

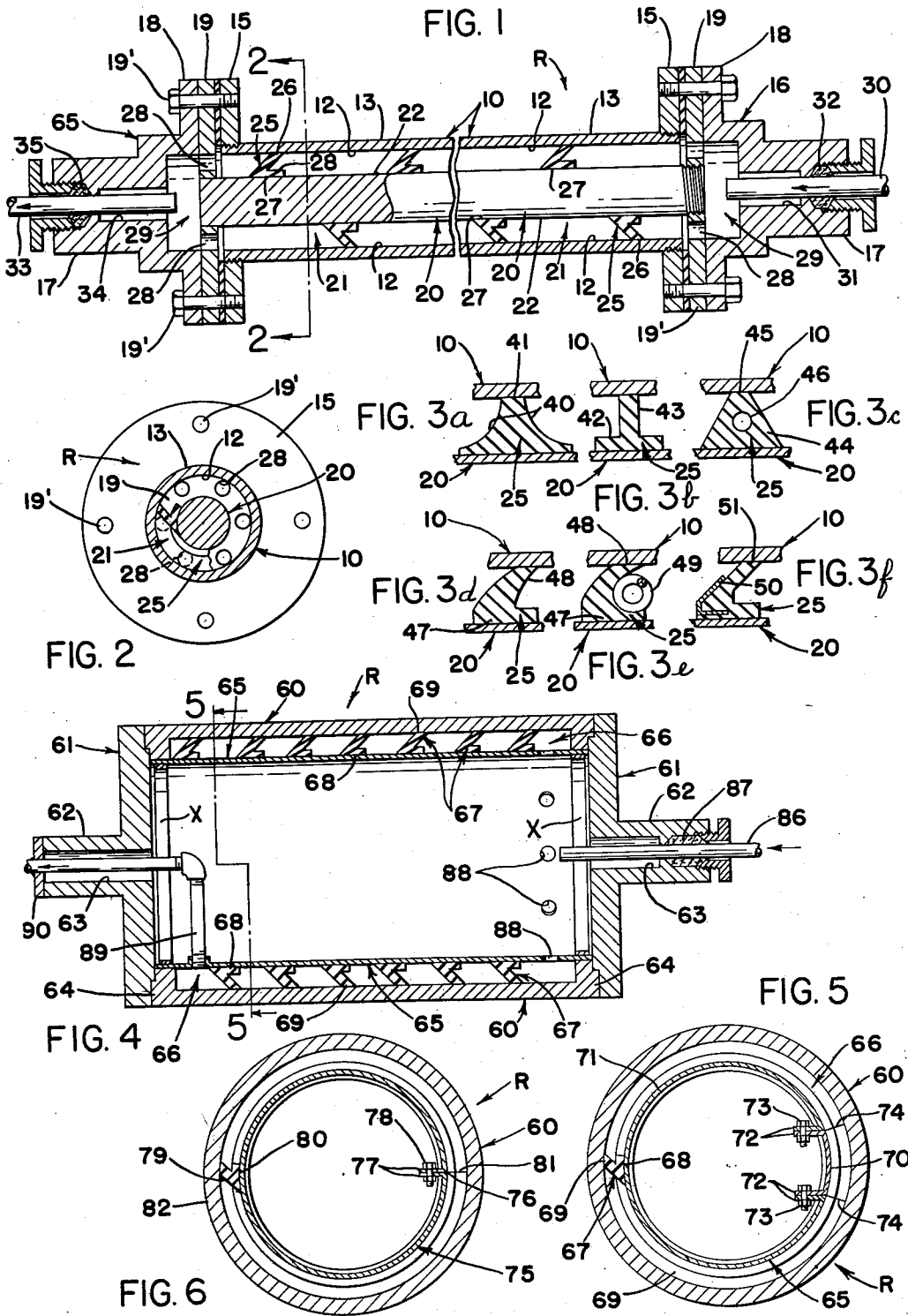
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PROCESSING ROLLS

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3,080,150

PROCESSING ROLLS

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3 Claims. (Cl. 165-76)

This invention relates to temperature controlled processing rolls and more especially to constructions for facilitating the transfer of heat through heat-conducting walls of processing rolls by the circulation of fluid heat-transfer medium in contact with the heat-conducting walls of processing rolls, and to structures for forming passages contiguous to the heat-conducting walls through which fluid heat-transfer medium may be circulated in contact therewith.

