United States Patent

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[54] **FLUID HEATED ROLL**
8 Claims, 2 Drawing Figs.

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[51] **Int. Cl.** **H05b 9/06,** H05b 5/00
[50] **Field of Search** 219/10.61, 469, 470, 471, 216, 338, 10.65; 165/104

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ABSTRACT: A roll for continuously heating an article of indefinite length such as a textile filament or fiber is disclosed. A source of heating is localized at a fluid filled chamber so the fluid can be boiled off and condensed on a tapered surface that is in heat exchange relationship with the exterior working surface of the roller means. The interior tapered surface acts to return the condensed fluid under the centrifugal action caused by the rotating roll means. This closed cycle fluid heating arrangement provides for uniform application of heat as it is removed from the surface of the heated roll, either by windage losses or by transfer to the moving article that is being heat treated.

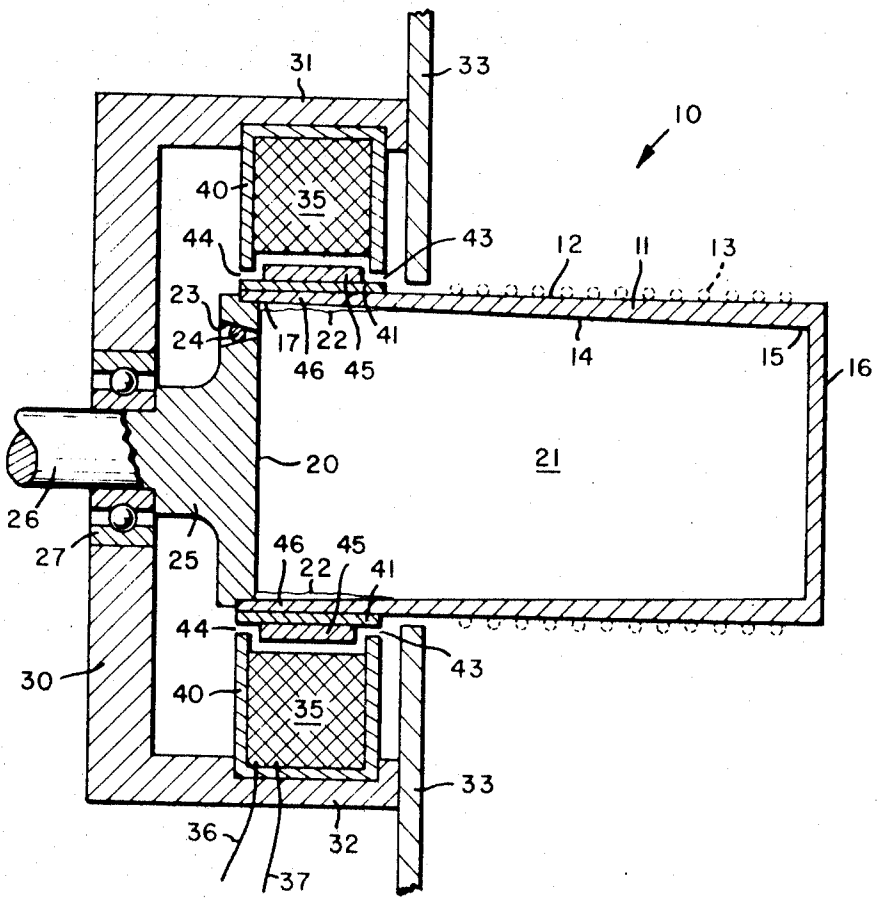


FIG. 1

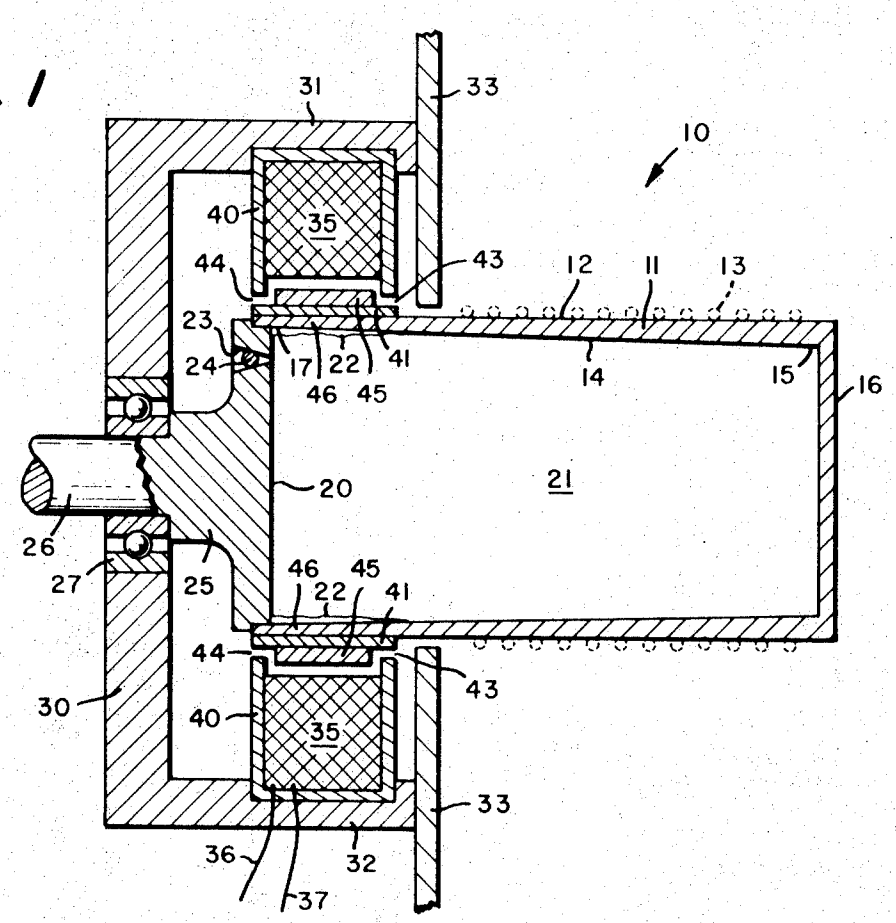
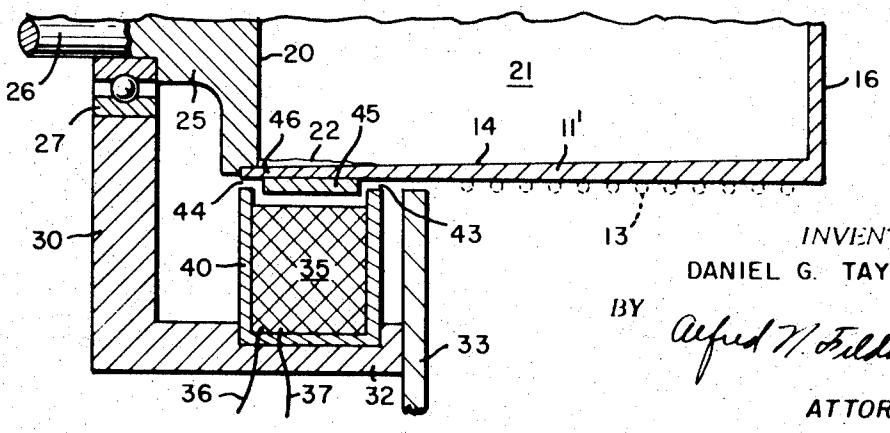


FIG. 2



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FLUID HEATED ROLL

BACKGROUND OF THE INVENTION

In certain industries, particularly the textile industry, it has become necessary to heat treat fibers or filaments in order to properly align or set the structure of the material from which the fibers are made. In order to accomplish this, the textile industry has used various heating means for heat treating a continuously moving, and indeterminate length of filament or fiber. A common type of heater is a flat heater plate that is electrically heated and has the filament or fiber drawn across its surface. Also used are various types of heated rolls. These heated rolls normally are a mechanically driven roll or shell that has an internal heating means applied to it so that the surface of the shell can have a number of turns of a filament or fiber wrapped around it for heat treating purposes. Various means of heating the shell have been used, such as circulating heated fluid, electric heaters, and inductively coupled heaters. In all of these cases, it has been difficult to hold a uniform surface temperature of the heated roll as it is spun at a substantial speed during the processing of a filament or fiber. There is a substantial windage loss of heat, as well as, a loss due to the actual heating of the filament or fiber being treated, as well as a conductive loss along the shaft. Various means for applying characterized heat to the internal surface of the roll have been suggested but all of these means are subject to the control problems of the amount of heat being delivered to the filament or fiber. If a roll is designed to deliver proper heat to one particular type of filament or fiber at a particular rotational speed, any changes in speed or type of filament or fiber processed makes that roll less efficient and desirable. All of the means for characterizing the heat delivered to the roll have been means which are mechanically fixed and therefore any change in the load on the roll defeats the purpose of the characterized heat transfer to the roll shell.

