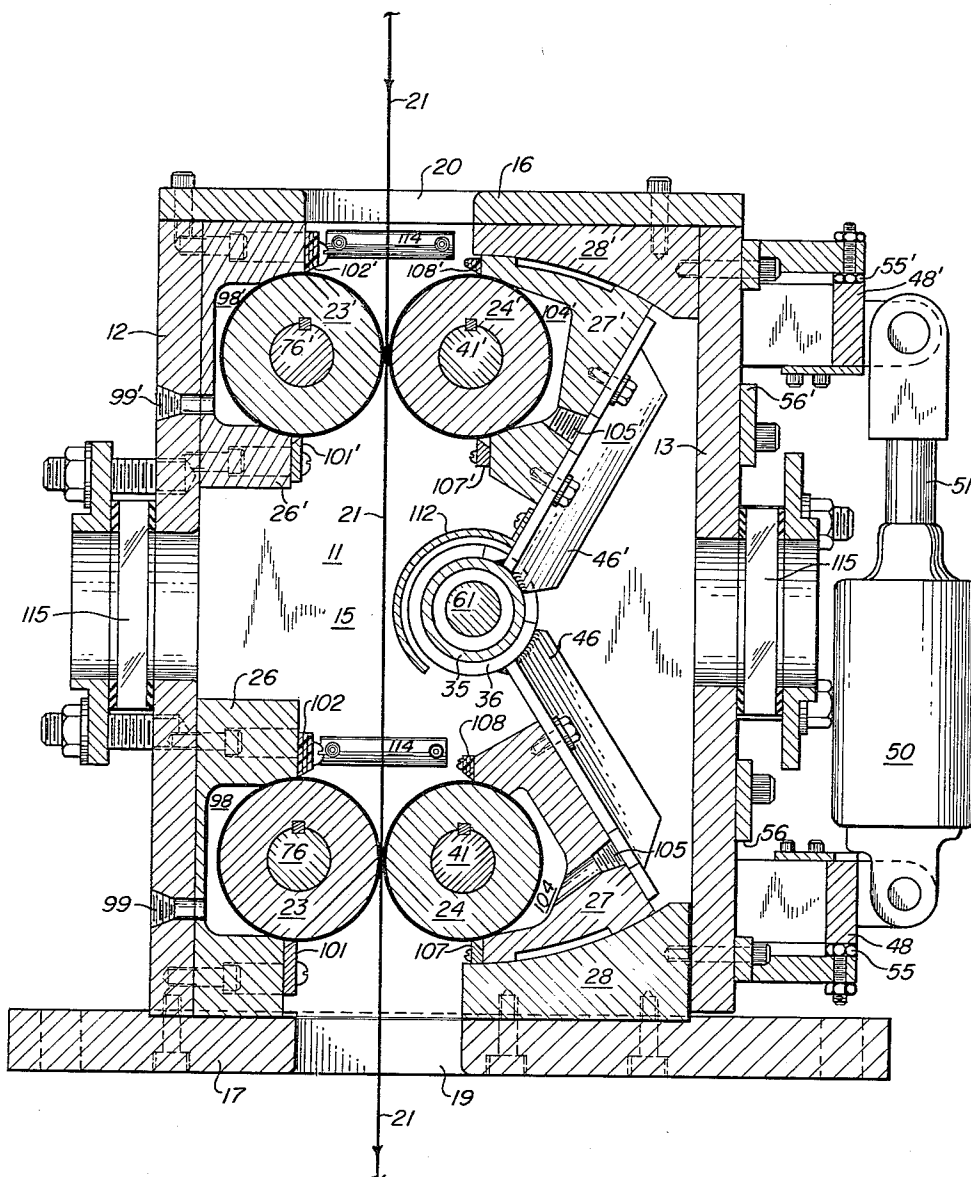
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4 Sheets-Sheet 4