In temperature controlled processing rolls utilizing a heat-transfer medium, it is inevitable that scum, slime, dirt and debris will collect on the surfaces exposed to the fluid heat-transfer medium, especially where water from natural sources is used as the heat-transfer medium, and that these accumulations materially cut down the efficiency of the heat transfer from or to the rolls. Further, where rigid baffles are used in the annular space through which the heat-transfer medium is circulated, it is difficult to secure water-tight joints between the edges or tips of the baffles and the heat-conducting surface, and, where a tight joint is obtained, it is difficult satisfactorily to assemble the same and usually the two corrode and adhere to each other so that it is not possible to disassemble the parts for cleaning without damaging some of the parts to such extent as to render them unsuitable for further use.

It is the purpose of this invention to overcome the disadvantages hereinabove noted of present temperature controlled processing rolls by providing for such rolls an insert for placing within the heat-conducting wall of the roll, which insert is of such less outer diameter than the inner diameter of the heat-conducting wall as shall provide a suitable annular space for the heat-transfer medium, and which insert shall have associated with it flexible and elastically compressible partitions, or projecting rib structures, which partitions are of such height as to extend across the annular space and, when in operative position, to be held under elastically deformable compression against the inner surface of the heat-conducting wall so as to form a compressibly and elastically fluid-tight joint with the heat-conducting wall of the roll.

Preferably the partitions are made of live rubber, or a similar rubber-like material, since materials of this type are not only flexible and elastically compressible and recoverable in shape after compression, but also, when wet with water, slide easily over the surfaces of heat-conducting walls. In other words, water is an excellent lubricant for rubber. The term "rubber" is herein employed in a generic sense to include any elastomer, that is, any rubber-like material which has the property of being flexible and elastically compressible, and capable of having its movements in compressive contact with a heat-conducting wall effectively lubricated by water. It may vary in degrees of firmness within the range normally pertaining to gasket packings.

These flexible and elastically compressible partitions of rubber permit the insert with which they are associated to be readily assembled in operative position with respect to the heat-conducting wall member of the processing roll because of the flexibility and compressibility of the partitions and of the effective lubrication of water for rubber, and also as readily disassembled, and when in assembled position to form fluid-tight joints between the edges of the partitions and the heat-conducting wall of

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the roll by reason of the elastically-compressible stresses in the partition acting in directions substantially normal to the heat-conducting wall and to the insert radially spaced therefrom.

Other objects and advantages of the invention will be apparent from the disclosure of the several embodiments of the invention as hereinafter more specifically described and illustrated in the drawings, in which:

FIG. 1 is a sectional view taken longitudinally of a heat-exchanger roll of this invention in which the heat-conducting wall is in the form of a generally cylindrical roll, the insert carrying the flexible elastically deformable partitions being located within the heat-conducting wall;

FIG. 2 is a sectional view taken on line 2-2 of FIG. 1;

FIGS. 3a, 3b, 3c, 3d, 3e and 3f are enlarged cross-sectional views illustrating some of the various shapes the flexible compressible elastically deformable partitions may have;

FIG. 4 is a sectional view taken longitudinally of a heat-exchanger roll illustrating a form of the heat-exchanger roll of this invention;

FIG. 5 is a sectional view of the heat-exchanger roll of FIG. 4 taken on line 5-5 of FIG. 4; and

FIG. 6 is a sectional view of a modification of the heat-exchanger roll of FIG. 4.

Referring to FIGS. 1 and 2 of the drawing, the numeral 10 designates the heat-conducting wall member of a roll R, annular in cross-section normal to a straight line axis, through which wall heat is to be conducted, and is generally referred to in this specification as the cylindrical heat-conducting wall 10. Specifically illustrated is a roll R having the heat-conducting wall 10, annular in cross-section, and having an inner cylindrical surface 12 and an outer cylindrical surface 13. As shown, the hollow heat-conducting wall 10 has an annular disc-like end supporting member 15 at each end thereof, and also at each end an axially disposed cylindrical end member 16, each end member 16 having outwardly extending cylindrical portion 17 of reduced diameter, and an annular flange portion 18 at the inner portion of the end member 16. The cylindrical portions 17 serve as journals by which the roll R is supported, as a roll of a mixing machine, calender or the like. The roll R is rotatable on the cylindrical portions 17 by means of suitable bearings and driving mechanisms, not shown. The annular discs 15 and 19 and the flange 18 at each end of the roll are detachably joined in a unit by suitable clamping means as by bolts 19'.

