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METHOD OF AND APPARATUS FOR SEALING MEDIUMS FROM ESCAPE

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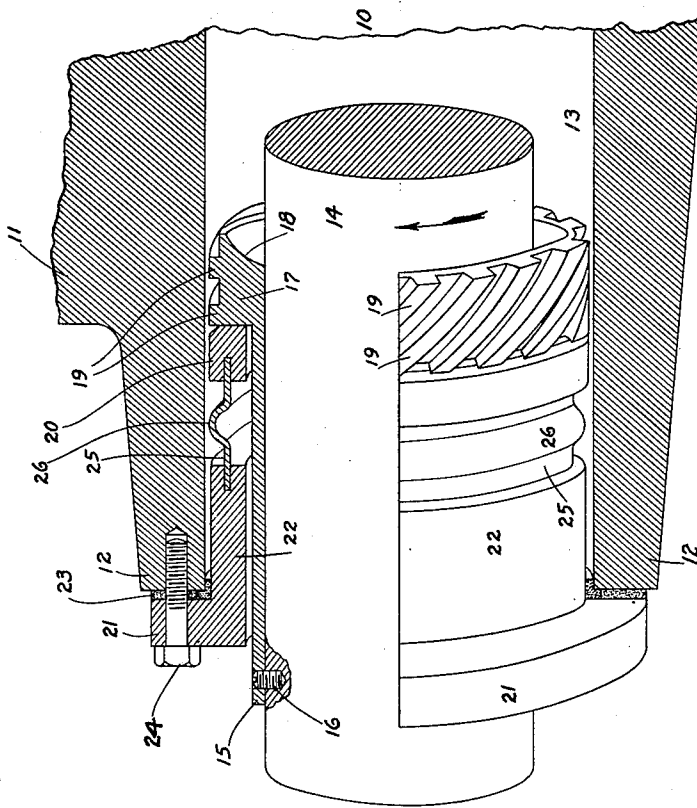


Fig. 1.

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METHOD OF AND APPARATUS FOR SEALING
MEDIUMS FROM ESCAPE

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This invention relates to an improved method of and apparatus for sealing mediums from escape, and more particularly to such sealing of mediums liable to be subjected to high pressures, such as water, steam, gases and other mediums; and it more particularly pertains to such sealing from escape about rotating parts, such as shafts, liable to be rotated at high speeds.

Heretofore, in the sealing of such mediums from escape, recourse has been had exclusively to mechanical, pressure and other packings which of necessity have been subjected to substantial pressures, friction and wear in order to resist the substantial pressure of the sealed medium which was directly subjected to such sealing means, while the substantial shaft speed has resulted in substantial wear of the packings and adjacent parts due to such direct pressure. This has necessitated frequent packing renewals as well as replacements of the parts juxtaposed to such packings. Such renewals and replacements have caused substantial maintenance expense as well as requiring far more expensive shut-downs of the apparatus for the substantial periods required for such renewals and replacements.

The object of this invention is to provide a method of and apparatus for sealing mediums from escape which subjects the packing to relatively small, if any, pressure of the medium tending to escape and which is consequently subjected to substantially less friction, and will have substantially longer service life and require relatively fewer repairs, replacements and plant or apparatus shut-downs therefor.

To attain these and other objects, and in accordance with the general features of this unitary invention of related and interdependent components, my improved method contemplates the movement of a portion of the sealed medium at a substantial velocity and at an angle past or away from the entrance to the path of possible escape of the sealed medium, and may contemplate that said velocity be intermediate the sealed medium and the path of its possible escape; and

