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Matsumura et al.

[11] **3,790,736**

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[54] **HEATING ROLLERS**

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[30] **Foreign Application Priority Data**

Oct. 21, 1972 Japan 47-105664

[52] **U.S. Cl.** **219/10.49,** 219/10.61

[51] **Int. Cl.** **H05b 5/08**

[58] **Field of Search** 219/10.49, 10.61, 469

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[57] **ABSTRACT**

In a heating roller of the type comprising a cylindrical cup shaped magnetic roller, a magnetic boss at the center of the inner surface of the bottom of the roller, a driving shaft connected to the boss, a stationary magnetic sleeve surrounding the boss and the shaft, a magnetic radial flange secured to one end of the sleeve to confront the open end of the roller and an exciting coil disposed in a space between the roller and the sleeve, a magnetic ring is secured to the outer end of the radial flange to extend in the axial direction for surrounding the peripheral surface of the open end of the roller with a narrow air gap therebetween.

9 Claims, 6 Drawing Figures

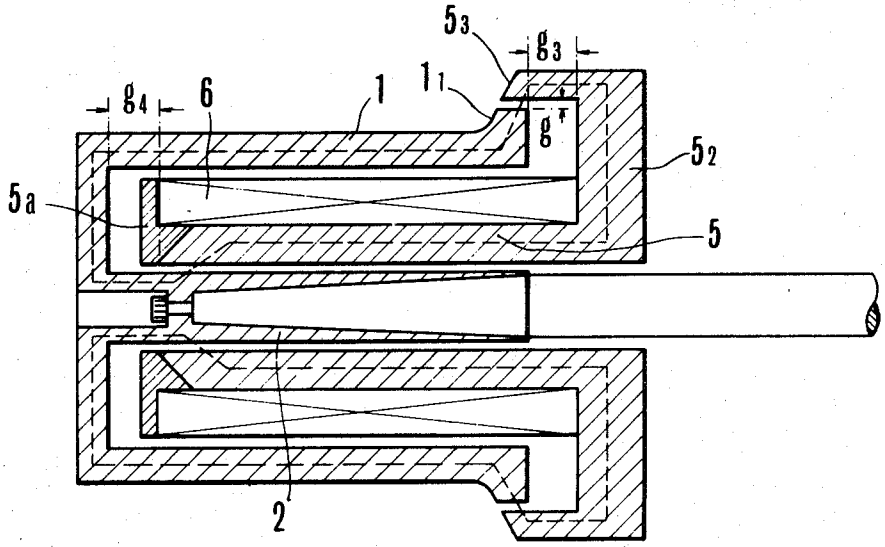


FIG. 1

PRIOR ART

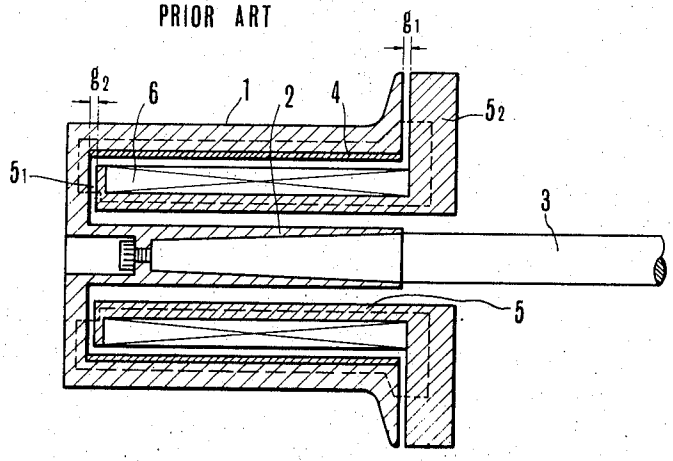


FIG. 2

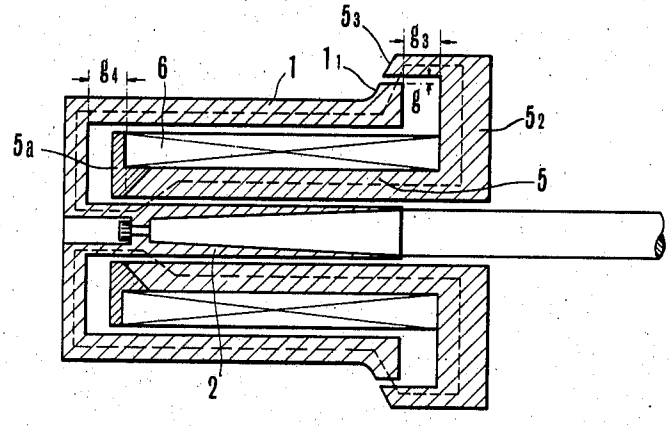


FIG. 3

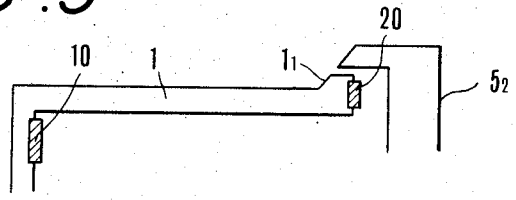


FIG. 4

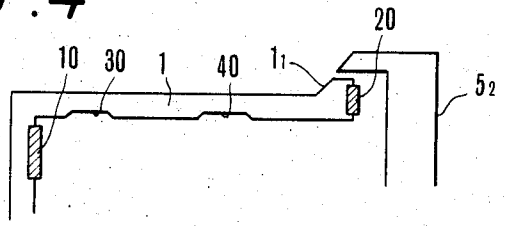


FIG. 5

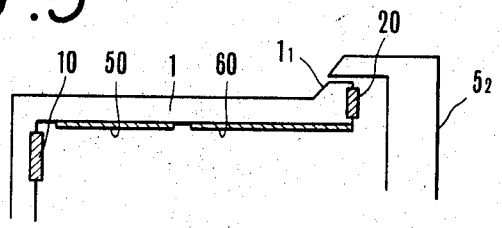
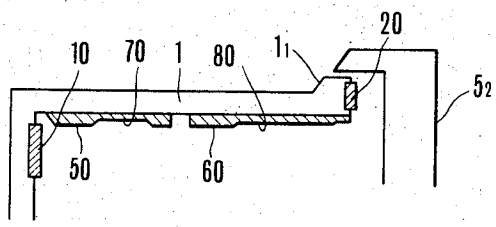


FIG. 6



HEATING ROLLERS

BACKGROUND OF THE INVENTION

This invention relates to a heating roller and more particularly to a rotary heating roller adapted to heat a member to be heated such as a thread or yarn.

The heating roller of the type described above is used to heat a synthetic fiber which is required to be heated at an extremely constant temperature. As shown in FIG. 1, a heating roller of the prior art construction comprises a cylindrical roller 1 having a cylindrical boss extending to the opening of the cylinder from the center of the bottom thereof. The opening of the cylindrical boss 2 is tapered to receive a rotary shaft 3. On the inner surface of the cylindrical roller 1 is formed a heat generating