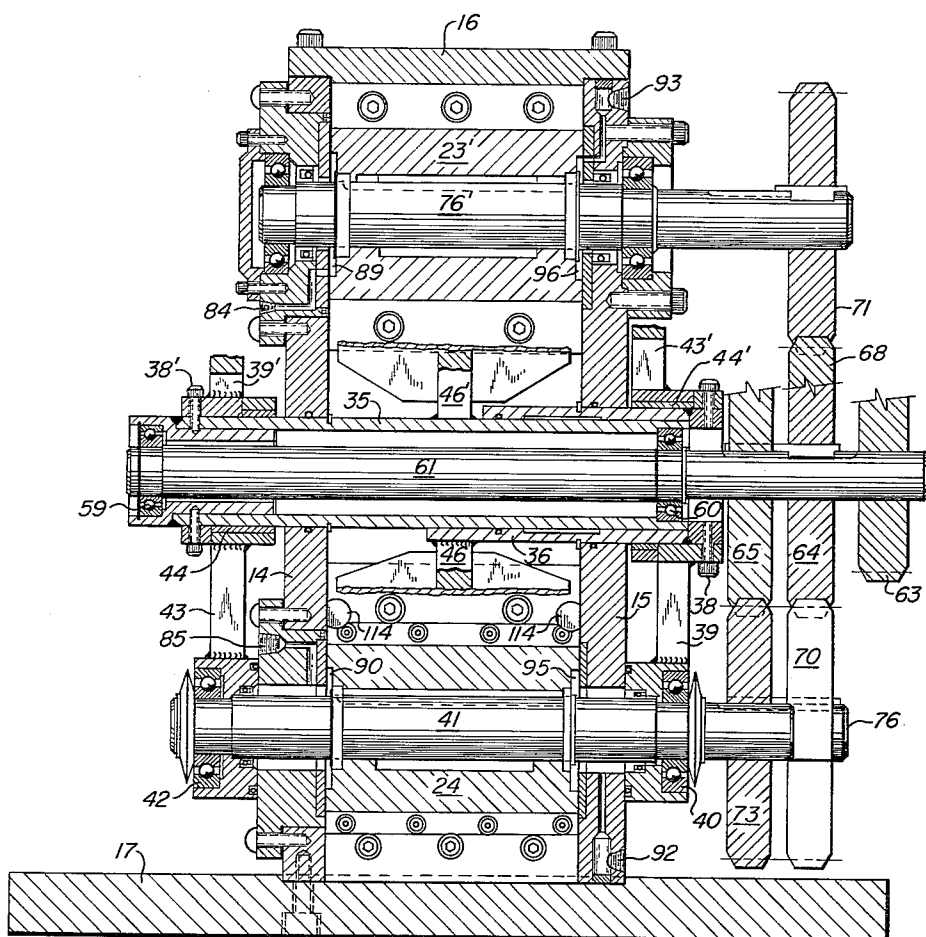


Fig. 4

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3,046,773

PRESSURE SEAL

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12 Claims. (Cl. 68—22)

This invention relates to a sealing device and more particularly to a device or apparatus whereby elongated material can be continuously conveyed with little or no leakage between adjacent regions that are characterized by having a pressure differential therebetween. The device is especially useful in pressure-sealing strands of elongated material in flat-band form as they are continuously passed into and out of a pressure vessel.

The terms "strand," "strands," "structure" and "structures" as sometimes used generically herein are each intended to include within their meaning elongated materials in any form, including monofilaments and multifilaments in yarn, thread, fabric, rod, tape, ribbon, strand, rope, bundle, tow, or other form, and also elongated sheets, films and the like, and which are of continuous (i.e., indefinite) length.

In the preparation of many textile materials or in subjecting them to a finishing treatment, it is often either necessary or advantageous to carry out a particular operation continuously under pressure. For example, elongated filamentary material comprised of a synthetic polymer such as a polymer or copolymer of acrylonitrile or the like is often subjected, while it is moving in a continuous path, to a relatively high temperature and pressure in the presence of saturated or wet steam in order to improve its useful properties, e.g., to improve its dye-receptivity, to obviate or minimize fibrillation thereof, etc. The problems encountered in such operations, which are sometimes designated as heat-relaxing or annealing operations, are described in, for example, U.S. Patent 2,708,843 (especially column 1, line 44, through column 2, line 15) and 2,932,183 (especially column 1, lines 14-59). Such problems include damage to the strand at ports of entry and exit, such damage including abrasion and elongation of the strand due to the friction of dragging the strand past the nonmoving portions of pressure seals; disturbance of the arrangement of the filaments in the strand pattern; difficulty in maintaining adequate and uniform pressure in the vessel due to loss of the pressurizing medium, e.g., steam, at the entry and exit ports through which the strand passes; inability of the sealing means to handle various thicknesses of material; lack of self-adjustability or slowness of self-adjustability of the sealing means; difficulty of providing an effective sealing unit which is relatively inexpensive, which is simple to construct and operate, which will not be subject to frequent breakdowns, and which will have a relatively long service life; as well as other problems.

