

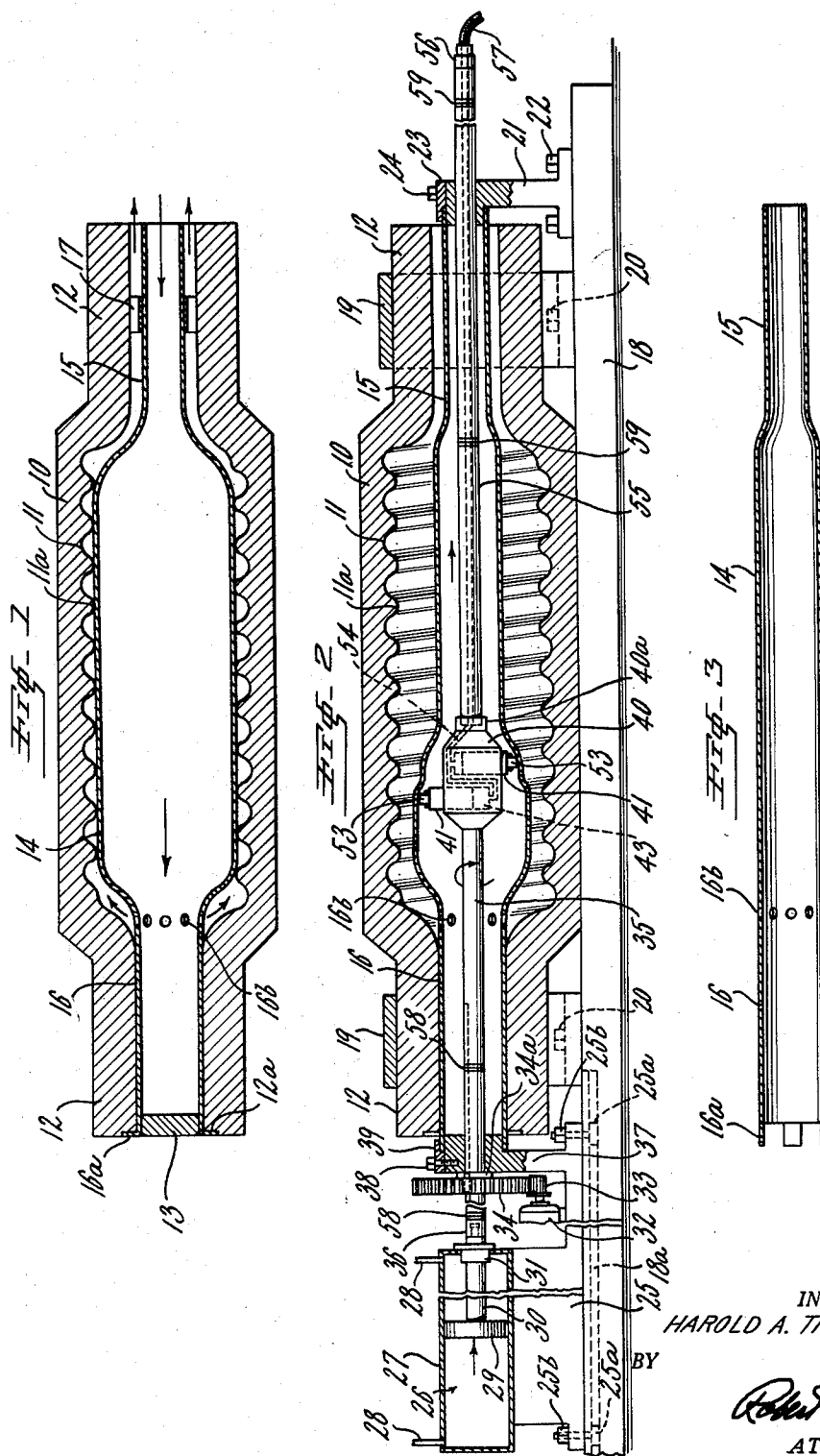
Oct. 13, 1959

H. A. THORNBURG
HEAT EXCHANGE ROLL

2,908,486

Filed July 7, 1955

2 Sheets-Sheet 1



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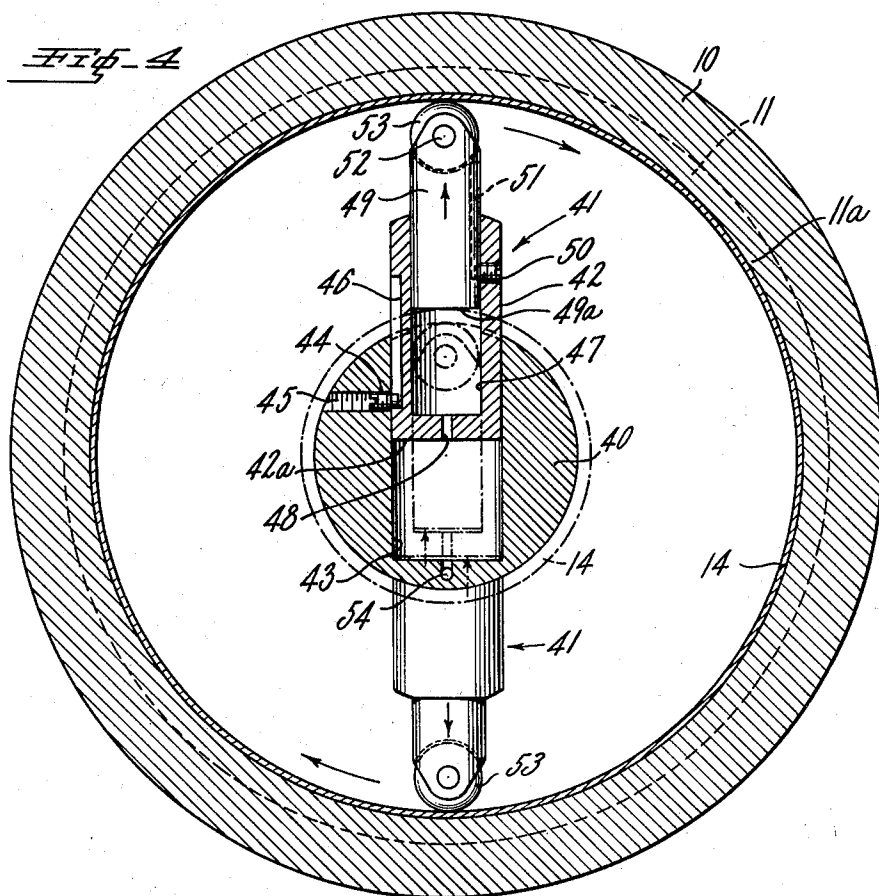
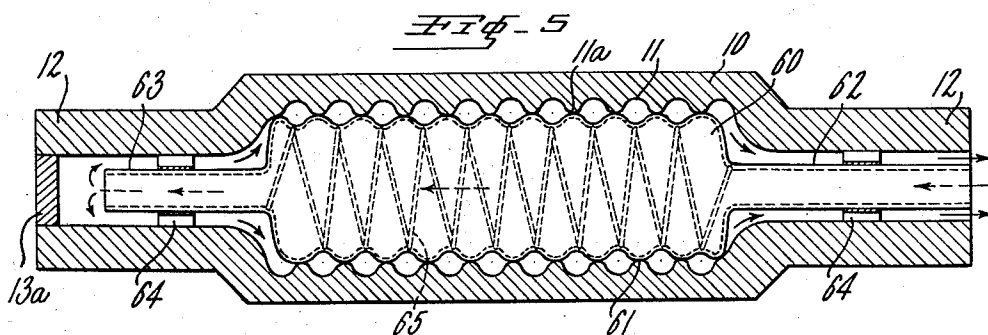
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2 Sheets-Sheet 2



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HEAT EXCHANGE ROLL

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Application July 7, 1955, Serial No. 520,434

8 Claims. (Cl. 257—95)

This invention relates to a roll for working rubber, and like materials and for other purposes, and more particularly to an improved roll having heat transfer means therein for maintaining a uniform roll surface temperature.

There have been numerous attempts in the prior art to develop such rolls with heat transfer means therein for effectively controlling and maintaining a uniform surface temperature both longitudinally and circumferentially of the roll. In many of these rolls the interior wall surface was substantially cylindrical, thereby limiting the total surface area in contact with the fluid medium employed, and consequently restricting the rate of heat transmission. In others, the entire interior cavity was filled with heat transfer medium which merely flowed from one end to the other. Obviously, the velocity of flow for a given pressure was low because of the necessity for moving a large quantity of medium through the cavity. Moreover, the temperature at one end of the roll varied greatly with that at the other end.

