

[54] **HEAT TRANSFER ROLL WITH
SEPARATE TEMPERATURE ZONES
FOR PROCESSING MATERIALS**

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165/146, 264/144

[51] Int. Cl. **F28f 5/02**

[58] Field of Search 165/89, 90, 146; 18/9, 10,
18/2 C; 264/144

[56] **References Cited**

UNITED STATES PATENTS

2,508,414	5/1950	Meyer.....	18/9 X
2,780,443	2/1957	Holloway.....	165/89
2,793,006	5/1957	Eaby.....	165/89
2,936,158	5/1960	Ramundo	165/89
2,972,472	2/1961	Konold	165/89

3,006,610 10/1961 Siegel 165/89

Primary Examiner—Albert W. Davis, Jr.

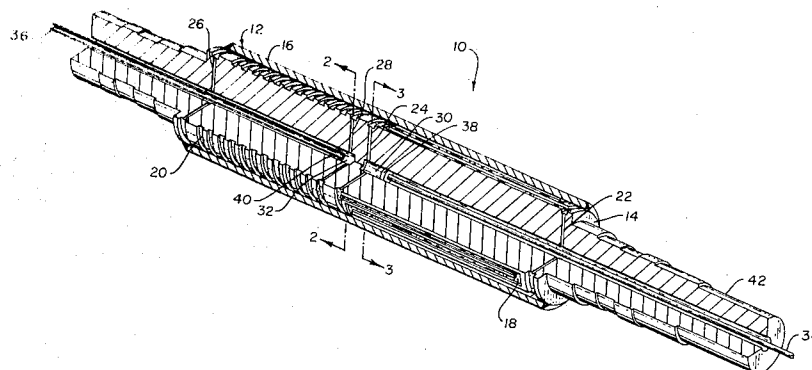
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[57]

ABSTRACT

Heat transfer roll for processing materials and having separate temperature zones along its outer surface. The roll has an outer shell and an inner shell with a series of serpentine channels formed between the two shells along a predetermined length of the roll, and with a helical channel formed between the two shells around the roll along the remaining length of the roll. A heat transfer medium circulates through the serpentine channels and is of a different temperature than the heat transfer medium that flows along the helical channel. The two channels are arranged so as to establish along part of the length of the roll working surface a uniform temperature zone above the serpentine channels and along the remaining length of the roll working surface a temperature gradient zone above the helical channel. The temperature from the uniform temperature zone is conducted in part to the adjacent temperature gradient zone to minimize possibility of thermal shock due to differential expansion.