It is a primary object of the present invention to provide a new and novel sealing means or unit for obviating or minimizing leakage from a pressurized region or zone through which a strand of elongated material is being continuously conducted.

Another object of the invention is to provide an adjustable device for sealing material in band form, which

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device is readily and economically fabricated and is simple to operate.

Still another object of the invention is to provide a sealing device which can handle various thicknesses of material and which can be operated so that the pressure on the material passing through the device is adjustable.

A further object of the invention is to provide a sealing arrangement which is self-adjusting to permit the passage of elongated material of uneven cross section and which will respond rapidly to such uneven cross sections.

Another object of the invention is to provide sealing apparatus through which the strand may be passed without the sealing apparatus applying any dragging forces or friction forces to the strand passing therethrough.

Still another object of this invention is to provide a sealing device which will be substantially free of the aforementioned problems found in previous sealing means.

These objects, and other objects which will become apparent as the specification proceeds are mainly accomplished by the use of a pressure-sealing device comprising a hollow chamber having at least one pair, and preferably two pairs of rolls mounted so the strand passes through the nip or nips thereof. The hollow chamber is adapted to contain therein a body of liquid, a portion of which extends into the constricted passageway in the nip of each pair of rolls. To provide self-adjustability of the width of this constricted passageway, at least one roll of each pair is mounted so its axis may be freely moved toward and away from the axis of its mate subject to the influence of a means resiliently urging such axes toward each other. The rolls are driven so their peripheral speeds are substantially equal to and in the same direction as the linear speed of the strand passing there-through.

To complete the seal and prevent the escape of pressure around the rolls on the side remote from the nip, a closure means or sealing shoe is provided to extend between a portion of the periphery of each roll and some portion of the hollow chamber. In order to maintain proper clearance between the closure means or sealing shoe and the movable rolls, the axis of a movable roll and its associated closure means may each be mounted for movement together about a common axis.

To minimize or eliminate the collection of filamentary material or debris within constricted regions within the sealing device, means are provided for the admission of liquid to the various recesses between the rotating rolls and the non-rotating members of the sealing device. Means are provided to admit liquid to recesses between the closure means and the rolls, which liquid lubricates the bearing surfaces therebetween and flows outwardly from each recess to wash away from, and prevent from entering into, this constricted space any filamentary material or debris which might be present within the hollow chamber. Also, means are provided for introducing liquid to recesses between the ends of the rolls and the end walls of the hollow chamber adjacent to the axes of said rolls so such liquid may flow radially outwardly through these constricted spaces to wash out any filamentary material or other debris and to prevent it from entering these constricted spaces.

For a clearer understanding of this invention and the advantages thereof reference may be had to the following description of a specific embodiment thereof pre-

sented for purposes of illustration only. The invention, however, is not limited to the specific details illustrated and described below but is defined in the subjoined claims and is to include all equivalents encompassed therein.

For a clearer understanding of this invention, reference may be had to the following description of a specific embodiment thereof taken in conjunction with the accompanying drawing wherein;

FIGURE 1 is an elevational view as seen from one end;

FIGURE 2 is an elevational view as seen from the opposite end;

FIGURE 3 is a cross-sectional view taken substantially along a plane parallel to FIGURES 1 and 2 and approximately half way between the ends there illustrated; and

FIGURE 4 is a vertical sectional view taken approximately along the lines IV—IV of FIGURE 1.

Referring next to the drawings, and more particularly to FIGURES 3 and 4, it is seen that this embodiment of a pressure sealing device includes a hollow chamber 11 generally surrounded by a pair of side walls 12 and 13, a pair of end walls 14 and 15, a top wall 16 and a bottom wall 17. Bottom wall 17 is preferably in the form of a flange adapted to be mounted on a portion of a pressure containing vessel with an opening 19 of bottom wall 17 in registry with a corresponding inlet or outlet opening of the pressure containing vessel. Top wall 16 is also provided with an opening 20 through which a strand 21 may be passed into or out from the hollow chamber 11 on route to or from the pressure containing vessel via opening 19.