layer 4 made of an electric conductive material. A stationary sleeve 5 having radial flanges 5_1 and 5_2 on the opposite ends is provided to surround the boss 2 and shaft 3. The diameter of the inner flange 5_1 is made smaller than the inner diameter of the roller 5 whereas the outer flange 5_2 is disposed to oppose a flange formed on the open end of the roller with a definite axial spacing therebetween. An exciting coil 6 is wound about sleeve 5.

When the exciting coil 6 is energized by alternating current, magnetic flux is generated to flow through the cylindrical roller, the outer flange 5_2 and the sleeve 5 as shown by dotted lines. Accordingly, the roller 1 is heated by the short circuit current induced in the heat generating layer 4, eddy current induced in the roller 1 and the hysteresis loss therein. The heated roller 1 is rotated by shaft 3 and the substance to be heated such as artificial fibers and chemical fibers which are brought into contact with the peripheral surface of the roller is efficiently heat treated.

With this construction attractive forces F_1 and F_2 act across the air gaps g_1 and g_2 formed between the flange at the opening of the roller and the outer flange 5_2 of the sleeve 5 and between the bottom of the roller and the inner flange 5_1 of the sleeve, and these attractive forces apply a thrust load on the shaft 3. Since the exciting coil 6 is energized by alternating current, the thrust load is applied intermittently thereby damaging the bearing of the rotary shaft.

Furthermore, since one end of the roller 1 is closed by the bottom and since the opposite end is located closely adjacent the flange 5_2, the heat at both ends of the roller is dissipated through the bottom and flange 5_2, and the temperature at the opposite ends is lower than that of the central portion of the roller. Moreover, the quantity of the magnetic flux linking the opposite end is smaller than at the central portion of the roller, so that the heat generated by the magnetic flux is smaller at the opposite ends. For this reason, the heat distribution of the prior art heating roller shown in FIG. 1 is not uniform thereby making it impossible to uniformly heat treat chemical fibers or the like.