SUMMARY OF THE INVENTION

The present invention is directed to a self-compensating type of heating arrangement for a heated roll so that the surface temperature remains uniform regardless of the type of filament being drawn around the roll or the windage losses at the surface of the roll. This is accomplished by utilizing a fluid and vapor fill within the roll and a tapered cylindrical configuration of the internal surface so that the centrifugal force operating on the fluid concentrates the fluid in a confined area so that it can be boiled to generate a vapor that transfers heat uniformly as needed to the internal surface of the heated roll. This type of an arrangement is self-compensating compensating in that as the surface of the roll is cooled more fluid condenses on the surface opposite the cooled portion thereby transferring more heat. The condensed fluid is centrifugally driven back to a concentrated heating area by the tapered configuration of the internal surface and the cycle continues or begins again. With this arrangement the heat necessary for operating the heated roll can be concentrated at the point of collection of the fluid itself, and provides for an exceedingly simple structure that is self-compensating in its operation.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a cross section of a preferred embodiment which utilizes a single cylindrical fluid chamber that is tapered so that the condensate is concentrated at a heated zone, and;

FIG. 2 is a partial cross section similar to FIG. 1 but which uses a slightly different magnetic circuit for the inductive heater.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A heated roll is generally shown at **10** and includes a generally cylindrically shaped shell which has an outer surface **12** that is the work surface upon which a number of turns **13** of a filament or fiber are represented in phantom. The filament **13** usually is close to its melting temperature and this puts a premium on uniform heating of surface **12**. The internal surface **14** of the shell **11** is tapered from a smallest diameter **15** at an end **16** to a largest diameter **17** at an end plate **20**. The two end plates **16** and **20** along with the shell **11** form a completely enclosed fluidtight chamber **21** that contains a heat exchange fluid **22** which is shown concentrated at the interior tapered surface having the largest diameter near the end plate **20**. The type of heat exchange fluid **22** selected depends on the temperature of operation of the heated roll **10** and could be selected so that when the heated roll **10** is operating at a proper temperature, the vapor pressure within the chamber **21** would be slightly below atmospheric so that the external atmospheric pressure on the shell **11** would cause it to be in a slight state of compression. This allows the shell **11** to be of a minimum thickness. The wall thickness and vapor pressure can be selected over a wide range to suit the function desired. Vapor pressures over a wide range of both positive and negative with respect to atmospheric could be used.

The chamber **21** is filled by means of a tapered hole **23** and is sealed by a ball **24**. Before the ball **24** is put into place, the chamber **21** is evacuated and filled with the desired amount of the heat exchange liquid or fluid **22**. Fluid **22** normally is a liquid that can be partially vaporized by heat. The ball **24** is then driven into a tapered hole **23** which seals chamber **21** in a fluidtight manner.

Formed integrally with the end plate **20** is a hub **25** that is integrally attached to a shaft **26** that is mounted in a bearing **27**. The bearing **27** in turn is mounted in a mounting means **30** that has extensions **31** and **32** that mount the shaft **26** and the heated roll **10** from a work surface **33**. The work surface **33** is part of a larger work surface upon which are mounted a number of heated rolls, depending on the type of machine desired. The shaft **26** is driven by an external motor or drive mechanism, not shown, and is not material to the present invention. The drive shaft **26** can be coupled to any number of other heated rolls **10** or can be individually driven. The normal type of driving mechanism for shaft **26** would be an individual synchronous motor.

In order to supply the heating necessary for vaporizing the heat exchange fluid **22**, a primary winding **35** connected by conductors **36** and **37** to an alternating current source of potential or provided. Encircling the primary coil **35** is a magnetic structure **40** which is U-shaped in general cross section. In order to provide an easy path for the magnetic flux that is generated by the coil **35**, a ring **41** is placed around the shell **11** and is of a magnetic material thereby providing a magnetic circuit with a pair of small air gaps **43** and **44**. In order to complete the heating means, a ring of conductive material such as copper **45** is placed in intimate contact with the magnetic ring **41**. It is obvious that flux device the generated in coil **35** passes around the magnetic circuit made up of the U-shaped member **40**, the leg **41**, and the two air gaps **43** and **44**. This flux encircles or links the copper or conductive ring **45**, thereby generating a substantial amount of current in the ring. Since this is a short circuited ring, the current flows freely and generates heat as a result of the current. This heat is transferred through the shell **11** at **46** to the heat exchange fluid **22**, boiling the fluid and creating a vapor of the fluid **22** in chamber **21**. This vapor condenses on the internal wall **14** as is needed to meet the heat load caused by the windage loss of the rotation of the heated roll **10**, by conduction to other parts of the device or by the heat being transferred to the filament **13**. As the fluid condenses on the cylindrical interior tapered surface **14**, the spinning action of the heated roll **10** causes the fluid to travel back along the taper to he heat exchange fluid **22** which is centrifugally held against the interior tapered surface **14** in the area directly opposite the heating ring **45** interior of the shell **11** at **46**. The fluid is then revaporized and sent out as a vapor to condense again thereby continuously providing heat transfer in a closed fluid circuit. As the demand for heat varies across the shell **11**, more vapor or less vapor condenses on the cylindrical internal tapered surface **14** to maintain a uniform heat flow so that the filament **13** can be heat