To permit continuous movement of the continuous length of strand 21 while maintaining a pressure differential across the pressure sealing device, hollow chamber 11 is provided with means for maintaining therein a body of liquid, such as water, and mechanical means for augmenting the pressure drop across this body of liquid. Such mechanical means include a pair of rotating rolls 23, 24 having a nip therebetween through which strand 21 passes. As will be explained later, roll 24 is mounted with its axis movable and resiliently urged toward the axis of roll 23 against the action of a stop to provide a certain minimum clearance between the peripheries of rolls 23 and 24 in the nip thereof.

To prevent the escape of pressure around roll 23 on the side remote from the nip with roll 24, a closure means or sealing shoe 26 is provided to obstruct the space between roll 23 and side wall 12. To prevent the escape of pressure around roll 24 on the side remote from the nip with roll 23, a closure means including sealing shoe 27 and a sealing block 28 are provided. Rolls 23 and 24, sealing shoes 26 and 27, and sealing block 28 extend substantially completely between end closures 14 and 15 to prevent leakage of pressure around the ends thereof.

Also positioned within hollow chamber 11 is a second pair of rolls 23', 24' having associated therewith sealing shoes 26' and 27' and sealing block 28' structurally and functionally similar to the corresponding elements previously described.

Centrally located between rolls 24 and 24' and extending through end walls 14 and 15 is a rotatable sleeve 35. Extending through end wall 15 and surrounding a portion of the length of sleeve 35 is a partial rotatable sleeve 36. Partial rotatable sleeve 36 is supported around rotatable sleeve 35 for rotary motion independent of the rotary motion of sleeve 35. Rigidly affixed to sleeve 36 by means of bolts 38 and movable therewith is a support 39 containing ball bearing 40 through which axle 41 of roll 24 passes. On the opposite end of axle 41, another ball bearing 42 is mounted in support 43 which is journaled for free rotation about rotatable sleeve 35 by journal means 44. Thus, if roll 24 should be moved toward or away from roll 23, movement of axle 41 will cause a corresponding movement of partial sleeve 36 without affecting sleeve 35. Rigidly secured

to sleeve 36 by bracket 46 is sealing shoe 27, which, therefore, moves when roll 24 moves and by equal amounts, thus maintaining a constant clearance between shoe 27 and roll 24. The remote faces of sealing shoe 27 slide on an arcuate surface of sealing block 28, said arcuate surface representing a portion of a cylinder whose axis is the axis of partial rotatable sleeve 36.

In a similar manner rotatable sleeve 35 has secured to it by bolts 38' a support 39' which supports a ball bearing (not shown) through which passes axle 41' of roller 24'. The other end of axle 41' is mounted in a ball bearing (not shown) in support 43' which is journaled about partial rotatable sleeve 36 by journal means 44'. Similarly, bracket 46' is rigidly affixed to sleeve 35 and supports sealing shoe 27' for movement therewith.

Thus the movement of rolls 24 and 24' toward and away from mating rolls 23 and 23' coordinates therewith the corresponding movement of sealing shoes 27 and 27' along the sliding arcuate surfaces of sealing blocks 28 and 28' through the use of rotatable sleeve 35 and partial rotatable sleeve 36. Also, the movements for each of the pairs of rolls is independent of the movements of the other of the pair of rolls.

As best seen in FIGURES 1 and 2, support 39 is provided with an extension thereof to which is mounted one end of a plate 48, the other end of which is mounted to an extension of support 43. Likewise, a plate 48' is mounted between extensions of supports 39' and 43'. Plates 48 and 48' are provided with pivotable mounting means for supporting therebetween pneumatic cylinder 50 and piston 51. Introduction of air or other gas into inlet 52 of pneumatic cylinder 50 urges plates 48 and 48' apart pivoting supports 39, 39', 43 and 43' about sleeves 35 and 36 thereby resiliently urging rolls 24 and 24' toward their mates 23 and 23'. Introduction of gas through inlet 53 serves to separate rolls 24 and 24' from their mates. In order to limit the travel of rolls 24 and 24', a pair of adjustable stops 55 and 55' are provided to set the minimum clearance at the nips of the rolls and fixed stops 56 and 56' are provided to set the maximum clearance to which the nips may be opened.