SUMMARY OF THE INVENTION

It is an object of this invention to provide a reliable heating roller capable of eliminating various defects mentioned above.

Another object of this invention is to provide an improved heating roller capable of uniformly heating the objects to be heated at high efficiencies.

Yet another object of this invention is to provide a novel heating roller which can eliminate the thrust load acting upon the driving shaft.

According to this invention, these and other objects can be accomplished by providing a heating roller of the type comprising a cylindrical cup shaped magnetic roller, a magnetic boss connected to the center of the inner surface of the bottom of the roller, a driving shaft connected to the boss, a stationary magnetic sleeve surrounding the boss and the shaft, a magnetic radial flange secured to one end of the sleeve to confront the open end of the roller and an exciting coil disposed in a space between the roller and the sleeve, characterized in that a magnetic ring is secured to the outer end of the radial flange, the ring extending in the axial direction to surround the peripheral surface of the open end of the roller with a narrow air gap therebetween which extends in the axial direction of the roller.

Various means are provided to assure uniform heat distribution of the surface of the heating roller. Thus, conductive layers are secured either on the inner surface or the open end of the roller or on the inner surface of the bottom of the roller. A non-magnetic disc is secured to the inner end of the sleeve to cause the magnetic flux to flow through the boss and the sleeve.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings:

FIG. 1 shows a diagrammatic longitudinal section of a prior art heating roller;

FIG. 2 shows a longitudinal section of one embodiment of this invention; and

FIGS. 3 to 6 are partial longitudinal sectional views of different embodiments of this invention. Throughout the drawings, like or corresponding portions are designated by the same reference characters.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In one embodiment of this invention shown in FIG. 2, the roller 1 is provided at its open end with a radially extending flange 1_1 having an axial circumferential surface. The outer flange 5_2 of the magnetic sleeve 5 has an inwardly projecting cylindrical ring 5_3 which surrounds the circumferential surface of the flange 1_1 with an air gap g extending in the axial direction. The spacing g_3 between the inner surface of the flange 5_2 and the open end of the roller 1 is made larger than said air gap g. On the inner end of the magnetic sleeve 5 is secured a non-magnetic radial disc 5*a* to face the bottom of the roller 1. The disc 5*a* is used for the purpose of holding the exciting coil 6 to cause the magnetic flux to flow through the inner end of the boss 2. The spacing between the inner wall of the bottom of the roller and the radial disc 5*a* is made smaller than the spacing g_4 between the inner wall and the inner end of sleeve 5.

When alternating current is passed through the exciting coil 6, the magnetic flux produced thereby flows through a magnetic path that can be traced from the inner end of sleeve 5, through boss 2, the roller 1, gap g, flange 5_2 and back to the outer end of sleeve 5. As the spacing g_3 between the open end of roller 1 and the inner surface of flange 5_2 is large, the leakage flux flowing through this spacing can be minimized. Moreover, as the non-magnetic disc 5*a* is provided between the bottom of the roller and the inner end of the sleeve 5,

and since the spacing g_4 between the inner end of the sleeve **5** and the inner wall of the bottom of the roller **1** is made sufficiently large the magnetic flux flows to the center of the bottom of the roller through boss **2** of magnetic material. By virtue of such magnetic circuit, it is possible to greatly decrease attractive force acting between the open end of the roller and the radial flange 5_2 and between the inner end of the sleeve **5** and the bottom of the roller **1**, thereby decreasing the thrust load acting upon the driving shaft **3**, whereby the damage to the bearing of the shaft can be minimized. Since the air gap g between the roller **1** and the radial flange 5_2 is small, the attractive force acting upon the peripheral surface of the open end of the sleeve **5** is large. However, as this attractive force acts uniformly around the open end of the sleeve it does not affect in any way the driving shaft **3**. Moreover, the left-hand force of the law of Fleming acting upon roller **1** decreases further the thrust load.

According to this invention the roller **1** is heated uniformly. More particularly, the right-hand end of the exciting coil **6** is exposed over a distance of g_3 so that more flux links the flange 1_1 thereby heating it strongly. However, as the dissipation of the heat generated in flange 1_1 is efficiently prevented by the overlying ring 5_3, thereby preventing the temperature of the open end of the roller **1** from being lowered.