Further contemplates the further movement of the sealed medium tending to escape, which further movement is in a direction tending to prevent such escape; and may further contemplate that said further movement be imparted, to the medium tending to escape, in the path of the possible escape of the sealed medium as well as that the direction of the said further movement may be substantially opposite that of the

possible escape of said medium; and more specifically contemplates that said further movement be imparted within a plurality of volumes, one of which is relatively small and preferably very thin and that it may tend to wire-draw the medium tending to escape, and that said volumes be juxtaposed and relatively rotated; and further contemplates that said last named volumes may be occupied by some sealed medium tending to escape; and more specifically contemplates that said relative rotation move the medium within said plurality of volumes in a direction tending to prevent its escape; and further more specifically contemplates that said thin volume be tubular, and that volume other than the tubular volume of said plurality of volumes be formed of a plurality of helical volumes, juxtaposed to and extending throughout the length of said tubular volume, and that said helical volumes be rotated in the direction of rotation of the shaft and cause movement of the medium in said volumes in a direction substantially opposite to that of the possible path of escape of the medium, and that said tubular volume be of sufficient thinness that the helical volumes rotating at their normal velocity will tend to move escaping medium in said tubular volume with said medium in said helical volumes; and that the passage of the confined steam or like medium from the container into the very thin volume or orifice expends work of the confined pressure medium and therefore reduces the pressure of the medium within the thin volume and bearing against the seal of the joint; that heat from the medium confined in the thin volume is transferred to the juxtaposed metal walls confining said thin volume; that the expelling of medium from the thin volume or orifice, and/or the medium from tending to enter the thin volume or orifice, into the container tends to maintain the lowered pressure and temperature of the medium in the thin volume or orifice by controlling the further entry of medium from the container.

The imparting of motion to the confined medium by the helical teeth 19 and by the surface 18 maintains a volume of the confined medium under reduced pressure intermediate the seal contacting surfaces 17—20 and the main body of the sealed medium. A relatively quiescent volume of the confined medium is maintained at reduced pressure about the sealing parts 20, 26 and 22. The pressure and temperature of such quiescent volume acts upon the part 26 and thereby controls the contact pressure of the sealing parts. The reduction in pressure of

such quiescent volume materially lessens the liability of leakage through the joint between the sealing parts.

When the shaft 14 is not rotating the maximum pressure and temperature of the confined medium obtains in the quiescent volume about the parts 20, 20, 22, which maximum is that of the main portion of the confined medium less the pressure drop incident to passing through the wire-drawing orifice between ring 20 and the surface of wall 11 and less the radiation losses to wall 11 and the parts 22, 26, and 20. Consequently the maximum frictional engagement and sealing pressure exists between the engaging surfaces of ring 20 and collar 17. The rotation of shaft 14 lowers the maximum pressure and temperature of the quiescent volume by impelling or expelling some of the confined medium from the quiescent volume and tending to preclude the entrance of further portions of the confined medium from the container into the quiescent volume. This reduces the pressure and frictional engagement and thereby increases the service life, of the contacting surfaces of the sealing parts 17, 20; and

Further contemplates the further sealing from escape the sealed medium in the path of its possible escape; and more specifically contemplates that said further sealing be intermediate the atmosphere and one of said intermediate volumes; and that said steps may co-act, co-operate and substantially contribute to the formation of a simple, inexpensive seal of high efficiency and long operative life.

To demonstrate the practical utility of my said method, a related, improved and novel apparatus embodying my invention, and which may be used advantageously and economically in practicing said improved method as a unitary invention, is provided to also serve as an example, to those skilled in the art, of the facility with which, after becoming familiar with my invention, the many forms and kinds of existing apparatus, with or without substantial modifications, may be employed in the efficient practice of my method. Said provided apparatus contemplates and includes a chamber which may contain a medium, for instance water, steam or gas, a rotatable shaft extending through a wall of such chamber, and surrounding said shaft is a normal path of possible escape of the sealed medium. Preferably at a point intermediate the body of the sealed medium in said chamber and the entrance to said normal path of escape means are provided which impart to the medium surrounding said shaft, and in contact with said means, movement at a substantial velocity and in a direction preferably at a substantial angle across and away from the mouth of the tubular path of possible escape of the medium, whereby but relatively little medium may be in said tubular pathway and such medium as remains in such pathway would be at a substantially reduced pressure. Preferably, upon the periphery of said means are formed a plurality of helical grooves which have very small clearance between the outer surface of said grooves and the inner surface of the opening through which the shaft extends, said clearance forming in part the tubular pathway of possible escape of the sealed medium. Said helical grooves form means for expelling medium tending to escape from about the shaft and into the stream of said medium moved by said first named means.