3 Claims, 4 Drawing Figures



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3,662,821

SHEET 1 OF 3

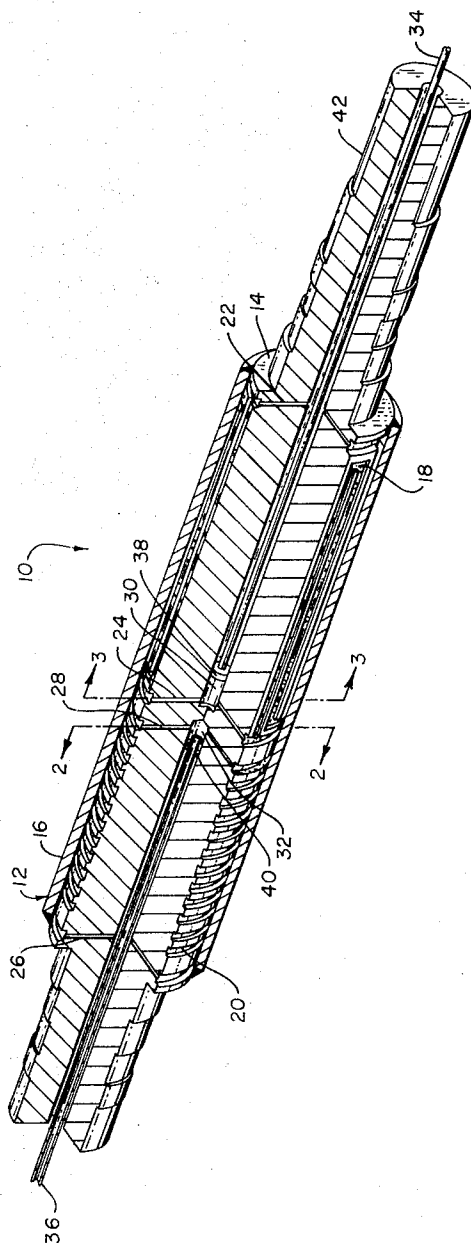


Fig. 1

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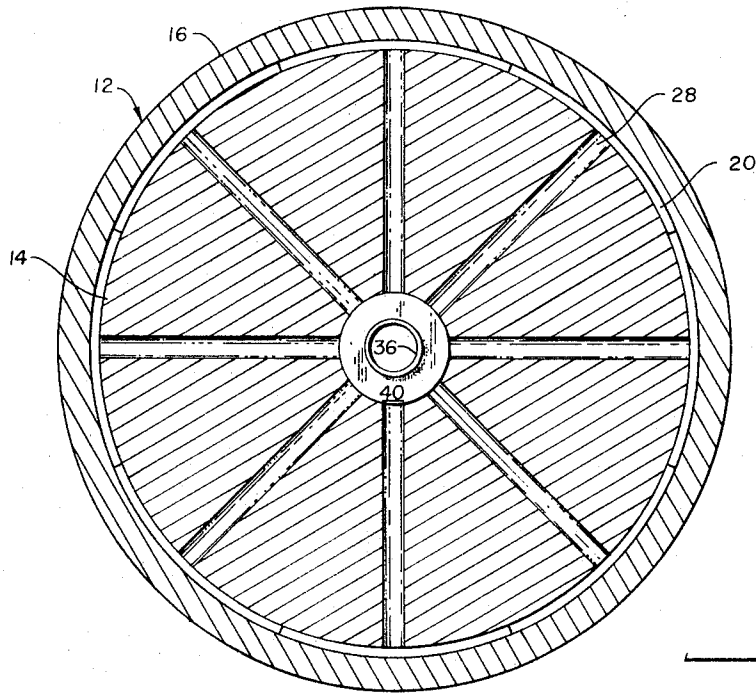


