

Jan. 6, 1959

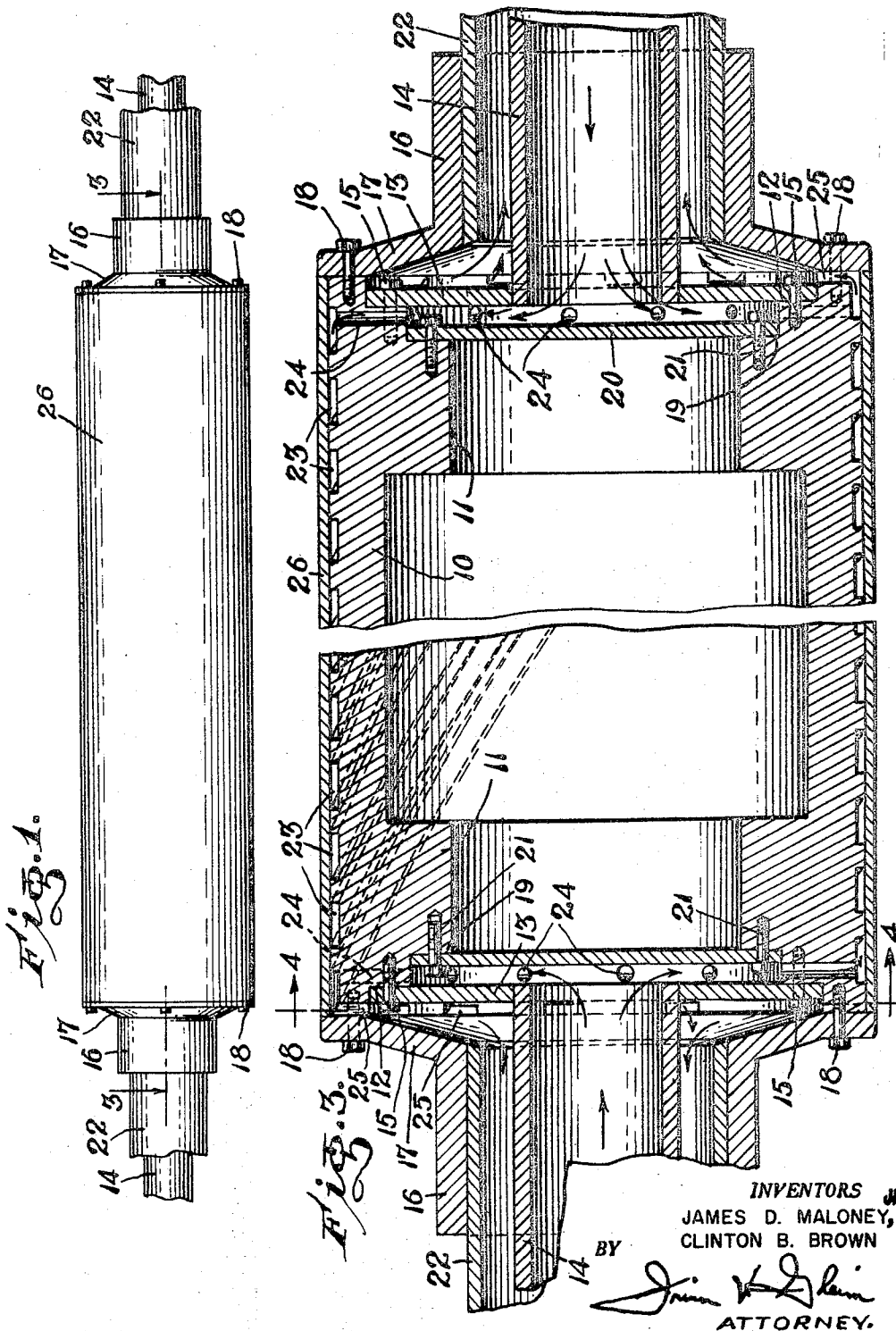
J. D. MALONEY, JR., ET AL

2,867,414

CHILLING ROLL FOR PAPER COATING MACHINES

Filed Dec. 23, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 4.

