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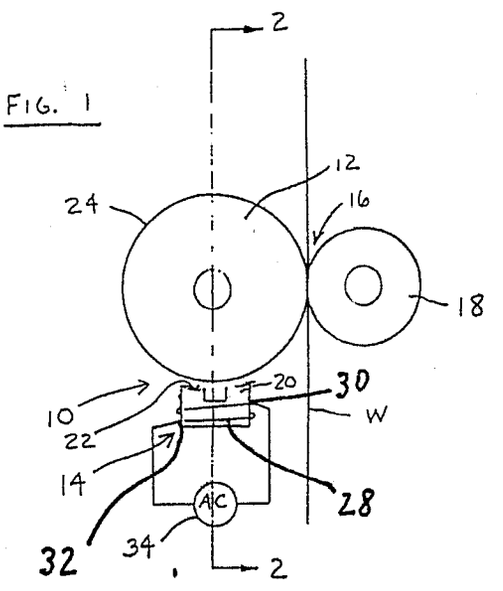
(54) **Heating apparatus for heating a calender roll.**

(57) A heating apparatus (10) is disclosed for heating a calender roll (12). The heating apparatus (10) utilizes heat supplied by induction heating and from a heat transfer medium. The heating apparatus (10) includes heating channels defined by the roll (12). The channels extend through the roll (12) such that the heat transfer medium is permitted to flow through the channels so that heat is transferred from the transfer medium to the roll (12). An induction heater (14) is disposed adjacent to the external surface (24) of the roll (12) and extends along substantially the entire length of the roll (12) such that when the induction heater (14) is energized, heat is induced in the region of the external surface (24) of the roll (12) for supplementing the amount of heat transferred from the heating medium so that the temperature of the external surface (24) of the roll (12) is increased to a level which, in the absence of the induction heater (14), would cause excessive shell stress. Furthermore, the temperature level is attainable without the hazards associated with the use of a heat transfer medium operating at least at such temperature level.

FIG. 1



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Description

This invention relates to a heating apparatus for heating a calender roll. More particularly, this invention relates to a heating apparatus for heating a calender roll in which the heating apparatus utililzes heat supplied by induction and from a heat transfer medium.

In order to increase the printability of paper and paperboard produced by a papermaking machine, various calenders have been employed to smooth the surfaces of the dried web.

Essentially, a calender includes at least one pair of cooperating rolls which define therebetween, a calendering nip for smoothing and finishing the surfaces of the dried web. According to the type of surface required, the calender rolls may be of polished metal finish or, a combination of one polished metal roll and a soft backing roll. Soft rolls include elastomeric-covered rolls and so-called filled rolls which may include a plurality of compressed cotton discs.

When a polished metal roll is utilized in combination with a soft roll, it has been found, in practice, that an improved gloss may bè imparted to the surfaces of the paper by heating the surface of the metal roll such that heat is transferred from the surface of this roll to the surface of the web extending between the metal and soft roll.

Many proposals have been disclosed in which a heating medium such as heated oil has been caused to flow through a plurality of channels, or ducts, extending through the roll. Heat from the oil is transferred to the roll so that such heat is transferred to the surface of the roll for heating the web passign therepast.

In certain applications, it is desirable to heat the surface of the roll above 149°C (300 degrees F.) and sometimes as high as 510°C (950 degrees F). However, in order to heat the surfaces of such calender rolls to these high temperatures, oil or the like heat transfer medium must be supplied at temperatures greatly exceeding these required surface temperatures -- thereby allowing for various heat losses and a significant temperature drop through the shell.

Two main problems are presented by the utilization of a heat transfer medium operating at such elevated temperatures. First, the shell of the calender roll is subjected to excessive stress and, secondly, handling oil or the like transfer medium at such elevated temperatures can be extremely hazardous.

U.S. patent number 3,489,344 to Keyes and assigned to Beloit Corporation addresses the problem of controlling the heat profile of a roll along with the cross-machine direction, but does not disclose means for overcoming the aforementioned problems.

The present invention provides a novel heating apparatus for heating a calender roll which includes the combination of an induction heater for inducing heat in the region of the external surface of the roll and heat transferred to the roll by means of a heat transfer medium passing through channels extending through the roll.

