Feb. 28, 1950 LE ROY EABY 2,498,662

CALENDER ROLL

Filed Dec. 31, 1946 3 Sheets-Sheet 1

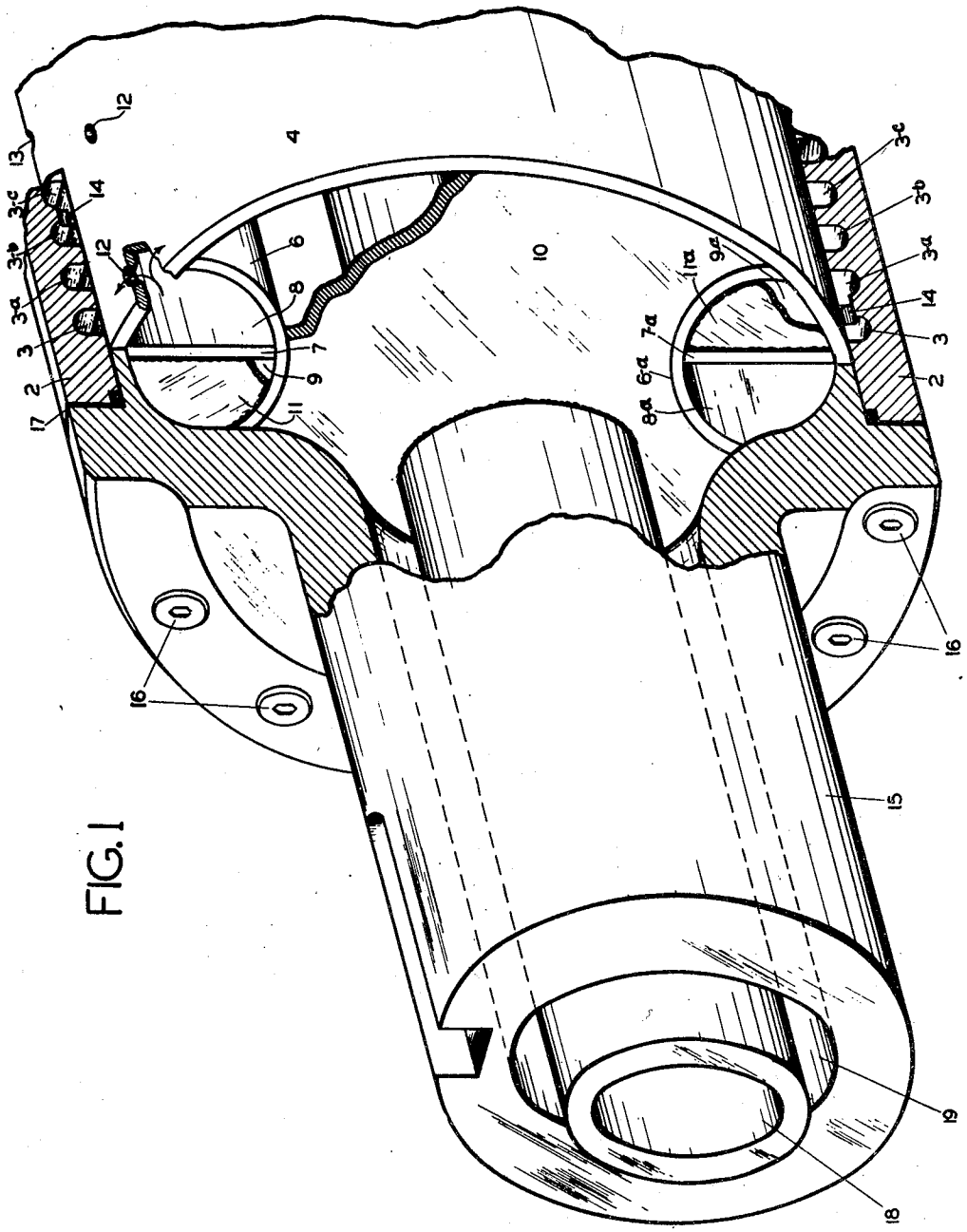



FIG. 1

*INVENTOR.*