Said apparatus further contemplates and in-

cludes packing or sealing means interposed between the aforesaid means and the atmosphere.

The foregoing and other objects of my invention will be more apparent from the following detailed description and the accompanying drawing, illustrating one embodiment of my invention in an improved apparatus, of the many different forms and characters of apparatus, each of which may be employed, with or without substantial modification, in the practice of my improved method.

In the accompanying drawing, the figure is a perspective view of an apparatus embodying my invention in which portions are broken away for clearness of illustration.

In the drawing, 10 represents a chamber having an outer wall, 11, and adapted to contain a medium, for instance water, steam or gas, under substantial pressure. A substantially circular projection, 12, extends from said wall, 11, and is provided with a cylindrical opening, 13, extending therethrough and into chamber, 10. Extending into and through said opening, 13, is a shaft, 14, having a sleeve, 15, mounted thereon and rigidly secured thereto by a screw, 16, or otherwise. Upon the end of sleeve, 15, extending toward chamber, 10, is an integral or secured enlarged head, 17, whose inner face, surrounding and projecting from shaft, 14, is provided with a concave recess, 18, whose outer edge extends adjacent to the inner wall of tubular opening, 13.

Upon the outer surface of head, 17, are formed a plurality of helical projections, 19, whose tops are provided with a relatively thin clearance space from the inner periphery of opening, 13.

Sleeve, 15, and its head, 17, may be formed of non-corrosive metal of good bearing quality and the outer face of head, 17, is machined to a good bearing surface extending preferably at a right angle to the axis of shaft, 14, with which bearing surface is adapted to contact the inner surface of a bearing ring, 20. The outer surface of projection, 12, is preferably machined and has mounted thereon the flange, 21, preferably formed integral upon the outer end of sleeve, 22, provided with ample clearance space between the sleeve, 15, and the inner surface of opening, 13. Between the adjacent surfaces of projection, 12, and flange, 21, is a gasket, 23, while said flange, 21, and gasket, 23, are secured to said projection, 12, by a plurality of cap screws, 24, or other convenient means. Extending between and suitably secured to the inner end of sleeve, 22, and the outer end of bearing ring, 20, is a packing gland which may be of any desirable construction, but I prefer to construct the same of a tube, 25, which is arched in cross section and has its opposite ends extending into channels formed in the adjacent ends of ring, 20, and sleeve, 22. The opposite ends of tube, 25, are secured in each of said channels by being swaged, preferably by making said channels slightly less in width than the thickness of the ends of tube, 25, and pressing said ends into said channels until the respective ends of tube, 25, seat themselves in the bottoms of said channels, preferably with force sufficient to slightly upset the ends of tube, 25, or swaging one or both walls of each of said channels against the tube.

The arched cross-section of tube, 25, may extend substantially uniformly between the adjacent faces of ring, 20, and sleeve, 22, but I prefer to form the same as shown in the drawing with the arch substantially in the center of tube, 25, with a straight portion of the tube wall upon each side of the arched portion, 26, of tube, 25.

From substantially this construction it will be appreciated by those skilled in the art that the sealed medium contained in chamber, 10, will be in contact with the concave surface, 18, of head

17. That upon rotation of this shaft in the direction of the arrow, the substantial velocity will cause said medium in contact with surface, 18, and adjacent thereto, to be moved at substantial velocity across the mouth of the relatively thin annular volume between head 17 and the inner surface of opening, 13, and that said movement will be across the mouth of said volume and in a direction toward chamber, 10, and away from the possible path of escape of the medium.

It will furthermore be appreciated by those skilled in the art that such of the medium tending to escape as may reach the annular volume intermediate head, 17, and the inner surface of opening, 13, will be of substantially less pressure than the medium in chamber, 10, and will by the rotation of said head, 17, with shaft, 14, be substantially expelled from said annular volume by the action thereon of said spiral grooves, 19, and that said medium will be expelled into and augment the volume of the medium set in motion by said surface, 18.