Fig-2

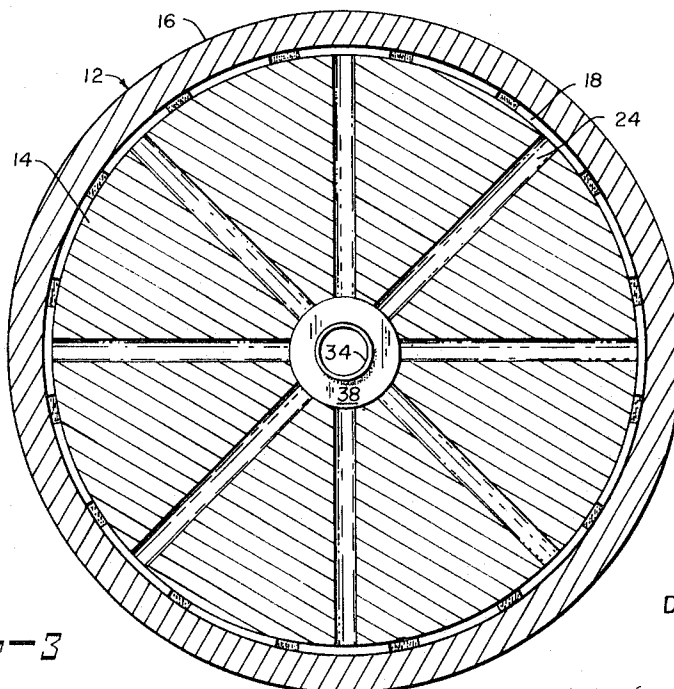


Fig-3

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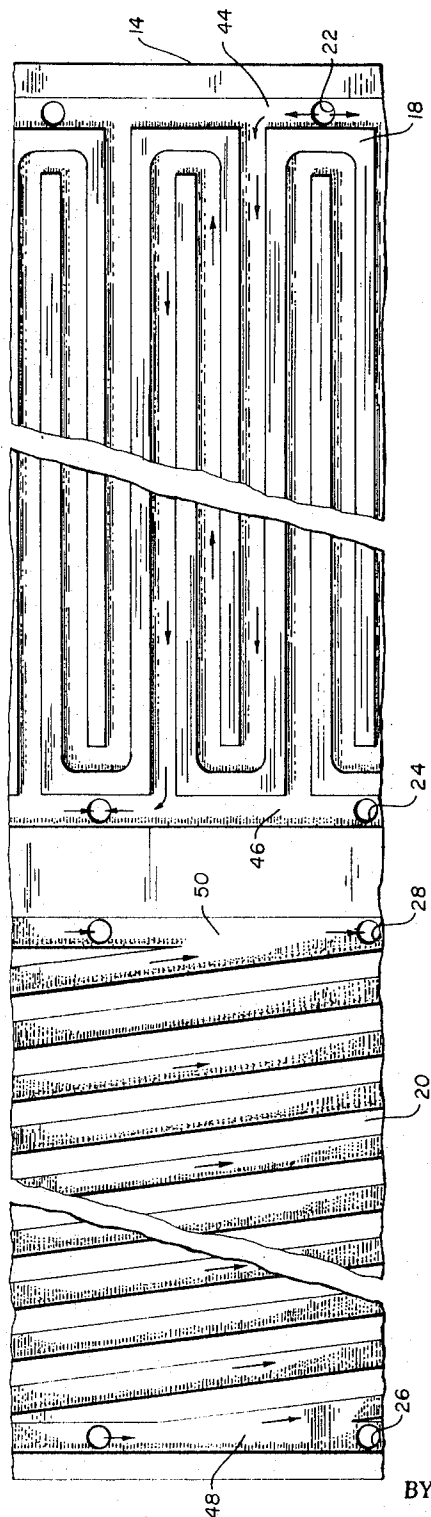


Fig. 4

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HEAT TRANSFER ROLL WITH SEPARATE TEMPERATURE ZONES FOR PROCESSING MATERIALS

BACKGROUND OF THE INVENTION

The present invention is directed to a roll suitable for calendaring, milling, sheeting and the like operations for heat exchange purposes by which materials such as plastics, rubber and the like are processed by heating, cooling, calendaring and the like; and particularly is directed to a roll having separate temperature zones along its working or outer surface.

One approach in the art by which a heat transfer roll may be operated at different temperatures along its working surface is illustrated by the Eaby U.S. Pat. No. 2,793,006. This patent discloses a roll that has between the outer shell and the core or inner shell annular channels for use with a temperature control fluid circulating system. Each annular channel is separated from the other annular channels, and the annular channels are divided into zones along the length of the roll by a series of concentric pipes for incoming and outgoing circulating fluids, and by shields for setting up separate exhaust chambers which are in communication with the different concentric pipes, multiple control valves and the like. In this manner of construction, separate injectors can supply fluid to each of the zones and the temperature can be controlled either by adjusting the valves supplying fluid to the different zones or by supplying the same quantity of fluid but at a different temperature. The cost of fabrication of this roll is quite high, however, because of the complexity of construction and the time entailed for such construction. For instance, the formation of the separate annular channels on the interior surface of the outer shell is a complicated, time consuming machining operation. In most instances such separate annular grooves would have to be made by means of a boring bar and the rate of metal removal would be very slow. The alignment of the shields relative to the annular channels and the securing of the shields would further complicate fabrication.

The Konold U.S. Pat. No. 2,972,472, discloses a heat transfer calender roll wherein between the outer shell and the roll body channels are milled in the roll body in a back and forth direction along the axial length of the roll. Heat transfer fluid circulates along the channels beneath the outer shell. The Ramundo U.S. Pat. No. 2,936,158, is another example of a heat exchange roll wherein the channels in which the heat transfer fluid flows beneath the outer shell are formed as "labyrinth circulating passages," in other words the channels are formed back and forth along the length of the roll as in the Konold patent. These two patents represent attempts to obtain a uniform temperature along the working surface of a heat transfer roll.

SUMMARY OF THE INVENTION

The heat transfer roll of the present invention has separate temperature zones along its outer or working surface and has defined between an outer shell and an inner shell a series of serpentine channels that extend back and forth along a predetermined length of the roll and are adapted for circulation therealong of a heat transfer medium, and a helical channel that extends around the roll along the remaining length of the roll and is adapted for a single pass of a heat transfer medium. The series of serpentine channels, when a heat transfer medium is circulating therealong, are adapted to provide a uniform temperature zone along the predetermined length of working surface of the roll. The helical channel, when a heat transfer medium is passing therethrough, is adapted to provide a temperature gradient zone along the remaining length of the working surface of the roll, the temperature from the uniform temperature zone being conducted in part to the initial working surface of the adjacent temperature gradient zone to affect a gradual temperature transition between the uniform temperature zone and the temperature gradient zone. In this manner the possibility of thermal shock due to differential expansion will be minimized.