Suitably supported within the sleeve 35 by means of ball bearings 59, 60 is a shaft 61 on which is mounted three gears 63, 64 and 65 as best shown in FIGURES 2 and 4. Gear 63 is operatively connected to a suitable source of motive power for rotating shaft 61 and gears 64 and 65 therewith. Gear 64 intermeshes with idler gears 67 and 68 which engage gears 70 and 71 mounted on axles 76 and 76' for rotating rolls 23 and 23'. Gear 65 intermeshes with gears 73 and 74 mounted on axles 41 and 41' to thereby rotate rolls 24 and 24'. Since gears 64 and 65 have equal numbers of teeth and since gears 70, 71, 73 and 74 have equal numbers of teeth, it is readily apparent that rolls 23, 24, 23' and 24' will all rotate in the same angular velocity. By suitable adjustment of the speed at which gear 63 is rotated, this chain of gears is operated so that the peripheral velocity of rolls 23, 24, 23' and 24' is equal to and in the same direction as the linear velocity of strand 21 passing through the nips of such rolls.

It will be seen from a consideration of the above described structure, that numerous constricted passageways exist between the continuously rotating portions of the structure (i.e. rolls 23, 24, 23' and 24') and the stationary portions of the structure (i.e. end walls 14 and 15 and sealing shoes 26, 27, 26', 27'). In order to substantially eliminate the collection of debris and broken filaments in these constricted spaces, means is provided for supplying water to recesses therebetween and flowing it through the constricted spaces in directions opposed to the directions of possible entry of such debris.

End wall 14 is provided with four liquid inlets 83, 84, 85, 86. As best seen in FIGURE 4, liquid inlet 84 communicates with an annular recess 89 in one end of

roll 23'. Water introduced through inlet 84 flows into recess 89 and then radially outwardly through the constricted space between the end of roll 23' and the adjacent portion of end plate 14. In a similar manner, liquid inlet 85 communicates with recess 90 in the end of roll 24 to provide a radially outward flow of water between the end of roll 24 and end plate 14. Likewise, inlets 83 and 86 communicate to recesses at the end of rolls 24' and 23 to provide radially outwardly directed flows adjacent to the ends of such rolls and end plate 14. Similarly, end plate 15 is provided with four inlets (only two of which, 92 and 93 are seen in FIGURE 4) which communicate with recesses (e.g. 95 in roll 24, and 96 in roll 23') from which water flows radially outwardly between the ends of rolls 23, 23', 24, 24' and end plate 15. This serves to keep debris and broken filaments out of the constricted space adjacent the ends of these rolls.

Shoes 26 and 26' are provided with recesses 98 and 98' into which liquid may be introduced through inlets 99 and 99'. This liquid flows outwardly from recess 98, 98' through the constricted spaces between sealing shoes 26, 26' and rolls 23, 23' past suitable sealing strips 101, 102, 101', 102'. In a similar manner shoes 27, 27' are provided with recesses 104, 104' to which liquid may be introduced through inlets 105, 105'. Inlets 105, 105' are connected by flexible conduits (not shown) to openings 106, 106' (see FIGURE 1) in end wall 14 to permit liquid to be introduced to recesses 104, 104' from outside hollow chamber 11. This liquid flows from recesses 104, 104' outwardly through the constricted spaces between rolls 24, 24' and sealing shoes 27, 27' past sealing strips 107, 108, 107' and 108' to flush out any debris which may tend to enter these constricted spaces.

Water or other liquid entering through the various inlets previously described fills up the interior of hollow chamber 11 and flows into the nips between rolls 23 and 24 and between rolls 23' and 24' to provide sufficient sealing to prevent the loss of pressure through the pressure sealing device. End plate 14 is provided with a drain 110 which may be used whenever it is desired to empty the interior of hollow chamber 11 of liquid for inspection, repairs, cleaning, or other purposes.

As shown in FIGURE 3, rotatable sleeve 35 and partial rotatable sleeve 36 may be protected from debris and broken filaments by means of shield 112 fastened to bracket 46', which shield substantially encloses sleeves 35 and 36 at least on the side thereof facing toward the pathway of strand 21.

In order to assist in keeping the edges of strand 21 from entangling in the constricted space adjacent the ends of rolls 23, 24, 23' and 24', bar guides 114 are provided which prevent unbroken filaments from wandering out to the ends of these rolls.

To permit observation of the interior of hollow chamber 11, sight glasses 115 may be provided in side walls 12 and 13.