FIG. **3** diagrammatically illustrates a modified embodiment of this invention wherein an annular conductor ring **10** is secured to the inner wall of the bottom of the roller **1** and a second annular conductor ring **20** is secured to the open end of the roller **1** to face the inner side of the radial flange 5_2. With this construction short circuit currents are induced in the rings **10** and **20** to prevent the temperature at the opposite ends of the roller from decreasing, thus assuring uniform heat distribution.

In another embodiment shown in FIG. **4**, annular grooves **30** and **40** are formed on predetermined portions along the inner wall of the cylindrical roller **1** for the purpose of adjusting the heat distribution thereof more precisely. These annular grooves permit selection of any value of the resistance of the roller for adjustment of the heat distribution of the roller **1**.

In the case shown in FIG. **5**, electric conductor layers **50** and **60** are applied on the inner surface of the roller **1** for increasing the heating capacity thereof. In operation, short circuit currents are also induced in these conductor layers so that the heat generating capacity is increased from that of the embodiment shown in FIG. **3**.

In the construction shown in FIG. **6**, the heat distribution of the embodiment shown in FIG. **5** is more finely adjusted. Thus, the conductor layers **50** and **60** are provided with grooves or notches **70** and **80**, respectively, for the purpose of adjusting their resistance values, and hence the heat distribution of the roller **1**.

As above described this invention provides an improved heating roller wherein the axial spacing between the open end of the roller and the radial flange of the sleeve is increased and the air gap therebetween is formed in the axial direction so that it is possible to decrease the thrust load upon the driving shaft as well as the damage to the bearing supporting the shaft. Moreover, as the exciting coil is protruded beyond the open end of the roller, the heating of the open end is increased by the leakage flux from the exposed portion of the exciting coil, thus assuring uniform heating of the roller. As the interior of the roller is vented to the atmosphere through an air gap which extends in the axial direction along the outer surface of the roller instead of an air gap which extends in the radial direction as in the prior art construction, the air in the roller is more effectively sealed thus preserving the heat and increasing the heat efficiency. Increased axial distance between the open end of the roller and the radial flange of the sleeve alleviates the accuracy of the machining. Further, provision of the short circuit ring or the annular groove on the inner surface of the roller ensures more uniform heat distribution in the axial direction of the roller.

While the invention has been shown and described in terms of some preferred embodiments thereof, it should be understood that many changes and modifications will be obvious to one skilled in the art without departing the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A heating roller comprising a cylindrical cup shaped magnetic roller, a magnetic boss connected to the center of the inner surface of the bottom of the roller, a driving shaft connected to said boss, a stationary magnetic sleeve surrounding said boss and said shaft with one end terminating in axially spaced relation to said inner surface, a magnetic radial flange secured to the other end of said sleeve to confront the open end of said roller in axially spaced relation thereto, an exciting coil disposed in a space between said roller and said sleeve, a magnetic ring secured to the outer end of said radial flange, said ring extending in the axial direction to surround the peripheral surface of the open end of said roller with a narrow air gap which extends in the axial direction of said roller, both of said spaced relations providing axial air gaps in the magnetic path through said roller and sleeve which are substantially greater than the air gaps provided by the radial spacing between said magnetic sleeve and said boss and between said ring and said open end of said roller thereby minimizing the axial thrust on said roller due to magnetic force.

2. The heating roller according to claim **1** wherein a non-magnetic radial disc is provided on the inner end of said sleeve to surround said boss.

3. The heating roller according to claim **1** wherein said exciting coil projects beyond the open end of said roller to said flange so as to inductively heat said open end.

4. The heating roller according to claim **1** wherein a radial flange is provided on the open end of said roller, and said magnetic ring is disposed to surround the outer peripheral surface of said radial flange on said roller.

5. The heating roller according to claim **1** wherein the inner surface of said roller is provided with at least one annular groove.

6. The heating roller according to claim **1** wherein an electric conductor layer is formed on the inner surface of said roller.

7. The heating roller according to claim **6** wherein said conductor layer is provided with a groove.

8. The heating roller according to claim **1** wherein a conductor ring is secured to the inner side of the bottom of said cup shaped roller concentric with said shaft.

9. The heating roller according to claim **1** wherein a conductor ring is secured to the open end of said cup shaped roller concentric with said shaft.

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