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Bauer et al.

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[54] **INDUCTIVELY HEATED GODET**

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[58] **Field of Search**...219/10.61, 216, 338, 469, 470, 219/471

[56] **References Cited**

UNITED STATES PATENTS

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1,172,586 12/1969 Great Britain.............219/469

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[57] **ABSTRACT**

A godet assembly in which a rotated, inductively heated cylindrical godet shell is provided on its inner wall with radially recessed openings from which there extends an axially recessed opening, preferably triangular in a longitudinal section, a non-magnetic material of high electrical conductivity such as copper being advantageously filled into these recessed openings in close adherent contact with the wall surfaces of the openings, such that the openings and preferably with the embedded non-magnetic material are arranged radially and axially to maintain a uniform temperature on the outer circumferential surface of the shell.

9 Claims, 2 Drawing Figures

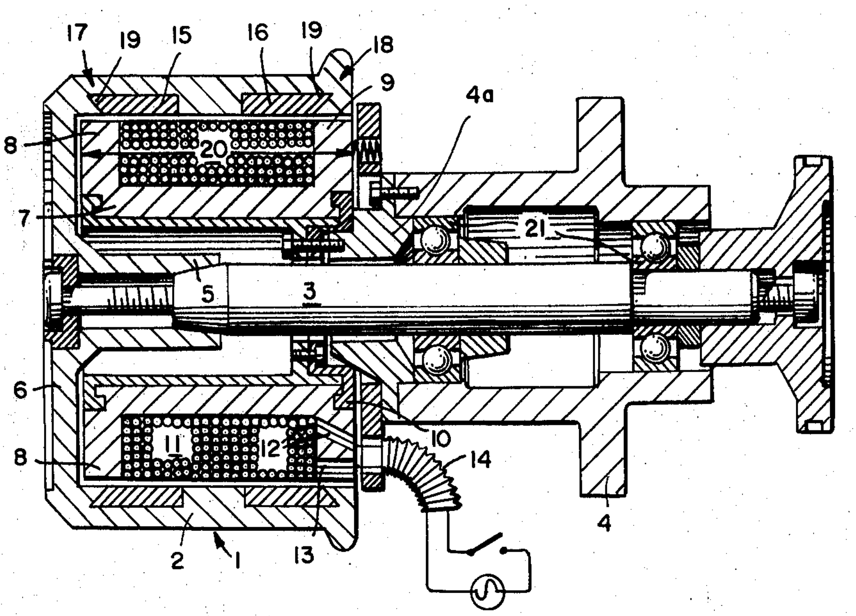


FIG. 1

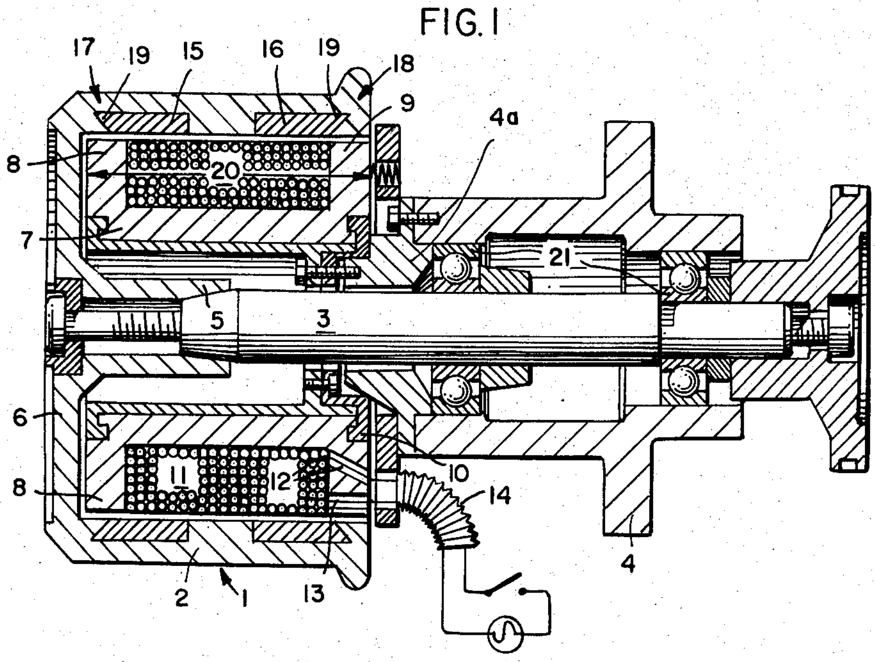
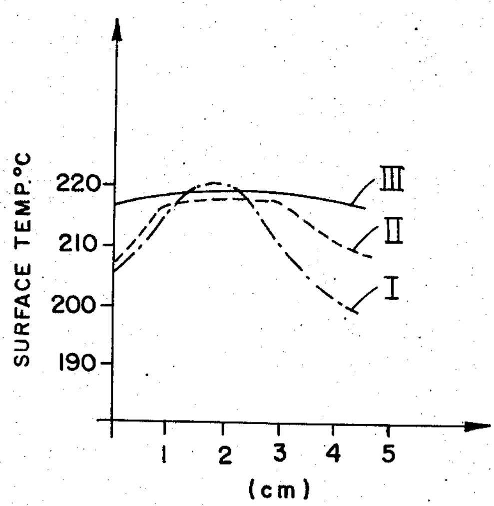