LE Roy Eaby

by

Curtis J. Hoffman

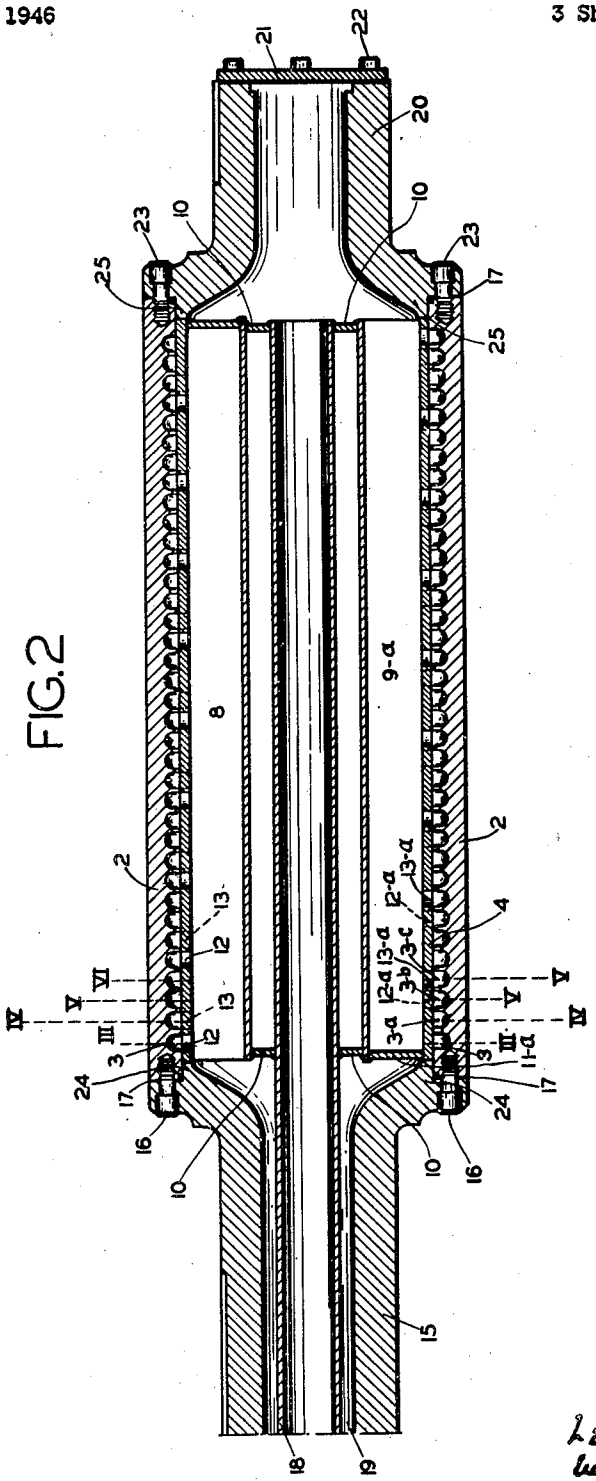
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CALENDER ROLL