Referring particularly to FIG. 1, an insert 20 is disposed within the roll R and is of such size and shape as to provide an annular space 21 between the inner surface 12 of wall 10 and the surface 22 of the insert 20, which surface 22 forms the boundary of the annular space 21 through which the fluid heat-transfer medium is circulated. The insert 20, as shown, is a cylindrical rod, but it is to be understood that the insert 20 may be a hollow cylinder and may be made of a metal or of other rigid material, such as a rigid plastic.

Attached to surface 22 of the insert 20 are partition means 25 which extend across the annular space 21 and are of such size and shape that when in operative position the free edges 26 of the partitions 25 are held in elastically deformable compressive contact with the surface 12 of the heat-conducting wall 10, thus forming a fluid-tight joint between the partition edges 26 and the heat-conducting wall 10 and also forming an elongated passageway for the flow of cooling fluid through the annular space 21. The base 27 of the partition 25 is preferably adhered to the surface 22 of the insert 20.

As shown in FIGS. 1 and 2, the insert 20 is supported

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centrally within the heat-conducting wall 10 by means of the annular discs 19, each end of the insert 20 fitting tightly into a central opening of a disc 19, or connected thereto by the usual screw thread joinder. Each of the annular discs 19 has a plurality of openings 23, which form passageways for heat-exchange medium between the annular space 21 and a chamber 29, located within each of the end members 16.

As is shown in FIG. 1, the flow of the heat-transfer fluid is in such a direction that the differential fluid pressure on each side of the partition 25 acts to press the tip 26 of the partition 25 with a positive force against the inner surface 12 of the heat-conducting wall 10 of the roll R. Thus, in FIG. 1, the heat-transfer fluid flows from right to left with gradually diminishing pressure and hence the differential pressure acts to press the tip 26 more firmly in contact with the inner cylindrical surface 12 of the heat-conducting wall 10 of the roll R, and consequently supplements the elastically deformable compressive force of the partition 25 due to the fact that the height of the partition 25 is substantially greater than the radial distance between the inner wall 12 of the heat-conducting wall 10 and the outer wall 22 of the insert 20.

Any suitable inlet and outlet for the heat-transfer fluid may be provided. As shown, an inlet pipe 30 passes through the central opening 31 in the end member 16, a packing gland 32 of conventional structure being provided to seal off the opening 31. The heat-transfer fluid passes into the annular space 21 of the roll R through inlet pipe 30 and then through chamber 29 and openings 23 into one end of the annular space 21, thence through the spirally elongated passageway. A suitable outlet means for the heat-transfer medium is provided at the other end of the roll, and may consist of an outlet pipe 33 passing through a central opening 34, and having a conventional packing 35. The heat-transfer medium passes from the annular space 21 through the openings 23 into the chamber 29 at the outlet end of the roll, and thence through the pipe 33 to a suitable discharge outside the roll.

The roll R is normally assembled in the following manner: the partition 25 is wrapped spirally around the outer surface 22 of the insert 20, the pitch of the spiral being such as to produce the desired degree of cooling, a lower pitch producing a longer spiral passageway and a greater heat-transfer capacity. With one of the end assemblies, including end member 16 and disc 19, removed, the insert 20 with the partition 25 attached thereto, is wet with water, and then slid into the roll, the water acting as a lubricant between the partition 25 and the inner surface 12 of the heat-conducting wall 10 of the roll, the tip 26 of the partition 25 bearing against the inner surface 12 of the heat-conducting wall 10 of the roll with an elastically compressive pressure. Other parts of the roll are then assembled and the roll R is ready for service in a machine utilizing a temperature controlled roll.