Preferably, the heat transfer medium circulating through the series of serpentine channels will be a heated fluid or steam, and the heat transfer medium passing along the helical channel will be a coolant medium such as water. When working with thermoplastic materials as in a milling operation, it is desirable to pass the material being processed along the heated portion of the working surface between the heat transfer roll and another roll, and then remove the material from the cooled portion of the working surface, which cooled surface enables the material to be readily removed without undesirably adhering to the working surface. Accordingly, a thermoplastic material processed on the roll of the invention will be brought up to desired temperature by contact with the working surface in the uniform temperature zone and then worked in that area, and will be moved along the working surface by means of a plow supported at desired spaced distance from the working surface of the roll until the material exits at the opposite end of the roll at the location of the cooled working surface without adhering to the working surface.

The carry-over of heat by conduction from the uniform temperature zone to the temperature gradient zone will minimize the possibility of a sudden change in temperature undesirably affecting any characteristics of the material being processed. More significantly, however, thermal shock will be minimized thereby preventing cracks from occurring in the heat transfer roll due to differential expansion. If the coolant is a chilled liquid, the single pass of the chilled liquid from the one end of the roll and around the roll for a predetermined length of the roll will result in the coolant circulating through the helical channel being raised in temperature as it approaches the terminal end of the helical channel at an intermediate point along the roll, thereby establishing a temperature gradient zone along that portion of the working surface of the roll. The temperature gradient zone can be further affected by adjusting the velocity of flow of the heat transfer medium in the helical channel. The serpentine channel series, on the other hand, will enable the heat transfer medium flowing therein to remain essentially at constant temperature, thereby establishing a uniform temperature zone along that portion of the working surface of the roll.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of the heat transfer roll with a portion of the outer shell removed and the roll in part cross section to illustrate the serpentine channels and the helical channels formed on the inner shell or core of the roll;

FIG. 2 is a cross-sectional view taken along line 2—2 of FIG. 1;

FIG. 3 is a cross-sectional view taken along line 3—3 of FIG. 1; and

FIG. 4 is a flattened-out development of a portion of the heat transfer roll beneath the outer shell, illustrating the appearance of the serpentine channels and the helical channel and the flow paths of the heat transfer mediums.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In reference to the drawings, 10 designates the heat transfer roll having an outer shell 12 and an inner shell or core 14 spaced from the outer shell. The outer surface of the outer shell forms the working surface 16 of the roll with which materials being processed will come into contact.

A series of serpentine channels 18 are formed as by a milling operation within the surface of the inner shell or core 14 along a predetermined axial length of the roll, and a single pass helical channel 20 is formed by a similar operation within the surface of the inner shell for the remaining axial length of the roll. The lengths of the two channels are determined by the nature of the material that is to be processed.

The inner shell or core 14 is also provided with sets of radially extending passages; passages 22 and 24 serving respectively as inlets and outlets for a heat transfer medium flowing

into and out of the serpentine channels 18, and passages 26 and 28 serving respectively as inlets and outlets for a heat transfer medium flowing into and out of the helical channel 20. Radially extending passages 22 and 24 are in communication with longitudinal central passage 30, and radially extending passages 26 and 28 are in communication with longitudinal central passage 32. The longitudinal central passage 30 is provided with a concentric pipe 34, and the longitudinal central passage 32 is provided with a concentric pipe 36.

The inner end of concentric pipe 34 is supported in spaced relation intermediate the central passage 30 by a plug or baffle 38; the inner end of concentric pipe 36 is supported in spaced relation intermediate the central passage 32 by plug or baffle 40.

OPERATION

In operation, the heat transfer roll 10 is supported for rotation by shaft 42 which is preferably integral with the inner shell or core 14 in the manner shown. The shaft is conventionally supported in a journal and bearing arrangement not shown, and by means of a rotary pressure joint, such as by a Johnson rotary pressure joint, not shown. A heat transfer medium, which may be steam, water, oil or some other suitable heat transfer medium, is introduced into the series of serpentine channels 18 by means of the longitudinal central passage 30 and radial passage inlets 22. The heat transfer medium subsequently exits from the serpentine channels through radial passage outlets 24 into the inner end of the central longitudinal passage 30 and into and through the concentric pipe 34.

A heat transfer medium, which may be chilled water or other suitable coolant, or a medium of a lower temperature than that introduced into the serpentine channels, is introduced into the helical channel 20 by means of the longitudinal central passage 32 and radial passage inlets 26. The medium subsequently exits from the helical channel through radial passage outlets 28 into the inner end of the central longitudinal passage 32 and into and through the concentric pipe 36.