FIG. 2



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INDUCTIVELY HEATED GODET

The invention generally relates to an inductively heated godet for textile machines or the like, e.g., for the heat treatment of filaments, threads, yarns, ribbons, foils or similar materials running continuously in contact with a rotatably mounted shell of the godet, this shell surrounding a stationary axial core of a ferromagnetic material which is wound by a coil connected with a source of alternating current.

Inductively-heatable godets of this type are generally known. For example, U.S. Pat. No. 3,412,228 describes a heating drum which consists of a freely rotatable hollow roller which is mounted for rotation at the end of a driven shaft. In the interior of the hollow roller there is fixedly arranged a core of laminated iron plates, which concentrically surrounds the drive shaft and which is arranged on a machine frame or support in such a way that it does not participate in the rotation of the hollow roller. The core carries one or more coils consisting of numerous windings whose connecting ends or electrical lead wires are directed outwardly and connected with an alternating current source. The coil forms the primary side of a transformer, whose secondary side is the hollow roller itself. When the coil is traversed by an alternating current, then there is generated in the core a magnetic field which enters the two face plates of the hollow roller and from there is conducted into the cylindrical shell of the roller. The magnetic flux in the shell generates an electrical potential standing perpendicular to the lines of force, which in turn induces a current in the shell or roller wall in a plane normal to the axis of the roller, i.e. circumferentially thereof. In consequence of the ohmic resistance of the shell or roller wall, it is heated by this so-called short-circuit current flowing therethrough. Eddy currents caused by the alternating magnetic flux also contribute to the heating of the shell.

The described inductive heating arrangement would be suitable for generating a substantially uniform temperature over the entire length of the shell circumference if the heat requirement of this shell were equally great at all points. However, this is not the case, since more heat is led off at the terminal ends of the shell than in its middle portion. As a consequence, a strong temperature drop takes place at the two ends of the shell, for example in an amount of up to 30° C., according to existing operating conditions.

In order to equalize the temperature profile, i.e. along the length of the roller, it is known from the above-noted patent U.S. Pat. No. 3,412,228 to arrange on the interior of the shell a number of rings of electrically well-conducting and non-magnetizable material, these rings having a thickness which is adapted to the heat requirement of the particular location on the roller wall. The evening of the temperature profile through such rings is brought about due to the fact that the rings have a considerably lower electrical resistance than the shell or roller wall, usually consisting of steel, so that with equal voltage applied thereto, a considerably higher current flows in the circumferential direction. This current results in a stronger local heat development, whereby one can compensate for the differing amounts of heat being lost over the length of the shell.

Measurements which we have made on godets constructed in this manner have shown that actually the

temperature profile still presents appreciable deviations from the desired linear distribution, which is due in part to the fact that because of the narrow space relations within the interior of the shell, there cannot be positioned an arbitrarily large amount of highly-conductive material at the necessary locations along the inner wall of the godet shell. Furthermore, we have also found that in the known hollow roller device, the effect of the highly-conductive layer also remains quite limited through the fact that the heat transmission between the rings or annular layers and the godet shell is not equally good at all points of the circumference. Difficulties are presented in installing such rings, which are usually best produced by carefully turning on a lathe in such a way that they will lie equally well on the interior wall of the shell at all places along the circumference.

One object of the present invention is to provide a means of effectively regulating the supply of heat to the godet shell in a rotatable, inductively-heatable godet assembly such that a highly uniform and linear temperature profile results over the length of the shell even under the most unfavorable conditions, i.e. such that the difference between the temperature at the middle of the godet and its terminal ends is as small as possible. Other objects and advantages of the invention will become more apparent upon consideration of the following detailed specification.