In FIGS. 3a, 3b, 3c, 3d, 3e and 3f are shown modifications of the partition 25, the heat-conducting wall 10 and the insert 20 having the same numerals as in FIGS. 1 and 2. In FIG. 3a, the partition 25 is in cross-section in the form of a truncated triangle, the sides being dished at 40 and the tip 41 being of considerable width to give a good bearing surface of the partition 25 against the wall 10; in FIG. 3b, the partition 25 in cross-section has a base portion 42 and a riser portion 43 extending from the central portion of the base 42; in FIG. 3c, the partition 25 is in cross-section a truncated triangle, with base 44 at insert 20 and cut-off apex 45 at wall 10, the partition 25 in this form also having a hollow opening 46 extending the length of the partition 25 to give to the latter greater flexibility and compressibility; in FIG. 3d, the partition 25 is in cross-section in the shape of an acute angle, and comprises a base portion 47 hav-

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ing an extension 48 arising from one side of base 47 and projecting over the other side of base 47; in FIG. 3e, the partition 25 is similar in cross-section to that of FIG. 3d but with a curved recess on the inner side of the angle in which a spiral spring 49 is disposed; and in FIG. 3f, the partition 25 is similar in cross-section to that of FIG. 3d but has a thin metal reinforcement 50 imbedded in and/or attached to the base and the outer extending side of the partition 25 to reinforce and hold the edge 51 of the partition in firm deformable compressive contact with the wall 10.

In the construction of FIGS. 4 to 6, the roll R has a heat-conducting cylindrical wall 60, supported at each end by circular plates 61 having centrally-disposed outwardly-projecting portions 62 with axially-disposed openings 63. The projections 62 serve as journals for the roll and the openings 63 as means for admission and discharge of heat-transfer media into and out of the interior of the roll R. The heat-conducting cylindrical wall 60 has at each end thereof inwardly-projecting shoulder portion 64 which serves as a cylindrical seat or support for a cylindrical insert 65. The insert 65, which may be of sheet metal or other rigid resilient material, supports a spirally-disposed flexible and compressible partition structure 67 having a base portion 68 and an inclined leg portion 69, the free edge of which contacts the heat-conducting wall 60 with a deformable compressive force which makes a fluid-tight seal. In this form a processing roll, the heat-conducting wall 60 and the insert 65 are assembled prior to attaching the end closure plates 61 to wall 60. This is readily accomplished by moving the insert 65 with its partitions 67 attached thereto from right to left (as shown in FIG. 4), with the heat-conducting wall 60 and the insert 65 being disposed co-axially, and rotating either the wall 60 or the insert 65 and thus "screw-in" the insert 65 and partition 67 past the flange 64 into the interior of the roll R.

To facilitate assembly, it may be desirable in some cases to have the insert 65, as shown in FIG. 5, made in sections which are movable into and out of the roll R independently one of the other and assembled together within the roll to form a unitary insert 65. Thus, the insert 65, as shown in FIG. 5, is made in two sections 70 and 71, although it is to be understood that three or more sections may be employed. Each section 70 and 71 is a longitudinal section extending the length of the insert 65, and one section is preferably, although not necessarily narrower than the other. As shown, section 70 is narrower than section 71. Each of the sections 70 and 71 has inwardly extending flanges 72 along its longitudinal edges, which flanges 72, when joined together by suitable fastening means, as bolts 73, complete the cylindrical insert 65.

With the two sections 70 and 71 joined together, but prior to insertion into the roll, the partition 67 is spirally wound around the sectional insert 65 and the base 68 of the partition 67 adhered to the outer surface of the sectional insert 65 as shown in FIG. 5. Each convolution of the partition 67 is then transversely cut in two places, as indicated by reference numeral 74, the cut being in a plane passing through the line of joinder of sections 70 and 71 on the outer surface of the insert 65, namely, at each point that the partition 67 passes over the line of joinder between the sections 70 and 71, so that, with the bolts 73 removed, the section 70 with that part of the partition 67 which is adhered thereto may be readily separated from section 71 with that part of partition 67 which is attached to the section 71. The section 71 is then reduced in cross-sectional size, as by bringing the two flanges 72 of the section together, in which reduced cross-section, it is inserted into one end of the roll R, past the shoulder 64 at that end, and then expanded to rest on the shoulders 64 at each end of the roll R. The narrower section 70 is then entered longitudinally into one end of the roll R until it is completely within the

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roll R, and is then forced outwardly between the two flanges 72 of the section 71, and bolted in place by means of the bolts 73. A ring x may also be placed in each end of the insert 65 to hold the insert 65 firmly in place against the shoulders 64 of the roll R. When reassembled within the roll R, the cut ends of the partition 67 abut at the cuts to restore the partition 67 to its spiral form defining the passageway 66 for the flow of heat-transfer medium therethrough.