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FIG. 2




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FIG. 3

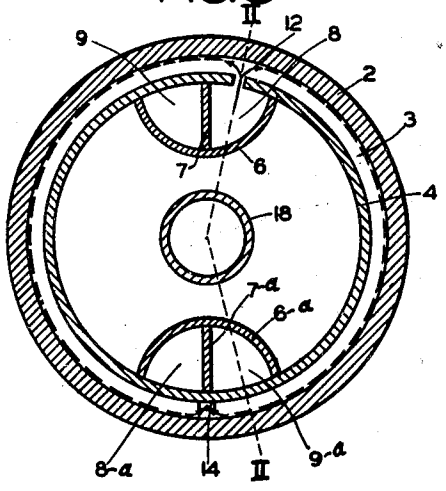



FIG. 4

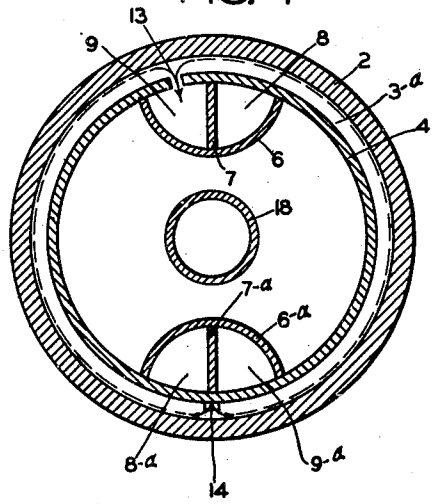



FIG. 6

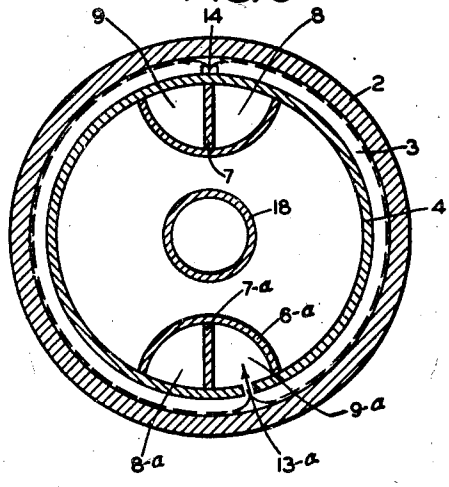
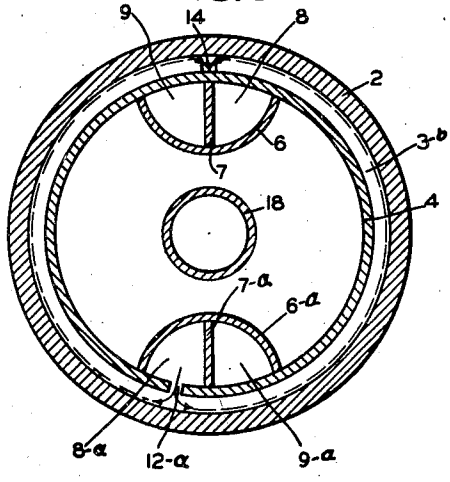



FIG. 5




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Patented Feb. 28, 1950

2,498,662

# UNITED STATES PATENT OFFICE

2,498,662

## CALENDER ROLL

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Application December 31, 1946, Serial No. 719,390

6 Claims. (Cl. 257—95)

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This invention relates to calender rolls and more particularly to calender rolls through which heat transfer fluid is circulated to control the temperature at the surface of the roll.

Numerous attempts have been made in the past to develop calender rolls having passages for the flow of heat transfer fluid to control the surface temperature. In many of the rolls of this type produced heretofore, the roll wall was too thick to allow the heat transfer fluid to properly control the temperature at the surface of the roll. In addition to this disadvantage, the rolls heretofore produced had relatively long fluid conducting passages making it impossible to have large quantities of heat transfer fluid flowing therethrough at high velocities. In many of the rolls heretofore developed, it was customary to feed fluid into one end of the roll and, after making at least three passes back and forth across the length of the roll, the fluid was discharged from the opposite end. Where a number of heat control passages are present, it has been customary to have the heat transfer fluid enter the passages from one end of the roll and leave from the opposite end. This system permits all the fluid which is at the proper temperature to enter one end of the roll and leave from the opposite end, causing a considerable temperature differential to exist across the roll between the point at which the fluid enters the passages and the point from which it leaves the pasages.

In addition to the disadvantages enumerated above, many of the conventional rolls are cast about pipes which form the passages, thus making it impossible to disassemble the roll for purposes of maintenance.