It has now been found, in accordance with the invention, that in an inductively-heatable godet assembly of the general type described herein, the temperature distribution over the length of the godet shell can be substantially improved by one especially advantageous embodiment in which a plurality of annular rings composed of a non-magnetizable material of high electrical conductivity are embedded in the inner wall of the cylindrical shell in a radially recessed portion thereof extending around the entire circumference of the shell, at least one of the embedded annular rings being profiled to profile an axial projection therefrom of smaller radial thickness extending toward the adjacent terminal end of the shell, this projection being in the form of an annular collar-like extension of the annular ring and also being embedded in a correspondingly axially recessed extension of the radially recessed portion of the shell, each of such rings being so disposed axially and radially of the shell as to maintain the outer circumferential surface of the shell at a substantially uniform temperature while being heated. The collar-like extensions of the annular rings adjacent the terminal ends of the shell preferably extend into the terminally heated zones of the shell.

With this particular construction, i.e. with the embedded annular collar-like projections being located in the terminal ends or terminal heating zones of the godet shell, the radial thickness of these projections as well as the radial thickness of the annular rings themselves can be very closely adapted to the specific heat requirements over the entire length of the shell. Thus, at each location along the outer circumferential surface of the shell, it becomes possible to supply that additional amount of heat required to compensate for variations of heat being lost. Moreover, because the electrically-conductive material is fully embedded in the recessed portions of the shell, it is in intimate adherent contact with the wall surfaces of the recesses and provides an optimum heat transfer at all points.

In order to be able to fully utilize this advantage of the invention, it is further recommended as a special embodiment of the invention that the collar-like projections of the annular rings be provided with a triangular cross-section, as taken on a longitudinal section through the axis of rotation of the shell, the radial thickness of each projection reducing gradually up to its apex located in the terminal zone of one end of the shell. This provides a certain constriction of the inductively heated shell such that there arises a uniform temperature profile over the entire length of the godet.

The individual annular rings with their collar-like projections are advantageously formed in the corresponding recesses by the powder spray process, which is well known, or they may also be formed by sintering and, in either of these processes, solidly joined with the godet shell. With use of these known powder-metallurgical methods, it is not necessary to first produce the rings outside the godet shell and then install them in corresponding recesses, but instead the rings with their projections are constructed directly in the recesses of the godet shell and are simultaneously joined most intimately with the shell. The recesses in the shell can be turned out in a likewise conventional manner according to a predetermined shape and configuration. Through these measures, it is assured that the heat transfer from the embedded rings to the godet shell is consistent throughout the length and circumference of the shell.

The invention is explained in greater detail with reference to the accompanying drawing in which:

FIG. 1 is a partly schematic and longitudinal sectional view through the axis of rotation of a preferred embodiment of the godet assembly according to the invention; and

FIG. 2 is a graphical representation of various temperature profiles achieved with different shell constructions of the godet.

Referring first to FIG. 1, the godet 1 consists essentially of the cylindrical shell 2 which is freely rotatably mounted by means of the drive shaft 3, in the machine frame or supporting member 4. The shaft 3 is secured at its outer end to an axially recessed projection or hub 5 which is situated on the face plate 6 of the godet. The hub 5 and the shaft 3 are surrounded by a core 7 of magnetizable material, such as laminated iron plates. The core 7 has a U-shaped cross-section which is constructed in the illustrated embodiment such that the two radial legs or shanks 8 and 9 are of equal length and terminate in close proximity to the inner wall of the godet shell 2. The core 7, with the aid of a mounting bracket 10, is rigidly joined through the intermediate support 4a to the machine frame 4, so that it does not participate in the rotation of the godet shell 2 and its drive shaft 3. The core 7 further carries a coil 11 consisting of several windings, whose terminal ends or lead wires 12 and 13 are directed out of the godet through a conduit 14 and connected with a source of alternating current which is shown schematically.

For the evening of the temperature profile, i.e. to provide a uniform temperature distribution over the length of the godet shell in accordance with the invention, two annular or circular rings 15 and 16 are embedded in the wall of the godet shell 2. These annular rings bear, in the heating zone of at least one and preferably both terminal ends 17 and 18 of the godet shell, the axially recessed collar-like projections 19 which are composed of the same material as the rings 15 and 16 and which extend around the entire circumference of the shell 2. These collar-like projections preferably have a triangular cross-section, as represented in FIG. 1, and are advanced so far into the terminal ends or zones 17 and 18 of the godet shell 2 as well as decreasing in thickness that the desired uniform temperature profile is closely approximated over the entire length of the heated godet.