It will also be understood by those skilled in the art as comprehended within the scope of my invention that where greater velocity or volume is desired than may be imparted by the rotation of the smooth surface, 18, in such case impeller blades may be mounted upon said surface, 18.

It will also be appreciated by those skilled in the art that by the substantial velocities of the cross currents thus set up at the inner end of collar 17, during the rotation of shaft 14, prevents or controls the further admission of confined medium from the container 10 to or through the thin volume intermediate the wall 11 and the collar 17 and ring 20, tends to prevent or control the building up of the pressure and temperature losses of the medium in such volume and that thereby a partial vacuum, or a substantially lesser pressure than prevails within the container 10, may be formed upon the outer surface of ring, 20, sleeve, 22, and tube, 25, and that under most disadvantageous conditions of operation only a part of the pressure in chamber, 10, may be exerted thereon; and that when pressure is exerted thereon, such pressure increases the thrust of ring, 20, upon the bearing surface of head, 17, due to said pressure being uniformly induced upon the tube, 25, which tube is normally under longitudinal spring compression from screws, 24, holding the juxtaposed surface of ring, 20, and head, 17, in sealed engagement; and that said longitudinal spring compression of tube, 25, may compensate for relatively longitudinal movement of shaft, 14, and walls, 11, as well as for slight wear, and also that different thinnesses of gaskets, 23, may compensate for further wear.

It will furthermore be appreciated by those skilled in the art that my method and apparatus provide a very substantial, efficient and inexpensive sealing of even the highest pressures and under conditions of the highest practicable shaft speeds, and of service life longer than was obtainable in the prior art.

The invention herein described may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to me of any royalty thereon or therefor.

Having now so fully described my invention that others skilled in the art may therefrom make and use the same, what I claim and desire to secure by Letters Patent is:

1. The method of employing a medium, confined under pressure in a chamber, to prevent escape of said medium between relatively movable sealing parts in a joint between said chamber wall and a shaft extending therethrough, comprising the steps of mechanically reducing the pressure of a portion of the confined medium adjacent said joint to provide a zone of reduced pressure of said medium between said joint and the adjacent portion of the chamber wall, and employing said medium under said reduced pressure to maintain the parts of said joint in sealing relation.

2. The method of employing a medium, confined under pressure in a chamber, to prevent escape of said medium between relatively movable sealing parts in a joint between said chamber wall and a shaft extending therethrough, comprising the steps of mechanically reducing the pressure of a portion of the confined medium adjacent said joint by impelling, at a point intermediate the sealing parts and the interior of said chamber, a portion of said confined medium away from the sealing parts to provide a zone of reduced pressure of said medium between said joint and the adjacent portion of the chamber wall, and employing said medium under said reduced pressure to maintain the parts of said joint in sealing relation.

3. The method of employing a medium, such as steam confined under pressure in a chamber, to limit its only undesirable path of escape between relatively movable contactable sealing parts in a joint between a portion of the wall of the chamber and a rotatable shaft extending therethrough, comprising the steps of passing, from the chamber, some of the medium to be sealed therein across the entrance to said path through a relatively small annular orifice; expanding said passed medium into a confined space; and holding the sealing parts in contact by the expanded medium with stress relative to the pressure of the expanded medium.

4. The method of employing a medium such as steam, confined under pressure in a chamber, to prevent escape of said medium between relatively movable sealing parts in a joint between said chamber wall and a shaft extending therethrough; comprising the steps of, mechanically and by heat transfer therefrom, reducing the pressure of a portion of the confined medium adjacent said joint to provide a zone of reduced pressure of said medium between said joint and the adjacent portion of the chamber wall, and employing said medium under said reduced pressure to maintain the parts of said joint in sealing relation.