One of the principal objects of my invention is to provide a calender roll having a thin outer wall resulting in a minimum temperature differential between inside and outside roll surfaces.

Another object of my invention is to provide a roll structure making possible an equable distribution of heat transfer fluid across the inside surface of the thin roll wall. This is accompished by the provision of two sets of heat transfer fluid inlet apertures spaced diametrically opposite each other and two sets of heat transfer fluid outlet apertures spaced diametrically opposite each other. These two sets of inlet and outlet apertures extend the entire length of the roll. This arrangement permits ingress and egress of heat transfer fluid from two portions of the roll diametrically opposite one another, thereby making it possible to more accurately control the temperature across the face of the roll.

A futher object of this invention is to provide a relatively light roll having large inlet and outlet manifolds which permit the use of large quantities of heat transfer fluid, but which has the central cavity closed to prevent the entrapment of large quantities of heat transfer fluid therein. By this arrangement it is possible to utilize the fluid for controlling the temperature of the roll shortly after it has entered the roll. This greatly facilitates the ease with which the temperature of the working surface of the roll can be controlled.

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A still further object of my invention is the development of ideal heat transfer conditions resulting from the turbulent fluid velocities made possible by the large volumes of fluid passing through relatively small and short annular channels.

It is also an object of this invention to provide a roll which can be easily disassembled and assembled for purposes of cleaning the fluid passages and repairing the internal parts of the roll.

It is also an object of this invention to provide a roll having insulation disposed between the body of the roll and the gudgeons. The purpose of this insulation is to prevent heat transfer from the gudgeons to the roll body or vice versa. This system greatly aids in maintaining a uniform temperature on the surface of the roll.

In order that my invention may be more readily understood, it will be described in connection with the attached drawings in which:

Figure 1 is an isometric view of the intake and outlet end of the calender roll partially broken away to show the internal construction of the roll,

Figure 2 is a longitudinal cross-sectional view taken on the line II—II of Figure 3 showing the internal construction of the roll,

Figure 3 is a vertical cross-sectional view taken on the line III—III of Figure 2,

Figure 4 is a vertical cross-sectional view taken on the line IV—IV of Figure 2,

Figure 5 is a vertical cross-sectional view taken on the line V—V of Figure 2, and

Figure 6 is a vertical cross-sectional view taken on the line VI—VI of Figure 2.

Referring to Figure 1, there is shown a roll casting 2 having annular channels 3 running circumferentially around its inner surface. An inner cylinder 4 is provided which fits tightly into the central cavity of the casting 2, thereby closing the open side of the annular channels 3. The cylinder 4 is provided with two half sections of pipe shown at 6 and 6—*a* spaced diametrically opposite each other, and running the entire length of the inner cylinder. Each of these half sections of pipe is divided lengthwise by metal partitions 7 and 7—*a*, thereby forming four manifolds, 8, 9, 8—*a*, and 9—*a*, (Figures 3–6) running the entire length of the cylinder on the inside thereof. The ends of the cylinder 4 are closed by means of plates 10. These plates 10 close the

ends of cylinder 4 with the exception of manifolds 8, 9, 8—*a*, and 9—*a*. The two manifolds 9 and 9—*a* are closed at one end only by means of plates 11 and 11—*a*. These two manifolds are positioned diametrically opposite one another. In Figure 1, it will be noted that the plates 11 and 11—*a* close the ends of the two manifolds designated at 9 and 9—*a*, while the two manifolds 8 and 8—*a* remain open. At the opposite end of the cylinder 4, the plates 11 and 11—*a* close manifolds 8 and 8—*a* while the manifolds 9 and 9—*a* remain open.

The cylinder 4 is provided with four series of apertures designated by the numerals 12, 12—*a*, 13, and 13—*a*. The apertures 12 communicate with manifold 8, the apertures 12—*a* with manifold 8—*a*, the apertures 13 with manifold 9, and the apertures 13—*a* with manifold 9—*a*.