In FIG. 6 is shown a modification, namely, a one-piece insert 75, cylindrical in shape and having a longitudinal split 76, a longitudinally and inwardly projecting flange 77 at each edge of the split 76, which flanges 77 are adapted to be joined by bolts 78. With the flanges 77 joined together, as shown in FIG. 6, a partition 79 is spirally wound around the insert 75 and the base 80 of the partition 79 adhered to the outer surface of the insert 75. The partition 79 is then transversely cut, as indicated by the reference numeral 81, the cut being in a plane passing through the line of juncture 76 of the flanges 77 on the outer side of the insert 75, namely, at each point that the partition 79 passes over the split 76. With the bolts 78 removed, one flange 77 is pulled in over the other flange 77 to make the insert sufficiently smaller in section to move readily into the cylindrical wall 82 of the roll, whereupon it is expanded and forced into place, and then the flanges are bolted together to form the cylindrical insert 75, having partition 79 forming the spiral passage for the flow of heat-transfer medium therethrough.

It is to be understood that the partition structure may be of any suitable form, such as shown in FIGS. 3a to 3f, and that the partitions are of such height from base to edge that when placed within the cylindrical wall they are deformed somewhat and compressed, so as to form a fluid-tight seal with the wall member 60.

Any suitable inlet and outlet for the heat-transfer fluid may be provided. As shown in FIG. 4, an inlet pipe 86 passes through opening 63 of one of the journals 62, a packing gland 87 of conventional structure being provided to seal off the opening 63. The heat-transfer fluid passes through openings 88 into the annular space 66 and through the spirally elongated passage formed by the partition 67 to a discharge pipe 89, which leads the fluid outwardly through a packing gland 90 in opening 63 at the opposite end of the wall member 60. This pipe may be attached to insert 65 prior to assembly of the end plates 61. It will be noted that the flow of heat-transfer medium is in such direction that the differential pressures on opposite sides of the annular partitions act to press positively the tips of the partitions 67 in lip-sealing contact with the heat-conducting wall 60.

It is obvious that the heat-exchanger roll of FIGS. 5 and 6 can be readily disassembled for cleaning the parts contacted by the heat-transfer fluid from accumulated scum and dirt, and then reassembled for normal service.

In all the modifications of this invention, a fundamental principle is common. Each has a flexible deformable compressible partition structure to form, in the annular space between the heat-conducting wall of the roll and the insert spaced from that wall, an elongated passage, the partition being associated with, that is, attached to, the insert and being held, when the heat-exchanger of the roll is in operation, in resilient deformable compressive contact with the heat-conducting wall of the roll. The means for holding the partitions in deformable compressive contact with the heat-conducting wall are the following: the ratio of the height of the flexible partition to the radial height of the annular space between the insert and the heat-conducting wall of the roll is designed to be such as to maintain a desired degree of compression between the wall-contacting edge of the partition and wall, and the partition being so positioned that the differential pressure on each side of the partition,

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caused by the flow of heat-transfer fluid through the passageway, places a lip-sealing pressure on the partition by urging the free edge of the partition in pressure-sealing contact with the inner surface of the heat-conducting wall. It is also possible to utilize spring devices to assist in maintaining resilient contact of partition and heat-conducting wall. In fact, any combination of the above factors may be employed, the invention residing in the utilization of flexible deformably compressible partitions, unattached to the heat-conducting wall of the roll but held in a positive resilient compressive contact with said heat-conducting wall.

Again, there is an outstanding advantage over prior rolls having cooling facilities, namely, the insert and circulation partitions may be removed for cleansing, both the heat-conducting wall and the insert and partitions, of accumulated films, scum, dirt, etc., all of which cut down the efficiency of the cooling of the roll, and the insert and partitions readily reassembled in operative relation with the heat-conducting wall without damage to any of the parts.