In operation, strand 21 is fed through the nips between rolls 23 and 24 and between rolls 23' and 24' at a speed substantially equal to the peripheral velocity of such rolls. Hollow chamber 11 is filled with a liquid, such as water, and is maintained full by the constant flow of additional liquid through the various inlets previously described. Excess liquid is permitted to drain outwardly through opening 19 and to overflow upwardly through opening 20. Adjustable stops 55 and 55' are set so that under the resilient urging of pneumatic cylinder 50 and piston 51, rolls 24 and 24' are moved toward rolls 23 and 23' until a minimum clearance substantially equal to the thickness of strand 21 is achieved. Thus, in normal operation, strand 21 is not crushed or compacted as it passes through the nips of these rolls.

When an occasional enlargement of strand 21 reaches the nip of a pair of rolls, the rolls rapidly separate an appropriate distance to permit enlargement of strand 21 to pass therethrough and immediately thereafter return

to the normal clearance under the resilient urging of pneumatic cylinder 50 and piston 51. When the enlarged portion of strand 21 reaches the other pair of rolls, the other pair rapidly opens up in the nip thereof to permit passage of this enlarged portion and then returns to the normal nearly closed position automatically in the same manner.

Thus, when an enlarged portion of strand 21 reaches the pressure sealing device of this invention, one pair of rolls opens at a time to permit passage of the enlarged section therethrough and then closes prior to the opening of the other pair of rolls. This prevents loss of pressure through this pressure sealing device when an enlargement of strand 21 occurs, particularly when such enlargement is non-uniform across the width of strand 21 (such as existing only on one side of strand 21, e.g., the side near end wall 14 or 15).

It has been found essential for maximum speed of response of the opening of the nips between the rolls upon encountering an enlargement in strand 21 that the rolls be driven at a peripheral speed substantially equal to the linear speed of the strand passing therebetween. This permits the rolls to open up rapidly to permit the enlargement of strand 21 to pass therethrough without the necessity for applying substantial tension to strand 21 to drag it through the nip while opening up the nip.

By the use of the liquid inlets feeding to the recesses and producing liquid flows through the various constricted spaces in directions opposed to the directions taken by broken filaments and other debris, such constricted spaces may be maintained clean and operable for extended periods of time without the necessity of shutting down and manually cleaning out the pressure seal of this invention. The presence of the liquid within hollow chamber 11 also serves to lubricate the bearing surfaces between moving and non-moving portions of the pressure seal.

In actual tests, utilizing a device substantially as illustrated in the accompanying drawings, it has been found possible to maintain a pressure differential across the pressure sealing device of approximately 25 lbs. per square inch while feeding an endless strand through a body of water about two feet tall having therein two pairs of rotating rolls having a minimum clearance of about .03 inch (which is substantially equal to the thickness of strand 21).

I claim:

1. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:

- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber having a pair of opposite end walls and being adapted to contain a body of liquid therein;
- (b) a first roll supported within said chamber between said end walls for rotation about its axis;
- (c) a second roll also supported within said chamber between said end walls for rotation about its axis, the axes of said rolls being substantially parallel;
- (d) means for resiliently urging at least one of said rolls toward the other of said rolls to define a constricted passageway between the peripheries of said rolls through which said elongated material is passed;
- (e) means for rotating said rolls at a peripheral speed substantially equal to and in the same direction as the linear speed of the elongated material passing through the constricted passageway between the rolls;
- (f) closure means extending between said end walls and substantially blocking the space between each

- roll and said hollow chamber, said closure means being provided with recesses facing said rolls;
- (g) means for supplying liquid to said recesses whereby liquid will flow from said recesses through the constricted spaces between said closure means and said rolls; and
- (h) means for supplying a liquid to the interior of said hollow chamber to maintain therein a body of liquid a portion of which extends into the constricted passageway between the rolls.
2. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:
- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber having a pair of opposite end walls and being adapted to contain a body of liquid therein;
- (b) a first roll supported within said chamber between said end walls for rotation about its axis;
- (c) a second roll also supported within said chamber between said end walls for rotation about its axis, the axes of said rolls being substantially parallel;
- (d) means for supplying liquid to the constricted spaces between the ends of said rolls and said end walls, said liquid flowing radially outwardly from the axes of said rolls past the peripheries of said rolls;
- (e) means for resiliently urging at least one of said rolls toward the other of said rolls to define a constricted passageway between the peripheries of said rolls through which said elongated material is passed;
- (f) means for rotating said rolls at a peripheral speed substantially equal to and in the same direction as the linear speed of the elongated material passing through the constricted passageway between the rolls;
- (g) closure means extending between said end walls and substantially blocking the space between each roll and said hollow chamber; and
- (h) means for supplying a liquid to the interior of said hollow chamber to maintain therein a body of liquid a portion of which extends into the constricted passageway between the rolls.
3. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:
- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber having a pair of opposite end walls and being adapted to contain a body of liquid therein;
- (b) a first roll supported within said chamber between said end walls for rotation about a fixed axis;
- (c) a second roll also supported within said chamber between said end walls for rotation about a movable axis, said movable axis being substantially parallel to and movable toward and away from said fixed axis;
- (d) means for resiliently urging said second roll toward said first roll to define a constricted passageway between the peripheries of said rolls through which said elongated material is passed;
- (e) means for rotating said rolls at a peripheral speed substantially equal to and in the same direction as the linear speed of the elongated material passing through the constricted passageway between the rolls;
- (f) first closure means fixedly secured to said hollow