It will be noted from an examination of Figures 1 and 2 that the annular channels 3 are arranged in groups of two channels each, the channels in each group being connected by an axial break-through channel 14. It will also be noted that adjacent groups of annular channels are connected to the longitudinal inlet and outlet manifolds at points diametrically opposite one another and the break-through channel connecting the two annular channels in adjacent groups are positioned diametrically opposite one another.

The end of the roll is provided with a gudgeon 15 which is secured to the casting 2 by means of studs 16. The joint between the gudgeon and the casting is sealed by means of a gasket 17. A pipe 18 passes through the center of the opening in the gudgeon and extends longitudinally through the center of the roll, passing through the left hand plate 10 to the right hand plate 10. This is clearly shown in Figure 2. It will be observed that the hollow gudgeon 15 thus has two concentric passages therein, the outer passage designated at 19 is used as the inlet passage for heat transfer fluid into the roll while the inner passage formed by the pipe 18 is used for the discharge of heat transfer fluid from the roll.

The hollow gudgeon 20 at the right hand end of the roll is sealed at its end by means of plate 21 held by means of studs 22. The gudgeon 20 is secured to the casting 2 by means of studs 23 in a manner similar to that by which the gudgeon 15 is secured to the casting 2. The gudgeon 15 is provided with an annular shoulder 24 which engages the end of the cylinder 4 and the gudgeon 20 is provided with a similar shoulder 25 which engages the other end of the cylinder 4, thereby holding the cylinder 4 securely in place.

Referring to Figure 2, which is a longitudinal cross-section of the roll taken on the line II—II of Figure 3, it will be observed that the manifold 8 is open at the left end of the roll to permit ingress of heat transfer fluid into the manifold 8 from whence it passes through apertures 12 into the annular channels 3 which are in open communication therewith. Figure 2 also shows the manifold 9—*a* open at the right hand end to permit egress of fluid from manifold 9—*a* after it has passed through apertures 12—*a* from the annular channels 3 which communicate therewith.

In Figure 2 the top half of the roll is cut through the inlet apertures 12 to show the means for transferring the heat transfer fluid from the longitudinal inlet manifold 8 through the apertures 12 into the annular channels 3. The exhaust apertures 13 are designated by dotted lines merely to show their relative lateral positions with respect to the inlet apertures 12. It will be understood, of course, that these exhaust apertures are not on the same vertical plane as the inlet apertures. Likewise, the bottom portion of the roll is cut through the exhaust apertures 13—*a* to show means for transferring heat transfer fluid from the annular channels 3 through exhaust apertures 13—*a* into outlet manifold 9—*a*. In this instance, the inlet apertures 12—*a* are designated by dotted lines merely to designate their relative position with respect to exhaust apertures 13—*a*, and here again, it will be understood that the inlet apertures and exhaust apertures are not on the same vertical plane.



Reference to Figures 3, 4, 5, and 6 will illustrate more clearly the manner in which the annular channels 3 are supplied with heat transfer fluid from the manifolds 8 and 8—*a*, and the manner in which the fluid passes from the channels 3 into the manifolds 9 and 9—*a* for egress from the roll. This flow of heat transfer fluid will be more specifically hereinafter described.

In order to supply heat transfer fluid to the annular chanels 3 at a rate sufficient to force it through the channels 3 at turbulent velocity, axial inlet manifolds 8 and 8—*a* are provided, being sufficiently large that the pressure drop along their length is negligible. In the preferred embodiment shown in Figure 2 the fluid-carrying capacity of these inlet manifolds is greater than the total fluid-carrying capacity of all the annular channels 3. By making the axial inlet manifolds large, it is possible to supply fluid to all the annular channels at substantially the same rate of flow. The axial inlet manifolds are disposed as closely as possible to the annular channels as shown in Figure 2 so that the pressure drop of the fluid passing through the apertures 12 will be at a minimum. In a roll constructed according to this invention the pressure drop between the pump and the working area, which in this case is the annular channels 3, is held at a minimum so as not to necessitate undue pumping pressures in the system.