5. The method of employing a medium, such as steam confined under pressure in a chamber, to limit its only undesirable path of escape comprising a joint between a portion of the wall of the chamber and a rotatable shaft extending therethrough, and which path is obstructable by the contactable surfaces of sealing parts which are relatively revolvable when the shaft is rotated, comprising the steps of passing, from the chamber, some of the medium to be sealed therein across the entrance to said path through a relatively small annular orifice; expanding said passed medium into a confined space, holding the sealing parts in contact by the expanded medium

with stress relative to the pressure of the expanded medium, and expelling medium away from the entrance to said path by and while the shaft is rotating for reducing the pressure in said volume and the stress of contact of the sealing parts.

6. The method of claim 5 characterized by said expansion space being relatively thin and long, and by heat transfer from medium in said space to the atmosphere.

7. In a packing about a shaft the combination of a container for a pressure medium, a rotatable shaft extending through the wall of said container, relatively revoluble contactable sealing parts about the shaft and obstructing a path intermediate said wall and the shaft, said path affording the only undesirable means of escape from the container of the medium under pressure, there being in said path a confined annular space having an orifice communicating with the interior of the container, said orifice being at a substantial angle and juxtaposed to the entrance to the contactable surfaces between said sealing parts, means for maintaining the contactable surfaces of the sealing parts in contact under a stress whose magnitude is relative to the pressure of the medium in said space, and means for lowering pressure of the medium in said space while the shaft is rotating; whereby the sealing parts are held together with a greater stress when medium is in such space while the shaft is not rotating, and with less stress when medium is in such space while the shaft is rotating.

8. Means for sealing mediums including means adapted to contain a medium under pressure and having a tubular opening extending thereinto, a rotatable shaft in said opening, a collar having helical teeth on its periphery and rigid upon said shaft and having its opposite sides respectively subjected to and not subjected to the pressure of the medium in said means, and means on the side of said collar subject to said pressure for moving the medium in bodily contact therewith at an angle to the opening, said last named means and said helical teeth reducing the pressure of the medium upon the sealing ring, a sealing ring surrounding said shaft and adapted to be in sealing engagement with the side of said collar not subjected to the pressure of the medium in said means, a mounting ring for said sealing ring, means for securing said mounting ring to said second stated means, and a tubular sealing gland arched in cross-section and secured to and extending between said sealing and mounting rings.

9. Means for sealing mediums including means adapted to contain a medium under pressure and

having a tubular opening extending thereinto, a rotatable shaft in said opening, a collar rigid upon said shaft and having its opposite sides respectively subjected to and not subjected to the pressure of the medium in said means, a sealing ring surrounding said shaft and adapted to be in sealing engagement with the side of said collar not subjected to the pressure of the medium in said means, a mounting ring for said sealing ring, means for securing said mounting ring to said means, a tubular sealing gland arched in cross-section and secured to and extending between said sealing and mounting rings, helical grooves formed in the periphery of said collar, and the side of said collar opposite that engaged by said sealing ring having a concave surface surrounding said shaft and extending substantially to the outer periphery of the collar, said helical grooves and said surface reducing the pressure of the medium upon said sealing ring.

10. In a packing for steam or other substantial pressure medium, the combination of a receptacle adapted to contain such medium, a shaft adapted to be rotated and passing through a wall of said receptacle, a collar of substantial thickness on and rotatable with said shaft, tubular means surrounding said shaft and having elements at opposite ends one of which elements is secured leak proof to said receptacle and the other of which engages the adjacent face of said collar in sealing engagement, there being a relatively long thin annular opening surrounding said collar and a substantial part of said tubular means, and there being a relatively long thin second annular opening surrounding said shaft within said tubular means and extending from said sealing engagement to the atmosphere, the face of said collar opposite the face thereof subjected to said sealing engagement being exposed to the pressure medium which said receptacle may contain, and means upon the periphery of said collar for expelling by the rotation of said collar and its shaft the pressure medium within said first stated opening and into the receptacle, whereby said expelled medium resists the pressure of said medium which otherwise would be upon said sealing engagement.

11. The combination of claim 10 further characterized by said exposed face of said collar being provided with recessed means for imparting diagonally inward motion to said medium in contact therewith to and commingling the same at said mouth with the medium expelled from said mouth, whereby said commingled medium resists the pressure of said medium which otherwise would be upon said sealing engagement.

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