This application is a division of my earlier application Serial No. 327,741, filed December 24, 1952, now Patent No. 2,915,292 granted December 1, 1959.

The specific embodiments of this application are to be understood as illustrative only and not in limitation of the invention herein disclosed, which is capable of being varied by one skilled in the art without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. The combination of (a) a hollow cylindrical metal processing roll rotatable on its axis and having (i) a cylindrical cavity therein with an inner cylindrical surface and (ii) a circular axial opening into and at each end of said cavity of substantially smaller diameter than that of the cavity, and (b) a removable fluid-circulating insert of greater over-all diameter than that of the said axial openings and constructed for insertion into and withdrawal from said cavity through said smaller axial openings, said insert comprising (i) a flexible thin hollow metal cylindrical imperforate wall member defining with the said inner cylindrical surface an annular space and capable of being distorted in shape to reduce the over-all diameter of the fluid-circulating insert to an extent which enables the said insert to be passed freely through either of said smaller axial openings, (ii) a flexible elastically-deformable relatively thin tipped partition structure extending spirally around and attached at its base to the outer cylindrical surface of the said flexible metal cylinder and having thin tipped portion deformably compressed against the said inner surface to provide an elongated passageway for the passage of heat-transfer medium through said annular space, and (iii) means permitting the said fluid-circulating insert to be temporarily distorted to reduce its cross-section sufficiently to enable the said insert to be passed readily through said smaller axial openings into and out of said cavity.
2. In a hollow cylindrical processing roll roatable on its axis, the combination of (a) a hollow cylindrical metal roll having a heat-conducting metal cylindrical wall defining a cylindrical cavity therein with an inner cylindrical surface and a circular axial opening therein of substantially smaller diameter than that of the cavity, and (b) a fluid-circulating insert of greater over-all diameter than that of the said axial opening and constructed for insertion into said cavity through said axial opening so as to be removable into and out of operable position within said roll, the insert construction comprising (i) a hollow flexible relatively thin-walled metal cylinder split longitudinally along a generative element of the cylinder and having an outer cylindrical surface of such dimensions that when in operable position within the roll an annular space of limited cross-sectional area is defined by the cylindrical inner surface of the heat-conducting

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wall and said outer cylindrical surface, (ii) a flexible elastically-deformable partition structure extending radially from the said outer cylindrical surface of said thin-walled metal cylinder and positioned helically around and attached to said outer cylindrical surface, (iii) said partition structure having a relatively thin dip deformably contacting the said smooth inner cylindrical surface and of a radial height greater than the radial distance across said annular space to place said partition structure in elastically-deformable detached contact against said smooth inner cylindrical surface, (iv) said partition structure being cut through where each convolution of the partition structure crosses the said line of split, and (v) means permitting the flexible metal cylinder with the partition structure integrally attached thereto to be distorted to a sufficiently smaller cross-section to be readily passed through said smaller axial opening into the cavity of the roll.

3. In a processing roll rotatable on its axis, the combination of (a) a hollow cylindrical metal roll having an outer cylindrical processing surface and a cylindrical cavity therein with a cylindrical surface substantially the length of the roll and an axial circular opening at each end of the roll into said cavity of smaller diameter than that of the cavity, and (b) a fluid-circulating insert of greater over-all diameter than that of said axial openings and adapted for insertion into said cavity through said smaller axial openings, said insert comprising (i) a thin-walled flexible metal cylinder having an outer diameter defining with the cylindrical surface of said cavity an annular space, (ii) said metal cylinder being made in a plurality of longitudinal sections, one of which sections is

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larger than one-half of the metal cylinder, (iii) a flexible elastically-deformable relatively thin tipped partition structure extending spirally across said annular space and attached at its base to the outer cylindrical surface of the said metal cylinder to provide an elongated passageway for the passage of heat-transfer medium through said annular space, (iv) said partition structure being cut through where each convolution of the partition crosses a generative element line of joinder between the sections in a plane passing through the respective lines of joinder, (v) means permitting the section of the metal cylinder which is larger than one-half the metal cylinder with the portion of the partition structure attached thereto to be temporarily distorted to reduce its cross-section sufficiently to enable said section to be passed through said smaller axial opening into said cavity, and (vi) means for detachably joining all sections to complete within the said cavity the said fluid-circulating insert.

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