This invention is an improvement upon the prior art devices and its principal object is to provide a roll which is so constructed as to efficiently employ the principle of helical counterflow in heat transmission in order to obtain a uniform surface temperature both circumferentially and longitudinally of the roll.

An important object of the invention is to provide a roll which is so constructed as to increase the total internal surface area of said roll in contact with the heat transfer medium for a higher rate of heat transmission.

Another important object is to provide a roll which is so constructed as to permit higher velocity of heat transfer medium flow so that for a given temperature and quantity of medium a higher rate of heat transmission will occur.

A further object of the invention is to provide a roll having a thinner wall for a higher rate of heat transmission without a loss of roll strength.

Still another object is to provide a roll having a heat conductive tube therein which is so constructed as to provide for a higher rate of heat transmission.

The foregoing and other objects and advantages of the invention will become apparent from a consideration of the following specification and claims when read in conjunction with the accompanying drawings wherein:

Fig. 1 is a longitudinal sectional view illustrating the roll of the invention and one type of heat conductive tube disposed therein;

Fig. 2 is a longitudinal sectional view showing the apparatus for properly positioning and forming the heat conductive tube within the roll of Fig. 1;

Fig. 3 is a longitudinal sectional view of the heat conductive tube of Fig. 1 prior to positioning the same within the roll;

Fig. 4 is an enlarged cross sectional view showing a part of the apparatus of Fig. 2 in fully extended position, and

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Fig. 5 is a longitudinal sectional view of the roll and another type of heat conductive tube disposed therein.

Referring to Fig. 1, there is shown a roll 10 which is especially adapted for rubber working machines such as calenders and mills. However, it will be understood that the roll is not limited to such machines but has wider application to a variety of installations wherein it is necessary or desirable to maintain a uniform roll surface temperature in order to properly work the particular material employed.

Roll 10 has hollow trunnions 12 at each end, one of which is closed by a conventional plug 13, and may be made of any suitable material, preferably a ferrous metal such as chilled iron. The roll 10 may be economically cast because the only necessary change in existing casting procedure would be to provide the expendable sand core with a helical rib. As is apparent, roll 10 is hollow and its interior surface 11 forms an enlarged central cavity therein. Surface 11 is provided with a helical rib 11a which has an internal diameter approximately two and one half times the internal diameters of trunnions 12, and is preferably cast integrally with roll 10; however, the rib may also be machined therein by a tool similar to a conventional internal threading tool, if so desired. Helical rib 11a produces a higher rate of heat transmission by increasing the internal surface area of the roll and by permitting a decrease in roll wall thickness. No loss of roll strength occurs because there are no two points in the groove adjacent the rib 11a which are diametrically opposite each other. Therefore, there are no weak sections such as found in rolls having a series of interconnected annular or longitudinal grooves.

Within the cavity of roll 10 there is disposed a heat conductive tube 14 which is preferably constructed of a relatively thin-walled, highly conductive metal such as aluminum or copper, for a higher rate of heat transmission. Tube 14 is provided with an inlet end 15 and an outlet end 16, each of which extends into trunnions 12. Inlet end 15 is secured in one of the trunnions 12 by means of a conventional spider 17 extending therebetween. Spider 17 may be rigidly attached to inlet 15 and trunnion 12 in any suitable manner, preferably by welding. Outlet end 16 is secured in the other of trunnions 12 in any suitable manner, preferably by means of a press fit therebetween. If desired, outlet end 16 may be additionally secured in trunnion 12 by providing the former with outwardly extending flange portions 16a which are seated in corresponding recesses 12a in the latter, and welded thereto. Plug 13 may be made so as to fit tightly within outlet end 16 and if desired, may be welded thereto. The central portion of tube 14 is expanded in the cavity of the roll 10 whereby the exterior surface of the tube 14 abuts the rib 11a to form a helical passage therebetween.

In operation, the roll 10 and tube 14 rotate together, and as indicated by the arrows in Fig. 1, the heat transfer medium flows into the central portion of tube 14 through the opening of inlet end 15 in one direction; then the medium flows out from the numerous apertures 16b in outlet end 16, through the helical passage formed by the rib 11a and the central portion of tube 14, around inlet end 15 in trunnion 12, and out of the roll, in the opposite or counter direction.