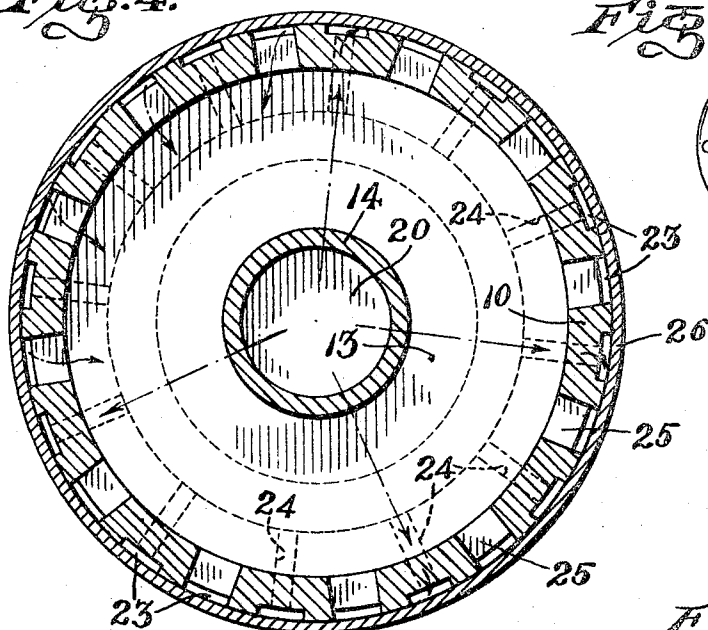


Fig. 2.

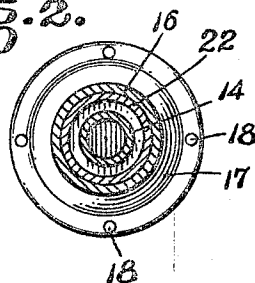
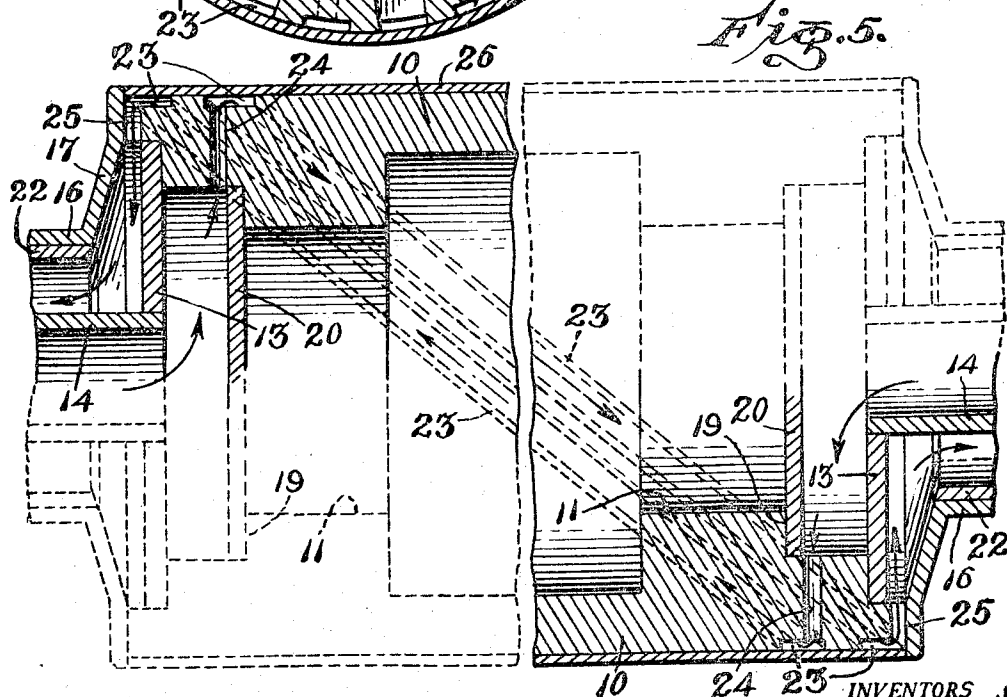


Fig. 5.



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1

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CHILLING ROLL FOR PAPER COATING MACHINES

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Application December 23, 1955, Serial No. 555,061

1 Claim. (Cl. 257—95)

The present invention relates to a chilling roll for paper coating machines and particularly to a chilling roll for use in a paper coating machine such as that described in Patent No. 2,647,842, issued August 4, 1953 to R. N. Griesheimer and Robert C. Hydell.

Heretofore, the design of rolls for heat transfer (heating or cooling) has centered mainly around drier drums and calender rolls. In the case of drier drums, there is little or no nip loading, while calender rolls carry nip loads in the range of 1000–1500 lb. per inch of roll face. On the other hand, nip loading on the chilling roll of this invention amounts to 150–200 lb. per inch of face. This difference in loading is an important distinction because it affects the structure of the roll. The heavier structure required by the higher nip loadings makes it difficult to accomplish good heat transfer because of the thick sections. The intermediate to low loading imposed on the roll of this invention is carried by an inner core, thus allowing the outer shell to be relatively thin.