It is particularly desirable to arrange these two annular rings 15 and 16 adjacent the terminal ends of the godet shell 2 such that at least their triangular projections partially overlap the radial positions of the core legs 8 and 9, respectively, while still permitting a flow of the magnetic flux or lines of force directly over a small air gap in the wall of the godet shell 2. Thus, by sloping these triangular projections outwardly toward the ends of the godet and away from the facing ends of the core legs 8 and 9, the magnetic flux is directed in a constricted path towards the ends of the godet shell and then sharply around the apices of the projections along the combined outer circumferential surfaces of the rings and their projections in a similarly restricted concentric path.

The particular shape or configuration of the core 7 as represented in FIG. 1 has thus proved to provide especially favorable results in combination with profiled rings 15 and 16. This core has two equally extended legs 8 and 9 providing an outside dimension 20 which corresponds at least approximately to the length of the heatable godet shell 2. The axial and radial arrangement of the collar-like projections 19 of rings 15 and 16, whether of triangular cross-section or some other shape, should then extend into the range or in the close vicinity of the maximal outside dimension 20 of the core legs. In this manner, the magnetic flux is compelled to permeate the godet shell 2 up to the ends of its effective length and to generate electrical currents by induction in this location, resulting in a short-circuit heating of the godet shell in its terminal zones. The illustrated U-shaped configuration of the core furthermore has the purpose of assuring that no mechanical forces of any kind are transmitted to the bearings 21 or the shaft 3, which would be the case if, for example, there were to be used in place of the illustrated core 7, an elongated core such as is shown in U.S. Pat. No. 3,412,228. Similarly, mechanical forces would be transmitted to the shaft 3 and thereby the bearings 21 if the shanks had different lengths, in which case the longer shank would necessarily be positioned adjacent a projection or fitted into a recess of the godet shell.

By experimentation, it was surprisingly ascertained that in many instances it is even possible to completely omit the inlaid or embedded annular rings 15 and 16 with their projections 19 and still achieve a highly improved and quite adequate evening or linearization of the temperature along the length of the godet shell. In other words, in place of the embedded profiled annular rings, it is feasible to merely provide recesses in the inner wall of the godet shell of the corresponding shape or configuration. This means that the inner wall contains at least two radially recessed openings extending around the entire circumference of the shell and an axially recessed opening of smaller radial dimension, preferably with the same triangular cross-section as taken on a section longitudinally of the shell, this axially recessed opening also extending around the entire circumference of the shell while protruding from one side of one and preferably both of the radially recessed openings toward the adjacent terminal end or zone of the godet shell.

With a triangular or similar cross-section of this concentric axially recessed opening, the radial gap thereacross reduces gradually from the radially recessed opening outwardly to an apex located in the terminal zone of the shell. Again, this gap of reducing dimensions preferably overlaps the radially positioned legs of the wound core so as to provide a sharp constriction in the thickness of the godet shell at its terminally heated ends. The corresponding constriction or displacement of the path of the magnetic flux through the shell at one and preferably both ends is in itself sufficient to generate a larger amount of heat where it is most required so as to bring about a very substantial linearization of the temperature profile along the length of the shell.

Although this omission of the embedded electrically-conductive material so as to merely provide corresponding radially and axially recessed openings does not give the best results, such an alternative embodiment of the invention is obviously less expensive and often provides satisfactory results. Moreover, the recessed openings alone offer a means of first determining the optimum configuration for a subsequent inlay of the highly conductive material, or if the results obtained with only these openings proves to be sufficient for a given case, the resulting godet shell can be utilized without any further construction. It is, of course, also feasible to fill such useful recesses with a suitable non-magnetic and electrically non-conducting insulating material.

The effect achieved with the illustrated embodiments of the godet shell with the required recesses or embedded rings can be readily observed in FIG. 2. In this graph, the horizontal axis represents the length of the godet shell in centimeters. On the vertical axis, there is plotted the surface temperature in degrees Centigrade of the heated godet. Curve I shows the temperature gradient ordinarily achieved over the length of the godet, i.e. when no turned recesses are present in the godet shell so that it has a uniform wall thickness. In this case, temperature differences of 20° C. and more appear between the ends of the godet and its midpoint. If, according to the invention, suitably turned or formed recesses are arranged in the interior of the godet shell as illustrated in FIG. 1 without any embedded material, then it is already possible to reduce such temperature differences by one-half, as is represented by curve II.

Curve III represents the temperature profile or gradient over the length of the godet constructed as in FIG. 1 with inlays of copper or brass which were introduced and intimately adhered within the recesses by the powder-spray process.

Further tests have shown that in addition to copper as the embedded material, there can also be used copper alloys, such as bronze or brass. It is also possible to use other non-magnetizable but good electrically-conducting materials, such as aluminum or the like.