The heat transfer medium that flows back and forth along the serpentine channels makes a rapid transit of the channels beneath the working surface 16 so as to promote a uniform temperature along that portion of the working surface.

For instance, in reference to the serpentine channel illustrated in FIG. 4, a heat transfer medium will enter through inlet to radial passage 22 into a collector channel 44. The heat transfer medium will flow along the path illustrated by the arrows into one of the series of serpentine channels and then into a collector channel 46 for exit through outlet to radial passage 24.

In reference to the helical channel illustrated in FIG. 4, a heat transfer medium will enter through inlet to radial passage 26 into a collector channel 48 and will flow in a single pass along the helical channel and then into a collector channel 50 for exit through outlet to radial passage 28.

The heat transfer medium that flows along the helical channel has longer to travel as it flows in the channel around the roll, and therefore heat conducted in part from the serpentine channel tends to affect the temperature of the heat transfer medium in the helical channel before the heat transfer or coolant medium exits from the helical channel. Also, heat will be imparted to the working surface from the materials being processed and the temperature of the surface above the helical channel will be affected and in turn will be conducted to the heat transfer or coolant medium in the helical channel causing its temperature to increase as it flows to the intermediate part of the roll. In this manner, if there is considerable differential in temperature of the two heat transfer mediums in use, the carry-over in part of the temperature from the uniform temperature zone will bring about a gradual transition between the uniform temperature zone and the temperature gradient zone and minimize the possibility of thermal shock

and possible cracking of the roll. The carry-over of temperature, however, will under normal operating conditions not affect the temperature of the extreme end of the roll where it is desired that the material being processed will be readily removed without undesirably adhering to the heat transfer roll.

While the invention has been described in detail with particular reference to preferred embodiments thereof, it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

I claim:

1. A roll for processing materials and adapted to have separate temperature zones along its outer surface with which the material being processed come into contact, said roll comprising:

an outer shell;

an inner shell spaced from the outer shell;

means between the outer shell and the inner shell for forming separate temperature zones along the outer surface of the outer shell, said means adapted to provide a uniform temperature zone along a predetermined length of the roll, and to provide a temperature gradient zone along the remaining length of the roll; and means for introducing between the inner and outer shells within said uniform temperature zone and withdrawing therefrom a heat exchange medium; and means for introducing a second different temperature heat exchange medium between the inner and outer shells within and at the portion of said temperature gradient zone remote from the uniform temperature zone and means for withdrawing said second heat exchange medium from and at the portion of said temperature gradient zone adjacent said uniform temperature zone.

2. A roll for processing material and comprising:

an outer shell;

an inner shell;

first means included between the outer and inner shells and establishing along the outer surface of the roll for a predetermined length of the roll a uniform temperature zone;

second means included between the outer and inner shells and cooperating with the first means and establishing along the outer surface of the roll for the remaining length of the roll a temperature gradient zone;

the first and second means being arranged so that temperature from the uniform temperature zone will be conducted in part to the adjacent temperature gradient zone to affect a gradual temperature transition between the uniform temperature zone and the temperature gradient zone; and means for introducing between the inner and outer shells within said uniform temperature zone and withdrawing therefrom a heat exchange medium; and means for introducing a second different temperature heat exchange medium between the inner and outer shells within and at the portion of said temperature gradient zone remote from the uniform temperature zone and means for withdrawing said second heat exchange medium from and at the portion of said temperature gradient zone adjacent said uniform temperature zone zone

3. A roll for processing materials and adapted to have separate temperature zones along its outer surface with which the materials being processed come into contact, said roll comprising:

an outer shell;

an inner shell spaced from the outer shell and defining therebetween a series of channels through which heat transfer mediums may be circulated;

one of said channel series being serpentine in configuration beneath the surface of the outer shell, and the other of the channel series being helical in configuration beneath the surface of the outer shell, the serpentine channel series being disposed along a predetermined length of the roll,

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and the helical channel series being disposed along the remaining length of the roll; and
inlet means for introducing the respective heat transfer mediums into the respective channel series and outlet means for said heat transfer mediums to pass out of said channel series, the outlet means from the helical channel

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series for said heat transfer medium being adjacent the serpentine channel series, whereby the heat transfer medium circulating through the serpentine channel series is of different temperature than the heat transfer medium circulating through the helical channel series.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,662,821 Dated May 16, 1972
Inventor(s) Daniel I. Saxon

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the cover sheet insert -- [73] Assignee Eastman
Kodak Company, Rochester, New York --.

Signed and sealed this 12th day of December 1972.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patents