The heating apparatus of the present invention overcomes the aforementioned problems associated with the prior art calender roll heating apparatus and provides a heating apparatus which provides a significant contribution to the art of paper calendering and the like.

Another object of the present invention is the provision of a heating apparatus for heating a calender roll in which a heat transfer medium is caused to flow through heating channels defined by the roll such that heat is transferred from the transfer medium to the roll. An induction heater induces heat in the region of the external surface of the roll for supplementing the amount of heat transferred from the heating medium.

Another object of the present invention is the provision of a heating apparatus for heating a calender roll in which the temperature of the external surface of the roll is increased by induced heating to a level which, in the absence of the induction heating means, would cause shell stress.

Another object of the present invention is the provision of a heating apparatus for heating a calender roll in which the external surface of the roll is heated to a temperature level without the hazards associated with the use of a heat transfer medium operating at such an elevated temperature level.

Another object of the present invention is the provision of a heating apparatus for heating a calender roll in which the heating medium is supplied to the roll at a temperature within the range 204 to 316°C (400 to 600 degrees F.) so that various hazards associated with the use of such heating medium above the aforementioned temperature range is avoided.

Another object of the present invention is the provision of a heating apparatus for heating a calender roll in which the heat transferred to the roll by the heat transfer medium maintains the induced heat in the region around the external surface within such region by inhibiting the flow of induced heat inwardly through the roll away from the aforementioned region.

Another object of the present invention is the provision of a method of heating a calender roll in which the heat transferred to the roll from the heat transfer medium inhibits dissipation of the induced heat inwardly through the roll away from the external surface of the roll.

Other objects and advantages of the present invention will be apparent to those skilled in the art by a consideration of the detailed description contained hereinafter taken in conjunction with the annexed drawings. It should be appreciated by those skilled in the art that the present invention is not limited to the specific embodiment described herein, but rather the present invention envisages many variations and modifications which fall within

the spirit and scope of the present invention as defined by the appended claims.

The present invention relates to a heating apparatus for heating a calender roll utilizing heat supplied by induction and from a heat transfer medium. The heating apparatus includes heating channels defined by the roll. The channels extend through the roll such that the heat transfer medium is permitted to flow through the channels so that heat is transferred from the transfer medium to the roll. An induction heater is disposed adjacent to the external surface of the roll and extends along substantially the entire length of the roll such that when the induction heater is energized, heat is induced in the region of the external surface of the roll. It should be understood that a plurality of heaters may extend along the length of the roll rather than having just one heater. This induced heat supplements the amount of heat transferred from the heating medium so that the temperature of the external surface of the roll is increased to a level which, in the absence of the induction heater, would cause shell stress. Furthermore, the temperature level is attainable without the hazards associated with the use of a heat transfer medium operating at such elevated temperature level.

More specifically, the heating channels extend longitudinally through the roll so that the heating medium flows throughout the length of the roll for transferring heat from the heating medium to the roll. The heat from the heating medium is transmitted through the roll towards the external surface thereof by conduction.

In a first embodiment of the present invention, the heating medium is oil whereas in an alternative embodiment of the present invention, the heating medium is superheated water.

The heating medium is supplied to the roll at a temperature within the range of 204 to 316° C (400 to 600 degrees F.) such that the hazards associated with the use of a heating medium above this temperature range is avoided.

The heating medium may be supplied at a temperature that is within the range 121-177° C (250-350° C F.) above the temperature of the roll surface.

The induction heater induces heat in the region of the external surface of the roll. The heat transferred to the roll by the heat transfer medium maintains this induced heat in the aforementioned region by inhibiting the flow of the induced heat inwardly through the roll away from such region.

The present invention includes a method of heating a calender roll utilizing heat supplied by an induction heater and a heat transfer medium. The method includes the steps of passing the heat transfer medium through the heating channels as defined by the roll for transferring heat from the heating medium to the roll so that the roll is heated. The method also includes the step of energizing an induction heater disposed adjacent to the external surface of the roll, the induction heater extending along the length of the roll such that heat is induced in the region of the external surface of the roll. Furthermore, the heat transfer to the roll from the heat transfer medium inhibits dissipation of the induced heat inwardly through the roll away from the external surface of the roll.