In carrying out these experiments for the production and use of such godets according to the invention, it has been found that the inlays or embedded rings are effective in a double respect. In the first place, as a consequence of the better electrical conductivity of these rings compared to the godet shell, there is generated an additional amount of heat within the rings which is given off by direct heat conduction to the tightly adherent shell. In the second place, however, there arises still another effect, namely that the magnetic flux is displaced by the non-magnetizable inlays and with a suitable placement and configuration of these inlays flows into those parts of the godet shell in which the additional amount of heat is needed. In this manner, these parts are fully traversed by the flux and in a somewhat restricted path, so that an increased current is even generated by induction in these parts and consequently there arises an additional supply of heat. This double effect of the inlays according to the invention can be utilized especially well if the core, in a generally known construction, exhibits a U-shaped cross-section, in which case the outside or outermost axial dimension of the two equally extended legs of the core corresponds at least approximately to the useful thread contacting length of the godet shell.

The godet shells of the invention are relatively easily constructed by using conventional powder-metallurgical techniques in order to provide the embedded rings of copper or the like. By using the optimum configuration of these inlays, the godets of the invention permit a much more uniform heat treatment of transported threads, yarns and similar materials.

The invention is hereby claimed as follows:

1. In a godet assembly having a rotatable, cylindrical, inductively-heatable shell enclosing a stationary core of a ferromagnetic material wound with an induction coil with means to supply an alternating current to said coil for heating said shell, the improvement which comprises:

a core having a U-shaped cross-section defined by a base member extending along the axis of the godet and oppositely disposed radial legs extending outwardly toward the terminal zone at either end of said shell; and

a plurality of annular rings composed of a non-magnetizable material of high electrical conductivity embedded in the inner wall of said cylindrical shell in radially recessed portions thereof extending around the entire circumference of the shell, including a pair of such rings adjacent said terminal zones, at least one of said pair of annular rings being profiled to provide an axial projection therefrom of smaller radial thickness extending into the adjacent terminal zone of said shell with the terminal zone being disposed radially oppositely of its corresponding core leg, said projection also being embedded in a correspondingly axially recessed extension of said radially recessed portion of said shell, each of said annular rings being so disposed axially and radially of the shell as to maintain the outer circumferential surface of said shell at a substantially uniform temperature while being heated.

2. A godet assembly as claimed in claim 1 wherein said annular rings are composed of a material selected from the class consisting of copper, copper alloys and aluminum.

3. A godet assembly as claimed in claim 1 wherein said projection of said annular ring has a substantially triangular cross-section as taken on a section longitudinally of said shell, the radial thickness of the projection reducing gradually up to an apex located in the terminal zone of one end of said shell.

4. A godet assembly as claimed in claim 1 wherein the projections of each annular ring have a substantially triangular cross-section as taken on a section longitudinally of the shell, the radial thickness of the projection reducing gradually up to an apex located in said terminal zone at either end of said shell.

5. A godet assembly as claimed in claim 1 wherein said annular rings are in intimate adherent contact with the inner walls of said radially and axially recessed portions of said shell.

6. In a godet assembly having a rotatable, cylindrical, inductively-heatable shell enclosing a stationary core of a ferromagnetic material wound with an induction coil with means to supply an alternating current to said coil for heating said shell, the improvement which comprises:

a core having a U-shaped cross-section defined by a base member extending along the axis of the godet and oppositely disposed radial legs extending outwardly toward the terminal zone at either end of said shell; and

a shell whose inner wall contains a plurality of radi-

ally recessed openings extending around the entire circumference of the shell, including a pair of such recessed openings adjacent said terminal zones, and an axially recessed opening of smaller radial dimension extending from one side of at least one of said pair of radially recessed openings into the adjacent terminal zone of said shell with the terminal zone being disposed radially oppositely of its corresponding core leg, each of said recessed openings being so disposed axially and radially of the shell as to maintain the outer circumferential surface of said shell at a substantially uniform temperature while being heated.

7. A godet assembly as claimed in claim 6, wherein the axially recessed openings extending from each radially recessed opening have a substantially triangular cross-section as taken on a section longitudinally of the shell, the radial gap across said axially recessed opening reducing gradually from said radially recessed opening outwardly to an apex located in said terminal zone at either end of said shell.

8. A godet assembly as claimed in claim 1 wherein said non-magnetizable material is a metal integrally formed and embedded in said radially recessed portion and said axially recessed extension of said shell by the powder spray process.

9. A godet assembly as claimed in claim 1 wherein said non-magnetizable material is a metal integrally formed and embedded in said radially recessed portion and said axially recessed extension of said shell by the sintering process.

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