In the operation of the roll, heat transfer fluid is supplied by means of a suitable pump not shown, which forces the fluid into the roll through the outer concentric passage 19 in the hollow gudgeon 15. Inasmuch as the plate 10 closes the central cavity of the inner cylinder and the plates 11 and 11—*a* close manifolds 9 and 9—*a* at the entrance end, all the heat transfer fluid is directed into manifolds 8 and 8—*a*. From manifolds 8 and 8—*a*, the fluid passes through apertures 12 and 12—*a*, respectively, to the annular channels 3. Referring to Figure 3, it will be noted that the first annular channel 3 is filled with fluid flowing through the aperture 12. Immediately after passing through aperture 12, the fluid stream divides, approximately one-half the fluid flowing around the roll in a clockwise direction, and the other half flowing around the roll in a counterclockwise direction. These two fluid streams meet at a point substantially diametrically opposite from the aperture 12 and a break-through channel 14 is provided in the approximate region where these two fluid streams meet. The fluid passes through break-through channel 14 and enters the second annular channel 3—*a*. This second annular channel is shown in Figure 4, where it will be observed that the fluid coming through the break-through channel 14 separates and flows around the roll approxi-

mately one-half in a counterclockwise direction, and one-half in a clockwise direction, meeting at a point substantially diametrically opposite the break-through channel 14. Outlet aperture 13 which is located close to the point at which the two fluid streams meet, provides passage for the fluid from the annular channel 3—*a* into the longitudinal manifold 9. The fluid is then carried through manifold 9 to the far end of the roll and is returned through the pipe 18 which forms the inner concentric passage through hollow gudgeon 15.

The third annular channel 3—*b* is supplied with fluid flowing through aperture 12—*a* from manifold 8—*a*. Immediately after passing through aperture 12—*a*, the fluid stream divides, approximately one-half of the fluid flowing around the roll in a clockwise direction and the other half flowing in a counterclockwise direction. These two fluid streams meet at a point substantially diametrically opposite the aperture 12—*a*, and a break-through channel 14—*a* is provided in the approximate region where these two fluid streams meet. The fluid passes through break-through channel 14—*a* and enters the fourth annular channel 3—*c*. This fourth annular channel is shown in Figure 6 where it will be observed that the fluid coming through the break-through channel 14—*a* separates and flows around the roll, approximately one-half in a counterclockwise direction, and one-half in a clockwise direction, meeting at a point substantially diametrically opposite the break-through channel 14—*a*. Outlet aperture 13—*a* which is located close to the point at which the two fluid streams meet, provides passage for the fluid from the annular channel 3—*c*, into the longitudinal manifold 9—*a*. The fluid is then carried through the manifold 9—*a* to the far end of the roll and is returned through the pipe 18 which forms the inner concentric passage through hollow gudgeon 15. It will be observed that aperture 12—*a* in the third annular channel 3—*b* is diametrically opposite aperture 12 in the first annular channel 3. It will also be observed from the drawing that the flow of heat transfer fluid through the third and fourth annular channels is exactly the same as through the first and second annular channels with the exception of the fact that the apertures and the break-through channel for the second series are each placed diametrically opposite the apertures and the break-through channel for the first series. This system is carried out throughout the entire length of the roll, thereby making it possible to supply heat transfer fluid at two points diametrically opposite one another, and thereby obtain a uniform mean temperature between the hottest and coldest portions of the heat transfer fluid.

The fluid, after passing through exhaust apertures 13 and 13—*a*, is carried along the manifolds 9 and 9—*a* towards the closed gudgeon 20. This closed gudgeon fills with fluid forcing it into the pipe 18. The pipe 18 carries the fluid through the central cavity of the roll and discharges it through the inner concentric passage in the gudgeon 15.