It is apparent that the fluid medium may heat or cool the roll depending upon the effect desired. For purposes of illustration it will be assumed that the medium is employed as a cooling agent. The entering medium is coolest at the inlet end 15 and gradually increases in temperature as it fills the central portion of tube 14 and approaches the outlet end 16, because it is picking up heat from the exiting fluid which is flowing in the reverse direction in contact with the exterior surface of tube 14

and interior surface 11 of roll 10 through the helical passage formed between tube 14 and rib 11a. This exiting medium is at approximately the same temperature as the entering fluid in the outlet end 16, and as the exiting medium flows through the channel it will be kept at this temperature by the cooler entering medium closer to the inlet end 15. The exiting medium will thus transfer the heat from the interior surface 11 of the roll 10 at a rapid uniform rate; thus the outer surface temperature of the roll 10 will be uniformly reduced and kept substantially constant throughout its length and its circumference as well, because of the efficient application of the helical, counter flow path principle.

In addition to forming the helical passage, rib 11a has other important functions. One is to greatly increase the total surface area of roll 10 available for contact with the heat transfer medium, and another is to reduce the thickness of the roll wall required without loss of strength, both functions resulting in a higher rate of heat transmission. The increase in heat transmission is also aided by forming the helical passage relatively small in comparison to the space formed in the central portion of tube 14; this construction permits a higher velocity of heat transfer medium flow so that for a given temperature and quantity of medium a higher rate of heat transmission will occur.

Referring to Fig. 2, the apparatus for clamping roll 10 and for installing tube 14 within the roll will now be described. Such apparatus is described and claimed in copending application Serial No. 520,536, filed July 7, 1955. A solid base 18 is provided to support roll 10 which is secured thereon by clamps 19 tightly engaging trunnions 12. Clamps 19 are in turn fastened to base 18 by any suitable means such as bolts 20. Inlet end 15 of tube 14 extends beyond trunnion 12 and fits snugly over a cylindrical hub portion formed on stanchion 21, which is firmly secured to base 18 by any suitable means such as bolts 22. Inlet end 15 is immovably secured to stanchion 21 by means of one or more clamps 23 and bolts 24.

The mechanism for clamping outlet end 16 and expanding the central portion of tube 14 comprises a bearing block 25 adjustable longitudinally of base 18 by means of T-bolts 25a and nuts 25b passing through a slot 18a therein. At one end of block 25 there is a double acting hydraulic motor 26 comprising a cylinder 27 having ports 28 and a piston 29. Integrally attached to piston 29 is a piston rod 30 which reciprocates through a conventional packing 31 in one end of cylinder 27. Adjacent the other end of bearing block 25 there is mounted a conventional electric motor 32 having a flanged pinion 33 which drivingly engages a gear 34 slidably mounted on rod 35 by means of a conventional spline connection. Rod 35 is connected to piston rod 30 by any suitable coupling such as 36, permitting relative rotation therebetween. At the other end of bearing block 25 is a stanchion 37 which is similar to stanchion 21. Stanchion 37 is provided with a hub portion around which outlet end 16 of tube 14 is secured by one or more bolts 38 and clamps 39, and through which shaft 35 rotates and reciprocates. Gear 34 may be provided with a small hub or washer 34a to space the gear from stanchion 37, and together with the flanged pinion 33, hub or washer 34a will permit gear 34 to rotate rod 35 but will prevent the gear from reciprocating therewith.

At the end of rod 35 remote from piston rod 30 is the expanding tool or head 40 in which are disposed a pair of diametrically opposed and axially offset, telescoping arms 41. Since the construction and operation of each arm is identical, a description of one will suffice for both. Referring now to Fig. 4, each arm 41 comprises an outer piston 42 reciprocable in bore 43 of head 40. The movement of outer piston 42 is limited by means of a stop screw 44 threaded into a bore 45 in head 40 and slidably engaging a slot 46 in outer piston 42. Outer

piston 42 is also provided with a large cavity 47 in which inner piston 49 reciprocates and a small aperture 48 for the flow of hydraulic fluid into cavity 47. The movement of inner piston 49 with respect to outer piston 42 is limited by a stop screw 50 threaded into outer piston 42 and slidably engaging a slot 51 in inner piston 49. Inner piston 49 is bifurcated at its outer end in which is mounted a shaft 52 upon which a roller 53 rotates.