Another requirement imposed by the process of Patent No. 2,647,842 is that the inter-nip distance between the coating application press and the press of which the present roll is a part must be held to a minimum. To meet this requirement, a roll of relatively small diameter is necessary; in fact, the smaller, the better, as long as its design is consistent with load and heat transfer requirements. For this reason, the advances in drier design have limited application, as it is almost impossible to provide the internal connections of the substantially large diameter driers in a roll of relatively small diameter.

Roll surface temperature is also of importance. Since it costs much more to transfer heat at low temperature (of the order of -50°F.) as compared to more conventional drier temperatures (of the order of $250\text{--}300^{\circ}\text{F.}$), it is desirable to so improve heat transfer conditions as to minimize the temperature difference between the roll surface and the cooling medium, still meeting the structural requirements of the shell which calls for a thickness of the order of $\frac{3}{8}$ inch.

In the mathematical expression for rate of heat transfer,

$$Q/\theta = HA\Delta T$$

Q/θ is the rate of heat transfer in heat units per unit time, such as B. t. u./hr.,

H is the overall heat transfer coefficient,

A is the area of roll surface through which the heat is transferred, and

ΔT is the temperature difference between the outer surface of the roll and the cooling medium within the roll.

The numerical value of heat transfer rate, Q/θ that is required is set by the production requirements imposed on the coating machine. Thus, for a given coater, operating at its rated capacity, the value of Q/θ is fixed, and the chill roll must be so designed to yield this rate of heat transfer.

2

The area available for heat transfer is related, among other factors, to the diameter of the chill roll, a factor limited by the space requirements of the coating process, as discussed above.

5 The cost of transferring heat at temperatures of the order of -50°F. is high, and dictates a design giving a minimum difference between roll surface and cooling medium. Hence, desirably, ΔT in the above equation is small.

10 This leaves the factor H, overall heat transfer coefficient, as the only means of attaining the desired rate, Q/θ , and H must be made as large as possible. To insure a high value of H, a relatively high velocity of the cooling medium, over the inside surface of the roll shell is required.

This requirement, as well as the others set forth above, is met by the chill roll of this invention.

15 Generally, in accordance with the present invention, there is provided a chilling roll consisting of an elongated inner cylinder of substantial thickness in the outer face of which is provided a plurality of spaced helical grooves. Sweated over the inner cylinder is a relatively thin shell which acts to close the outer portions of the grooves to thereby form passages between the inner cylinder and its shell. Alternate grooves at one end of the device communicate with radially drilled holes which, in turn, communicate with an annular space defined by a cover plate set within a recess and by flanges extending outwardly from an inner pipe. There is also provided an outer pipe and the remaining grooves communicate with the space between the inner and outer pipes and the aforesaid flange by means of milled openings in internal flanges of the inner roll. The device is such that brine such as, for example, methylene chloride brine at very low temperatures may be introduced simultaneously through both of the inner pipes whereupon the same may pass through the radial openings, thence through the communicating grooves to the milled passages at the opposite side of the device and thence through the space between the inner and outer pipes. Such action makes for a minimum heat transfer film coefficient for the brine as it passes through the grooves, it being understood that the flow of brine through the grooves is at high velocity and is in opposite directions in alternate grooves. Thus, also, the chilling surface, namely the outer surface of the shell, will have a more uniform temperature at all times than would otherwise be possible. The device contains many novel features which will be brought out in the appended specification.

20 It is accordingly an object of the invention to provide a novel chilling roll especially adapted for use with paper coating machines.

25 Another object of the invention is to provide, in a device of the character set forth, a novel arrangement of grooves whereby the "nip" between the instant device and a roll with which it may be utilized may not "ride" a particular groove.

30 Another object of the invention is to provide a device of the character set forth which is simple in construction, inexpensive to manufacture and yet effective and efficient in use.

35 Still another object of the invention is to provide, in a device of the character set forth, a plurality of brine-conducting grooves arranged in a roll in other than circumferential relationship therein in spaced relation to one another and with novel means whereby brine is directed in opposite directions therethrough in successive grooves.

40 Other and further objects of the invention will become apparent from a reading of the following specification taken in conjunction with the drawings, in which:

45 Figure 1 is an elevational view of an embodiment of the invention,

3

Figure 2 is an end elevational view thereof,

Figure 3 is an enlarged fragmentary sectional view, partially broken away, taken along line 3—3 of Figure 1,

Figure 4 is a sectional view taken along line 4—4 of Figure 3, and

Figure 5 is a view similar to Figure 3 but illustrating diagrammatically the direction of flow of fluid through the device embodying the present invention.