Although the present invention is described particularly relative to a calender for calendering a paper web, it should be appreciated by those skilled in the art that the present invention is not limited to paper web calenders but includes heating apparatus for heating a calender roll used in calendering any web-like material. Furthermore, although the present invention relates to a calender, it should be appreciated that the invention incudes an arrangement where one or more of the calender rolls is replaced by an extended nip provided by a shoe and cooperating blanket.

Figure 1 is a side-elevational view of the heating apparatus according to the present invention showing a calender roll and an adjacent induction heater.

Figure 2 is a sectional view taken on the line 2-2 of figure 1.

Figure 3 is a sectional view taken on the line 3-3 of figure 2, and

Figure 4 is a perspective view of the apparatus shown in figures 1 to 3.

Figure 1 is a side-elevational view of a heating apparatus generally designated 10 for heating a calender roll 12. The heating apparatus 10 utilizes heat supplied by an induction heater means generally designated 14 and from a heat transfer medium. Figure 1 shows a web of paper W extending through a calender nip 16 defined by the calender roll 12 and a cooperating soft calender roll 18. The induction heating means 14 includes a ferromagnetic core 20 having a concave surface 22 disposed adjacent to, and partially extending around, the external surface 24 of the calender roll 12. A wire coil 28 extends around the core 20 with opposed ends 30 and 32 of the coil 28 being connected to a source of alternating current 34 such that when the coil 28 is energized by the AC source 34, heat is generated within a region disposed adjacent to the external surface 24 of the calender roll 12.

Electromagnetic eddy currents are generated in the ferromagnetic core 20 by one of two methods. A copper wire coil 28 could be wound around the ferromagnetic core 20 so that when an alternating current source 34 is connected to the copper wire coil 28 the eddy currents are generated in the ferromagnetic core 20. Alternately, a liquid cooled copper tube could be run straight through a length of ferromagnetic core 20 so that when an alternating current source 34 is connected to the copper tube, eddy currents are generated in the ferromagnetic core 20. Independent of which method is used to generate the eddy currents in the ferromagnetic core 20, eddy currents will also be induced in the region of the calender roll external surface 24 which is adjacent to the ferromagnetic core 20. This region of the calender roll external surface 24 will be heated up by the induced eddy currents.

Figure 2 is sectional view taken on the line 2-2 of figure 1 and shows the disposition of the induction heater means 14 along substantially the entire length of the calender roll 12. The calender roll 12 defines a

plurali ty of elongate channels which extend along the length of the roll 12. Each individual channel 36-50 as shown in figures 2 and 3, is connected by radial branches 52 and 53 to a central channel 54 which extends through the supportive axle 56 of the calender roll 12. A heat transfer medium such as oil or superheated water is connected to the plurality of heating channels 36 to 50 such that the heat transfer medium circulates throughout the length of the roll calender 12.

Figure 3 is a sectional view on the line 3-3 of figure 2 and shows the plurality of longitudinally-extending heating channels 36 to 50 being disposed radially inwards relative to the external surface 24 of the calender roll 12 with each of the longitudinal channels 36 to 50 being equally spaced from the external surface 24. When heated oil or the like is circulated through these channels heat is transferred from the heat transfer medium to the calender roll 12 and this heat supplied by the transfer medium inhibits dissipation of heat supplied by the induction heater means 14 inwardly from the external surface 24 and the region adjacent thereto. By this means, the heat supplied to the calender roll 12 by the heat transfer medium is supplemented by heat induced by the induction heater means 14 and the stress that would have been applied to the shell, or region of the calender roll 12 in the absence of the induction heater means 14 is avoided. Furthermore, by supplementing the heat supplied by the heat transfer medium with heat from the induction heater 14, the oil or heating medium does not need to be heated above 316°C (600 degrees F.). Therefore, the hazards associated with handling oil or the like, at such elevated temperatures above 316°C (600 degrees F.) is avoided.