- chamber to substantially block the space between said first roll and said hollow chamber;
- (g) second closure means movably supported in said hollow chamber in fixed relation to the movable axis of said second roll to substantially block the space between said second roll and said hollow chamber; and
- (h) means for supplying a liquid to the interior of said hollow chamber to maintain therein a body of liquid a portion of which extends into the constricted passageway between the rolls.
4. A pressure-sealing device as defined in claim 3 including mounting means having its axis parallel to the axes of said rolls; means secured to said mounting means for supporting said second roll for rotary motion about its axis and for limited movement about the axis of said mounting means; means secured to said mounting means for supporting said second closure means for limited movement about the axis of said mounting means correlated with the movement of said second roll to preserve a fixed spacial relationship thereto.
5. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:
- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber having a pair of opposite end walls and being adapted to contain a body of liquid therein;
- (b) a plurality of pairs of rolls, each roll being supported for rotation about its own axis within said chamber between said end walls;
- (c) means for supplying liquid to the constricted spaces between the ends of said rolls and said end walls, said liquid flowing radially outwardly from the axes of said rolls past the peripheries thereof;
- (d) means for resiliently urging at least one of the rolls of each pair toward the other roll of the pair to define a constricted passageway between the peripheries of the rolls of each pair through which said elongated material is passed;
- (e) means for rotating said rolls at a peripheral speed substantially equal to and in the same direction as the linear speed of the elongated material passing through the constricted passageways between said pair of rolls;
- (f) closure means extending between said end walls and substantially blocking the space between each roll and said hollow chamber; and
- (g) means for supplying a liquid to the interior of said hollow chamber to maintain a body of liquid between said pairs of rolls, a portion of said body of liquid extending into the constricted passageway between the rolls of each pair.
6. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:
- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber having a pair of opposite end walls and being adapted to contain a body of liquid therein;
- (b) a plurality of pairs of rolls, each roll being supported for rotation about its own axis within said chamber between said end walls;
- (c) means for resiliently urging at least one of the rolls of each pair toward the other roll of the pair to define a constricted passageway between the

- ripheries of the rolls of each pair through which said elongated material is passed;
- (d) means for rotating said rolls at a peripheral speed substantially equal to and in the same direction as the linear speed of the elongated material passing through the constricted passageways between said pairs of rolls;
- (e) closure means extending between said end walls and substantially blocking the space between each roll and said hollow chamber, said closure means being provided with recesses facing said rolls;
- (f) means for supplying liquid to said recesses whereby liquid will flow from said recesses through the constricted spaces between said closure means and said rolls; and
- (g) means for supplying a liquid to the interior of said hollow chamber to maintain a body of liquid between said pairs of rolls, a portion of said body of liquid extending into the constricted passageway between the rolls of each pair.
7. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:
- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber having a pair of opposite end walls and being adapted to contain a body of liquid therein;
- (b) a plurality of pairs of rolls, each roll being supported for rotation about its own axis within said chamber between said end walls, one roll of each of said pairs of rolls being mounted for rotation about a fixed axis and the second roll of each of said pairs of rolls being mounted for rotation about a movable axis;
- (c) means for supporting each of said second rolls for rotation therein and for pivotable movement of the axis thereof about a common axis;
- (d) means for resiliently urging said second roll of each pair toward the first roll of the pair of define a constricted passageway between the peripheries of the rolls of each pair through which said elongated material is passed;
- (e) means for rotating said rolls at a peripheral speed substantially equal to and in the same direction as the linear speed of the elongated material passing through the constricted passageways between said pairs of rolls;
- (f) closure means extending between said end walls and substantially blocking the space between each roll and said hollow chamber;
- (g) means for supporting said closure means associated with each of said second rolls for pivotable movement about the same axis as said second rolls and each coordinated with the associated roll to maintain a fixed spatial relationship therewith; and
- (h) means for supplying a liquid to the interior of said hollow chamber to maintain a body of liquid between said pairs of rolls, a portion of said body of liquid extending into the constricted passageway between the rolls of each pair.
8. A pressure-sealing device adapted to permit the continuous passage therethrough of a continuous length of elongated material from a first zone maintained at one pressure to a second zone maintained at a different pressure, said device comprising:
- (a) a hollow chamber having openings therein communicating with said first zone and with said second zone, and through which said elongated material is passed, said chamber including a pair of opposite end walls and being adapted to contain a body of liquid therein;