Referring to Fig. 2, the head 40 is provided with a passageway 54 having openings into each of bores 43 and the end of head 40 opposite rod 35 is provided with a boss 40a having a hollow shaft 55 threaded therein. Hollow shaft 55 freely extends through the hub portion 21 and is rotatably coupled at 56 to a flexible coupling 57 which is in turn connected to a suitable source of hydraulic fluid supply (not shown).

The manner in which tube 14 is fabricated and positioned within roll 10 will now be described. As seen in Fig. 3, tube 14, before being inserted in the roll 10, is formed with a smaller tubular portion which serves as inlet end 15, and a larger portion, one end of which comprises outlet end 16 having flange portions 16a and apertures 16b formed therein. As stated above, tube 14 is preferably formed of relatively thin-walled, highly conductive metal such as aluminum or copper, and it may be given the shape of Fig. 3 by a conventional extrusion or drawing process. The apertures 16b are either drilled or punched before tube 14 is positioned within roll 10, and flange portions 16a are preferably formed by cutting out a series of circumferentially spaced, axially extending slots before tube 14 is located within roll 10, but this may be done after the positioning step, if so desired.

After roll 10 is clamped in the position shown in Fig. 2 by the clamps 19, tube 14 is inserted within the roll preferably from right to left with outlet end 16 entering the roll first. While tube 14 is being initially positioned within roll 10, bearing block 25 is located far enough away from the left end of roll 10 and piston 29 is fully retracted so that the expanding tool or head 40 is disposed completely outside roll 10. The hollow shaft 55 is preferably passed through roll 10 and tube 14 in the same direction as the tube, and is threaded into head 40 at 40a and coupled at 56 to flexible coupling 57. Inlet end 15 is now clamped on stanchion 21 and bearing block 25 is slid to the position shown in Fig. 2. At this time the telescoping arms 41 of expanding tool or head 40 are permitted to fully retract and the head will therefore slide within outlet end 16 of tube 14. Flange portions 16a of outlet end 16 are then clamped over stanchion 37 and bearing block 25 is firmly secured to base 18 by means of bolts 25a and nuts 25b. The operations of the hydraulic motor 26 and electric motor 32 are controlled by a suitable switch or switches (not shown); the head 40 being reciprocated by piston 29 through piston rod 30 and extension rod 35, and rotated by pinion 33 through gear 34 and rod 35. When head 40 extends far enough into roll 10 so that the expanding operation may begin, a suitable valve (not shown) connected to flexible coupling 57 is opened, whereby hydraulic fluid from a suitable source of supply (not shown) passes under pressure through hollow shaft 55, passage 54 in head 40 and into bores 43.

Referring now to Fig. 4 particularly, the incoming hydraulic fluid exerts pressure against the bottom face 42a of outer piston 42, and passing through aperture 48, acts against bottom face 49a of inner piston 49, as shown by the dotted arrows. Outer piston 42 will move outwardly first because the surface area of its bottom face 42a is greater than that of piston 49. When stop screw 44 engages the bottom of slot 46, outer piston 42 reaches its outer limit of movement. At this point, the hydraulic fluid acts against bottom face 49a forcing inner piston 49 outwardly until stop screw 50 engages the bottom of slot 51, limiting further movement. It will be noted that both outer piston 42 and inner piston

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49 are designed so that they are in their outermost positions when the enlarged central portion of tube 14 firmly abuts rib 11a, and thus there is no possibility of the tube being over expanded into the helical passage formed between the turns of helical rib 11a.

Obviously, pistons 42 and 49 comprising the telescoping arms 41 of head 40 will be expanded gradually by progressively increasing the fluid pressure as the head rotates relative to tube 14 about the axis thereof (in the direction of the arrows) and simultaneously reciprocates within roll 10 and relative to tube 14 along the axis thereof, until the central portion of tube 14 is radially expanded from its dot-dash line position to its solid line position. (Fig. 4), with its external surface abutting rib 11a. The longitudinal position of head 40 within roll 10 may be determined by any suitable gauge but preferably by scored markings such as 58 on rod 35 and/or 59 on shaft 55, as shown in Fig. 2, so that the central portion of tube 14 can be expanded to the proper shape without distorting apertures 16b or weakening the tube at the juncture of outlet end 16 and the central portion of tube 14.