Figure 4 is a perspective view of the calender roll 12 which may be a supercalender roll and the backing roll, or soft calender roll 18 with the web of paper or paperboard extending through the calender nip 16 defined by these cooperating rolls 12 and 18 respectively.

In operation of the heating apparatus 10, the heat transfer medium is passed through heating channels 36 to 50 which are defined by the calender roll 12 and heat is transferred from the heating medium to the calender roll 12 for heating the roll 12. The induction heater means 14 is energized such that the external surface 24 of the roll 12 is heated. Such induced heating heats not only the external surface 24 of the calender roll 12 but also the region in the vicinity of the external surface 24 of the roll 12. The heat transfer to the roll 12 from the heat transfer medium inhibits dissipation of the induced heat inwardly through the roll 12 away from the external surface 24 of the roll 12.

The present invention provides a simple apparatus for supplying supplementary heat to the surface region of a supercalender roll, thereby avoiding the problems of shell stress and the like. Furthermore, the present invention avoids the problems associated with handling an internal heat transfer medium at elevated temperatures.

Claims

1. A heating apparatus for heating a calender roll, said heating apparatus utilizing heat supplied by induction heating and from a heat transfer medium, said heating apparatus comprising:

heating channels defined by the roll, said channels extending through the roll such that the heat transfer medium is permitted to flow through said channels so that heat is transferred from the transfer medium to the roll; and

induction heating means disposed adjacent to the external surface of the roll and extending along substantially the entire length of the roll such that when said heating means is energized, heat is induced in the region of the external surface of the roll for supplementing the amount of heat transferred from the heating medium so that the temperature of the external surface of the roll is increased to a temperature level which, in the absence of said heating means, would cause excessive shell stress, said temperature level being attainable without the hazards associated with the use of a heat transfer medium operating at least at such temperature level.

2. A heating appartus as set forth in claim 1 wherein said heating channels extend longitudinally through the roll such that the heating medium flows throughout the length of the roll for transferring heat from the heating medium to the roll, the heat from the heating medium being transmitted through the roll towards the external surface thereof by conduction.

3. A heating apparatus as set forth in claim 1 wherein said heating medium is oil.

4. A heating apparatus as set forth in claim 1 wherein said heating medium is superheated water.

5. A heating apparatus as set forth in claim 1 wherein said heating medium is supplied to the roll at a temperature within the range 204 to 316°C (400 to 600 degrees Fahrenheit), such that said hazards associated with use of a heating medium above said temperature range is avoided.

6. A heating apparatus as set forth in claim 1 wherein said induction heating means is an induction heater which extends along the external surface of the roll, said induction heater inducing heat in said region, said heat transferred to the roll by the heat transfer medium maintaining the heat in said region within said region by inhibiting the flow of said induced heat inwardly through the roll away from said region.

7. A heating apparatus as set forth in claim 1 wherein said heating medium is supplied to the roll at a temperature within the range 121°C-177°C (250°F. - 350°F) above the roll surface temperature.

8. A heating apparatus for heating a calender roll, said heating apparatus utilizing heat supplied by induction heating and from a heat transfer medium, said heating apparatus comprising;

heating channels defined by the roll, said channels extending through the roll such that the heat transfer medium is permitted to flow through said channels so that heat is transferred from the transfer medium towards the external surface of the roll; and

an induction heater disposed adjacent to the external surface of the roll and extending along substantially the entire length of the roll such that when said induction heater is energized, heat is induced in the region of the external surface of the roll for supplementing the amount of heat transferred from the heating medium so that the temperature of the external surface of the roll is increased to a level which, in the absence of said induction heater, would cause excessive shell stress, said temperature level being attainable without the hazards associated with the use of a heat transfer medium operating at least at such temperature level.

9. A method of heating a calender roll utilizing heat supplied by an induction heater and a heat transfer medium, the method including the steps of:

passing the heat transfer medium through heating channels defined by the roll for transferring heat from the heating medium to the roll for heating the roll; and

energizing an induction heater disposed adjacent to the external surface of the roll, the induction heater extending along the length of the roll such that heat is induced in the region of the external surface of the roll, the heat transferred to the roll from the heat transfer medium inhibiting dissipation of the induced heat inwardly through the roll away from the external surface of the roll.