- (b) a drive shaft extending perpendicularly to said end walls;
- (c) a first sleeve coaxial with and surrounding said drive shaft mounted for free rotation relative to said drive shaft;
- (d) a second sleeve coaxial with and surrounding said first sleeve mounted for free rotation relative to said first sleeve, said second sleeve being axially shorter than said first sleeve;
- (e) a first roll mounted within said hollow chamber for rotary motion about a fixed axis parallel to the axis of said drive shaft;
- (f) a second roll mounted within said hollow chamber for rotary motion about an axis which is parallel to the axes of said first roll and said first sleeve and which is movable toward and away from the axis of said first roll, said first roll and said second roll forming a nip therebetween through which said elongated material is passed;
- (g) means for supporting said second roll for rotary motion about its own axis and for orbital motion about the axis of said first sleeve, said means being secured to said first sleeve;
- (h) first closure means extending between said end walls and substantially blocking the space between said first roll and said hollow chamber;
- (i) second closure means supported by said first sleeve for movement therewith about the axis of said first sleeve, said second closure means extending between said end walls and substantially blocking the space between said second roll and said hollow chamber;
- (j) a third roll mounted within said hollow chamber for rotary motion about a fixed axis parallel to the axis of said drive shaft;
- (k) a fourth roll mounted within said hollow chamber for rotary motion about an axis which is parallel to the axis of said third roll and said second sleeve and which is movable toward and away from the axis of said third roll, said third roll and said fourth roll forming a nip therebetween through which said elongated material is passed;
- (l) means for supporting said fourth roll for rotary motion about its own axis and for orbital motion about the axis of said second sleeve, said means being secured to said second sleeve;
- (m) third closure means extending between said end walls and substantially blocking the space between said third roll and said hollow chamber;
- (n) fourth closure means supported by said second sleeve for movement therewith about the axis of said second sleeve, said fourth closure means extending between said end walls and substantially blocking the space between said fourth roll and said hollow chamber;
- (o) means for resiliently urging said second roll towards said first roll and for resiliently urging said fourth roll towards said third roll;
- (p) means for supplying a liquid to the interior of said hollow chamber to maintain therein a body of liquid a portion of which extends into the constricted passageways or nips between said rolls; and
- (q) means for transmitting rotary motion from said drive shaft to each of said rolls.
9. A pressure-sealing device as defined in claim 8 wherein each of said closure means is provided with a recess facing its associated roll and including means for supplying liquid to each of said recesses whereby liquid will flow from said recesses through the constricted spaces between said closure means and said rolls.
10. A pressure-sealing device as defined in claim 8 wherein each end of each of said rolls is provided with an annular recess facing an end wall and including means for supplying liquid to each of said recesses whereby liquid will flow radially outwardly from said recesses through the constricted spaces between the ends of said rolls and said end walls.

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11. A pressure-sealing device as defined in claim 8 wherein said means for transmitting rotary motion from said drive shaft to each of said rolls includes a driven gear on the shaft of each of said rolls; a first drive gear on said drive shaft directly meshing with the driven gears on said second roll and said fourth roll; and a second drive gear on said drive shaft indirectly meshing with the driven gears on said first roll and said third roll.

12. A pressure-sealing device as defined in claim 8 including adjustable stop means to limit the minimum width of the constricted passageways or nips between

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the rolls of each pair of rolls achieved under the action of said means for resiliently urging said second and fourth rolls toward said first and third rolls, respectively.

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