At the completion of the expanding operation the fluid pressure in head 40 is released and pistons 42 and 49 comprising the expandible arms 41, are permitted to retract so that the tool 40 may be withdrawn from the roll through outlet end 16. After the tool or head 40 has passed to the left of apertures 16b the fluid pressure is increased slightly so that the expandible arms will bear against the interior of outlet end 16 and expand the same to a press fit within trunnion 12 as the tool is being retracted. When the head 40 approaches stanchion 37 the fluid pressure in head 40 is released, thereby allowing arms 41 to retract; the switches (not shown) activating hydraulic motor 26 and electric motor 32 are turned off; hollow shaft 55 is disconnected at 56 from flexible coupling 57; the bolts 25a and nuts 25b holding bearing block 25 are loosened, and bolts 38 and clamps 39 are removed from stanchion 37. The bearing block 25 is then slid away from outlet end 16, thereby pulling head 40 along with the bearing block 25 until the head is free of the roll 10. The hollow shaft 55 is detached from boss 40a on head 40 and completely withdrawn from the roll, preferably from left to right as viewed in Fig. 2; inlet end 15 of tube 14 is removed from stanchion 21 and is then supported in trunnion 12 by a spider 17 which may be welded to the trunnion and inlet end 15. If desired, the flange portions 16a of outlet end 16 may now be bent over to fit into recesses 12a and welded therein, and plug 13 may then be pressed into outlet end 16 for welding thereto.

Referring now to Fig. 5, roll 10 is shown as having a different type of tube 60 therein. Tube 60 has a central enlarged portion having a helical rib 61, an inlet portion 62 and an outlet portion 63. Rib 61 on tube 60 abuts rib 11a on the interior surface 11 of roll 10 to form a helical passage which is arcuate in cross-section. Inlet end 62 and outlet end 63 are each secured in trunnions 12 by means of spiders 64 extending therebetween. The left end of roll 10 is closed by means of a conventional plug 13a which may be welded in place, if desired.

Tube 60 is preferably constructed of an elastomeric material such as neoprene, silicone rubber or any other suitable elastomer capable of withstanding a wide range of temperatures, and is preferably molded to the shape shown in Fig. 5, in a conventional manner. The enlarged central portion of the elastomeric tube 60 is preferably reinforced by a helical winding of fabric cord embedded therein and vulcanized thereto. The fabric cord may be made of any suitable material such as nylon or cotton, and as will be apparent the helical turns of the cord 65 are spaced so that the elastomeric material extending between the helical turns protrudes outwardly to form rib 61.

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The assembly of tube 60 within roll 10 is relatively simple because the flexible enlarged central portion can be folded upon itself to fit within hollow trunnions 12, and thus the tube can be placed within the roll from either end. When the tube 60 is substantially enclosed within roll 10 the natural resilience of the central portion will cause it to assume its original shape, thereby substantially filling the central cavity in roll 10, except for the space between the convolutions of helical rib 11a. The tube 60 can then be moved until ribs 11a on roll 10 and 61 on tube 60 abut each other to form the helical passage, and this position can be determined by making inlet end 62 of such a length that when the open end thereof is flush with the end of trunnion 12 the aforementioned ribs will be in abutting relationship. Spiders 64 may then be interposed between trunnions 12, inlet end 62 and outlet end 63 to provide the necessary support therefor. Spiders 64 may be welded to trunnions 12 and secured to inlet and outlet ends 62 and 63 by any suitable cement.

In operation, inlet end 62 of tube 60 is open to receive the fluid heat transfer medium in the same manner as inlet end 15 of insert 14. The medium flows under pressure through inlet end 62, the central portion of tube 60 and through outlet end 63 in one direction, then reversing itself, the medium flows in a counter direction through the helical passage formed by ribs 11a and 61 and out of the roll.

The tube 60 of Fig. 5 has the advantage over tube 14 of Fig. 1 in that the former may be positioned within the roll 10 much more quickly and easily; however, it is preferable to use tube 14 because it is constructed of a highly conductive metal as compared to the less conductive elastomeric material of tube 60, thereby providing a significantly higher rate of heat transmission. It is apparent that elastomeric tube 60 could be formed with a substantially cylindrical central portion comparable to that of metal tube 14. However it is preferred that tube 60 be formed with rib 61 in order to increase the total surface area in contact with the heat transfer medium thereby increasing the rate of heat transmission.