FIG. 1

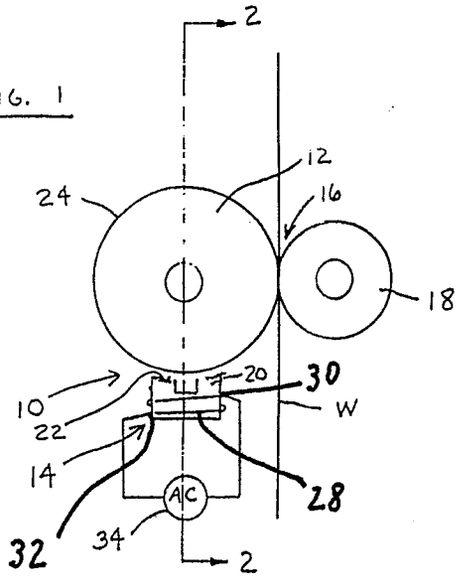
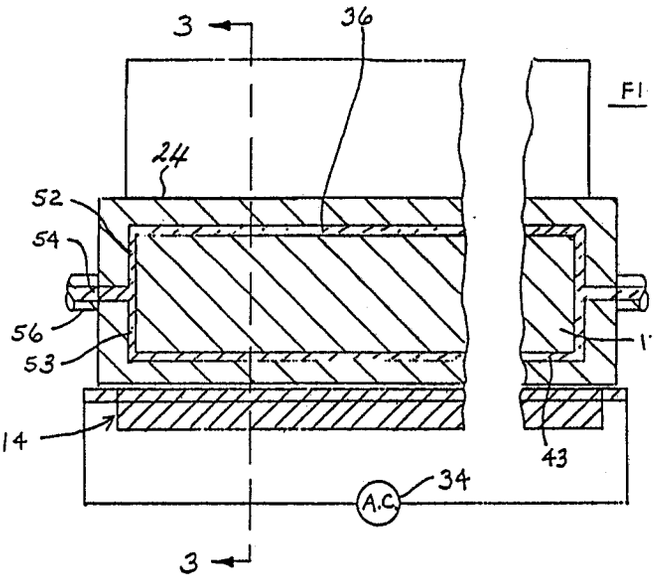


FIG. 2



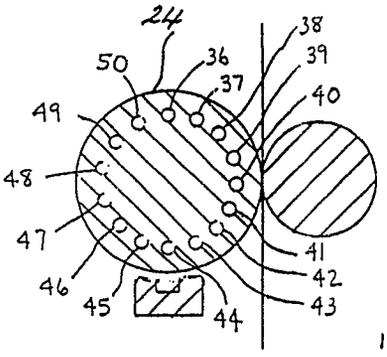


FIG. 3

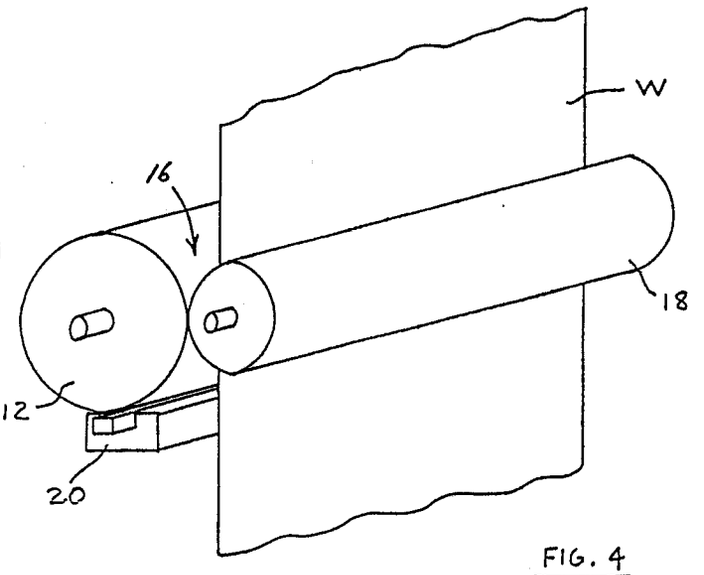


FIG. 4