It will be obvious to those skilled in the art that if fluid is supplied to the roll in a continuous stream, it will flow continuously through all portions of the roll and be discharged in a continuous stream.

It will be seen from the above description that I have developed a calender roll which is constructed in such a manner as to be easily disassembled and assembled by maintenance personnel. Also, the fluid passages in the roll are sufficiently large to permit the passage of relatively large quantities of heat transfer fluid into the longitudinal manifolds, thus making it possible to supply heat transfer fluid to the annular channels at a rate sufficiently high to cause turbulent fluid velocities in the annular channels. It will be apparent, too, that the provision of inlet and outlet apertures on opposite sides of the roll makes it possible to maintain a more uniform temperature around the surface of the roll. Also, the provision of a series of apertures along two sides of the roll extending the entire length of the roll makes it possible to maintain a uniform temperature throughout the entire length of the roll. Also, I have provided a roll constructed in such a manner that the roll wall is very thin, thereby reducing the temperature differential between the heat transfer fluid and the exterior surface of the roll.

When using the roll of my design, it is relatively easy to alter the temperature of the working surface thereof by altering the temperature of the heat transfer fluid entering the roll or by altering the rate of flow of the heat transfer fluid through the channels. Inasmuch as the fluid is utilized for controlling the temperature of the working surface immediately after it has entered the roll, any change in the temperature of the fluid or the rate of flow of the fluid entering the roll will have an immediate effect on the temperature of the working surface of the roll.

Rolls made in accordance with my invention are suitable for either heating fluid or cooling fluid depending upon the manufacturing operation in which the roll is to be used.

While I have illustrated and described a preferred embodiment of my invention it will be understood that the same is not so limited but may be practiced within the scope of the following claims.

I claim:

1. A heat exchange roll of the shell type comprising: an outer shell and an inner hollow cylinder with a plurality of annular heat transfer fluid channels disposed therebetween throughout the effective working area of the roll, means for circulating heat transfer fluid through all of said channels at substantially the same turbulent velocity including a plurality of inlet manifolds and a plurality of outlet manifolds positioned adjacent the annular channels and extending along the length of said effective working area, the combined heat transfer fluid-carrying capacities of which manifolds are at least as great as the sum of the capacities of said channels, said hollow cylinder having a plurality of apertures through its wall connecting the annular channels to said manifolds for the circulation of heat transfer fluid through all of said channels at substantially the same turbulent velocity.

2. A heat exchange roll of the shell type comprising: an outer shell and an inner hollow cylinder with a plurality of annular heat transfer fluid channels disposed therebetween throughout the effective working area of the roll, means for circulating heat transfer fluid through all of said channels at substantially the same turbulent velocity, said annular channels being arranged in groups of two channels per group, the annular channels of each group being connected to each other by a fluid-carrying break-through channel; a plurality of inlet manifolds and a plurality of outlet manifolds positioned adjacent the annular channels and extending along the length

of said effective working area, the combined heat transfer fluid capacities of which inlet manifolds are at least as great as the sum of the capacities of said channels; said inner hollow cylinder having a plurality of apertures through the wall thereof connecting one of the annular channels in each group to one of said inlet manifolds and connecting the other annular channel in each group to one of said outlet manifolds for the circulation of heat transfer fluid through said channels at substantially the same turbulent velocity; and means passing through the central cavity of the roll for discharging heat transfer fluid.

3. A heat exchange roll of the shell type comprising: an outer shell and an inner hollow cylinder with a plurality of annular heat transfer fluid channels disposed therebetween throughout the effective working area of the roll, means for circulating heat transfer fluid through all of said channels at substantially the same turbulent velocity, said annular channels being arranged in groups of two channels per group, the annular channels of each group being connected to each other by a fluid-carrying break-through channel; two inlet manifolds and two outlet manifolds positioned adjacent the annular channels and extending along the length of said effective working area, the combined heat transfer fluid capacities of which inlet manifolds are at least as great as the sum of the capacities of said channels; said inner hollow cylinder having a plurality of apertures through the wall thereof connecting one of the annular channels in each group to one of said inlet manifolds and connecting the other annular channel in each group to one of said outlet manifolds for the circulation of heat transfer fluid through said channels at substantially the same turbulent velocity.