Referring more particularly to the drawings, there is shown therein a relatively thick inner roll 10 preferably formed of steel and having at each end thereof an inwardly extending flange 11. The flanges 11 are each recessed in their outer faces, as indicated at 12, to receive the outwardly extending flange 13 of an inner pipe 14, the flange 13 being affixed to the roll 10, in each case by means of bolts 15.

A fitting 16 is provided at either end of the device and has at its inner end an integrally formed outwardly extending flange 17 which is affixed to, in each case, to one end of the roll 10 by means of bolts 18.

The flange 11 is further recessed at each of its ends, as indicated at 19 and a cover plate is affixed in each of the recesses by means of bolts 21. The cover plate is indicated at 20. An outer pipe 22 is affixed within each of the fittings 16.

In the outer face of the roll 10 is cut a plurality of spirally extending shallow grooves 23 which lie in spaced parallel relation to one another. Adjacent one end of the roll 10 each alternate groove 23 has communicating therewith a radially extending drilled hole 24. In the opposite end of the roll those grooves having the drilled hole in one end communicate with a radially extending milled groove 25.

Shrunk or sweated over the roll 10 is a shell 26, preferably of steel and in the form of a seamless pipe. The outer surface of the shell 26 is preferably chromium plated and polished.

In the operation of the present form of the invention, brine, such as methylene chloride brine at a very low temperature, is introduced into the device through both inner pipes 14 from whence it passes radially outwardly between the flanges 13 and plates 20, thence through the drilled holes 24 into the grooves 23 and thence across the entire surface of the roll to the opposite end thereof where it passes through the milled openings 25 into the space between the flanges 13 and 17 and thence outwardly between the inner pipe 14 and outer pipe 22. It will be apparent that alternate grooves 23 thus receive the chilled brine for passage therethrough in opposite directions and that the shell 26 will thereupon be chilled substantially uniformly due to the fact that the alternate grooves 23 are acquiring heat from the shell 26 as they pass therebeneath. In a given example, it was found that there was an increase of approximately 8° Fahrenheit in the brine temperature when it passed from one end of the roll to the other in an optimum design. Since alternate grooves are carrying such brine in opposite directions, it will be readily apparent that the acquisition of heat from the shell 26 into the brine will thus be more evenly distributed in the device as a whole. It will also be seen that since the grooves 23 extend at an angle other than perpendicular to the axis of the roll, and since the shell 26 is relatively quite thin, that the "nip"

4

or line of contact between the roll of the instant invention and a pressure roll or the like with which it may be used, may not "ride" a particular groove which would be the case if the grooves extended axially. That this is of importance will be apparent from the fact that in the case of a device of the present invention wherein the roll is one hundred inches in length, such "nip" load is ordinarily twenty thousand pounds. It will also be apparent that the angular relation of the grooves 23 as aforesaid, permits greater length of such grooves in a given roll thus permitting greater distribution of the heat-acquiring properties of the brine passing therethrough.

While but one form of the invention has been shown and described herein, it will be readily apparent to those skilled in the art that many minor modifications may be made without departing from the spirit of the invention or the scope of the appended claim.

What is claimed is:

A device of the character described comprising a drum having a first series of spaced helically extending grooves formed in the outer face thereof, said drum having a second series of like grooves each positioned between a pair of adjacent grooves of said first series of grooves, a shell affixed upon said drum, means for moving fluids through one series of grooves in one direction and through the other series of grooves in the opposite direction, means forming an inner chamber adjacent each end of said drum, means forming an outer chamber adjacent each end of said drum, a supply pipe connected to each of said inner chambers, a discharge pipe connected to each of said outer chambers, said drum having a radial hole extending from each alternate groove adjacent one end thereof to communicate with one of said inner chambers, said drum having a like radial hole adjacent the opposite end of each remaining groove to communicate with the other inner chamber, said drum having a plurality of passageways each formed in that end thereof remote from said radial holes and each interconnecting a groove with an adjacent outer chamber, said means forming said outer chambers comprising a relatively large circular recess in each end of said drum, and an annular flange affixed to said drum in each of said relatively large recesses, and said means forming said inner chambers comprising a relatively small recess formed in each end of said drum inwardly of and communicating with the relatively large recess of that end of the drum, and a cover plate affixed in each of said relatively small recesses, said supply pipes each being affixed at its inner end to the inner periphery of its associated flange; said recesses, flanges, cover plates and supply pipes being mutually concentric.

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