treated at a constant temperature regardless of the varying load caused by external cooling forces on the heated roll **10**.

In the modification disclosed in FIG. **2**, the heated roller **10** has a shell **11'** made of a magnetic material. This allows the elimination of the magnetic ring **41** that had been previously used. The copper or conductive ring **45** is directly in contact with the shell **11'**. This allows a more intimate and rapid heat transfer from the ring **45** to the fluid **22** and further allows the magnetic air gaps **43** and **44** to be from the core member **40** the shell **11'** itself.

With the present invention it is possible to provide a heated roll that is exceedingly simple in construction and which provides for a uniform heating of the external surface of the heated roll with varying loads and windage. The arrangement is self-compensating and is dependent on the taper of the interior surface for return of the condensed vapor back to a heated zone adjacent the conductive ring **45**. The means of heating the fluid can be varied from that disclosed to other heating means such as conventional electric heaters mounted internally of the shell **11** or by radiant heat applied to a localized zone opposite the fluid fill **22**. Since there are many possible variations of the mode of carrying the present invention out, and in the shape of the fluidtight chamber, the applicant wishes to be limited in the scope of his invention solely by the scope of the appended claims.

The embodiments of the invention in which an exclusive property or right is claimed are defined as follows:

1. A heated roll constructed for heating a moving article of indeterminate length, comprising: roll means having an exterior surface for heat treating said moving article of indeterminate length and including drive means adapted to be rotated to rotate said roll means; said roll means having an interior tapered surface in heat exchange relationship with said exterior surface; fluidtight chamber means having a heat exchange fluid partially filling said chamber means and including said tapered interior surface as a portion thereof to centrifugally concentrate said fluid at the largest diameter of said interior tapered surface; and heating means for concentrating heat at said largest diameter of said tapered surface to transfer heat to said fluid to boil some of said fluid into a vapor thereby transferring heat to said interior tapered surface by said vapor condensing on said interior tapered surface to give up heat to uniformly heat said roll means, said condensed fluid being returned to said largest diameter by centrifugal action of the rotation of said roll means and the interior tapered surface.

2. A heated roll constructed for heating a moving article as described in claim **1** wherein said heating means includes a flux generating structure which when energized with alternating current generates an alternating magnetic flux; and a shorted conductive ring linked by said alternating magnetic flux to have a heating current induced in said ring to heat said fluid.

3. A heated roll constructed for heating a moving article as described in claim **2** wherein said flux generating structure and said shorted conductive ring encircle said roll means adjacent the said largest diameter of said interior tapered surface.

4. A heated roll constructed for heating a moving article as described in claim **3** wherein said roll means is of a magnetic material and forms part of an alternating magnetic flux path for said flux generating structure.

5. A heated roll constructed for heating a moving article as described in claim **1** wherein said cylindrical interior tapered surface has a uniform taper and is closed by a pair of generally parallel plates to form a single cylindrical fluidtight chamber.

6. A heated roll constructed for heating a moving article as described in claim **5** wherein said heating means includes a flux generating structure which when energized with alternating current generates an alternating magnetic flux; and a shorted conductive ring linked by said alternating magnetic flux to have a heating current induced in said ring to heat said fluid.

7. A heated roll constructed for heating a moving article as described in claim **6** wherein said flux generating structure and said shorted conductive ring encircle said roll means adjacent said largest diameter of said interior tapered surface.

8. A heated roll constructed for heating a moving article as described in claim **7** wherein said roll means is of a magnetic material and forms part of an alternating magnetic flux path for said flux generating structure.

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