4. A heat exchange roll of the shell type comprising: an outer shell and an inner hollow cylinder with a plurality of annular heat transfer fluid channels disposed therebetween throughout the effective working area of the roll, means for circulating heat transfer fluid through all of said channels at substantially the same turbulent velocity, said annular channels being arranged in groups of two channels per group, the annular channels of each group being connected to each other by a fluid-carrying break-through channel; a plurality of inlet manifolds and a plurality of outlet manifolds positioned adjacent the annular channels and extending along the length of said effective working area, the combined heat transfer fluid capacities of which inlet manifolds are at least as great as the sum of the capacities of said channels; said inner hollow cylinder having a plurality of apertures through the wall thereof connecting one of the annular channels in each group to one of said inlet manifolds and connecting the other annular channels in each group to one of said outlet manifolds for the circulation of heat transfer fluid through said channels at substantially the same turbulent velocity.

5. A heat exchange roll of the shell type comprising: an outer shell and an inner hollow cylinder with a plurality of annular heat transfer fluid channels disposed therebetween throughout the effective working area of the roll, means for circulating heat transfer fluid through all of said channels at substantially the same turbulent velocity, said annular channels being arranged in groups of two channels per group, the annular channels of each group being connected to each other by a fluid-carrying break-through channel; a plurality of inlet manifolds and a plurality of outlet manifolds positioned adjacent the annular channels and extending along the length of said effective working area, the combined heat transfer fluid capacities of which inlet manifolds are at least as great as the sum of the capacities of said channels; said inner hollow cylinder having a plurality of apertures through the wall thereof connecting one of the annular channels in each group to one of said inlet manifolds and connecting the other annular channel in each group to one of said outlet manifolds for the circulation of heat transfer fluid through said channels at substantially the same turbulent velocity; each group of annular channels being connected to inlet and outlet manifolds placed substantially diametrically opposite the inlet and outlet manifolds for the adjacent group.

6. A heat exchange roll of the shell type comprising: an outer shell and an inner hollow cylinder with a plurality of annular heat transfer fluid channels disposed therebetween throughout the effective working area of the roll, means for circulating heat transfer fluid through all of said channels at substantially the same turbulent velocity, said annular channels being arranged in groups of two channels per group, the annular channels of each group being connected to each other by a fluid-carrying break-through channel; a plurality of inlet manifolds and a plurality of outlet manifolds positioned adjacent the annular channels and extending along the length of said effective working area, the combined heat transfer fluid capacities of which inlet manifolds are at least as great as the sum of the capacities of said channels; said inner hollow cylinder having a plurality of apertures through the wall thereof connecting one of the annular channels in each group to one of said inlet manifolds and connecting the other annular channel in each group to one of said outlet manifolds for the circulation of heat transfer fluid through said channels at substantially the same turbulent velocity; each group of annular channels being connected to inlet and outlet manifolds placed substantially diametrically opposite the inlet and outlet manifold for the adjacent group; gudgeons mechanically secured to each end of said thin outer shell, said gudgeons being provided with annular shoulders lying in engagement with the ends of the inner hollow cylinder to prevent lateral movement thereof; and concentric inlet and outlet conduits passing through one of said gudgeons to supply heat transfer fluid to said inlet manifolds and to carry fluid away from said outlet manifolds.



LE ROY EABY.


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The following references are of record in the file of this patent:

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## Certificate of Correction

Patent No. 2,498,662 February 28, 1950

LE ROY EABY

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows:

Column 7, line 60, for the word "channels" read *channel*;

and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 13th day of June, A. D. 1950.

[SEAL]

THOMAS F. MURPHY,
*Assistant Commissioner of Patents.*