While the invention has been shown and described in certain preferred forms, it is to be understood that various changes and modifications may be made therein by those skilled in the art without departing from the principles of the invention, the scope of which is to be determined by the appended claims.

Having thus described my invention, what I claim and desire to protect by Letters Patent is:

1. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll having hollow trunnions at each end thereof and an interior surface interposed between said trunnions with a helical rib thereon, a heat conductive tube within said roll, said tube having an exterior surface forming in co-operation with said rib a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and an outlet end extending into the other trunnion, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said roll.

2. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll having hollow trunnions at each end thereof and an interior surface interposed between said trunnions with

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a helical rib thereon, a heat conductive tube within said roll, said tube having a substantially cylindrical exterior surface abutting said rib to form a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and an outlet end extending into the other trunnion, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll.

3. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll having hollow trunnions at each end thereof and an interior surface interposed between said trunnions with a helical rib thereon, a heat conductive tube within said roll, said tube having an exterior surface with a helical rib thereon, said ribs abutting each other to form a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and an outlet end extending into the other trunnion, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll.

4. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll having hollow trunnions at each end thereof and an interior surface interposed between said trunnions with a helical rib thereon, a heat conductive tube within said roll, said tube having an exterior surface forming in cooperation with said rib a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and an outlet end extending into the other trunnion, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll, at least one of said ends of said tube being secured within said trunnions by means of a spider extending therebetween.

5. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll having hollow trunnions at each end thereof and an interior surface interposed between said trunnions with a helical rib thereon, a heat conductive tube within said roll, said tube having a substantially cylindrical exterior surface abutting said rib to form a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and being secured therein by means of a spider extending therebetween, said tube having an outlet end extending into the other trunnion and being secured therein by means of a press fit therebetween, said outlet end being connected to one end of said helical passage and

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the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll.

6. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll having hollow trunnions at each end thereof and an interior surface interposed between said trunnions with a helical rib thereon, a heat conductive tube within said roll, said tube having an exterior surface with a helical rib thereon, said ribs abutting each other to form a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and being secured therein by means of a spider extending therebetween, said tube having an outlet end extending into the other trunnion and being secured therein by a spider extending therebetween, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll.

7. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll constructed of a ferrous metal and having hollow trunnions at each end thereof, said roll having an interior surface interposed between said trunnions with a helical rib cast thereon, a heat conductive tube within said roll, said tube being constructed of a relatively thin-walled conductive metal and having an enlarged central portion with a substantially cylindrical exterior surface abutting said rib to form a helical passage for conducting a heat transfer medium in contact with said surfaces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and being secured therein by means of a spider extending therebetween, said tube having an outlet end extending into the other trunnion and being secured therein by means of a press fit therebetween and by welded interlocking engagement between outwardly extending flange portions on said outlet end which are seated in corresponding recesses in the end of said other trunnion, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll.

8. A heat transfer roll, for conducting a heat transfer medium therein in a helical counter-flow path so as to maintain a uniform surface temperature both circumferentially and longitudinally of said roll, comprising a hollow roll constructed of a ferrous metal and having hollow trunnions at each end thereof, said roll having an interior surface interposed between said trunnions with a helical rib cast thereon, a heat conductive tube within said roll, said tube being constructed of a relatively thin-walled elastomeric material and having an enlarged central portion with a cord helically wound therethrough and embedded therein, said elastomeric material protruding between the helical windings of said cord to form a helical rib on the exterior surface of said central portion, said ribs abutting each other to form a helical passage for conducting a heat transfer medium in contact with said sur-

faces in a helical-flow path, said tube having an inlet end extending into one trunnion for receiving the heat transfer medium and being secured therein by means of a spider extending therebetween, said tube having an outlet end extending into the other trunnion and being secured therein by means of a spider extending therebetween, said outlet end being connected to one end of said helical passage and the other end of said passage having an outlet in said one trunnion surrounding said inlet end for conducting the heat transfer medium in a counter-flow path thereby in conjunction with said helical-flow path maintaining a uniform surface temperature circumferentially and longitudinally of said hollow roll.

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