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APPARATUS FOR HEAT TREATING THERMOPLASTIC YARNS

Filed April 13, 1959

FIG. 1

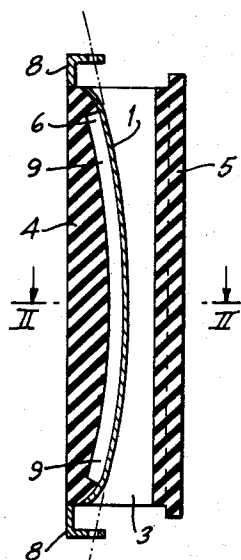


FIG. 3

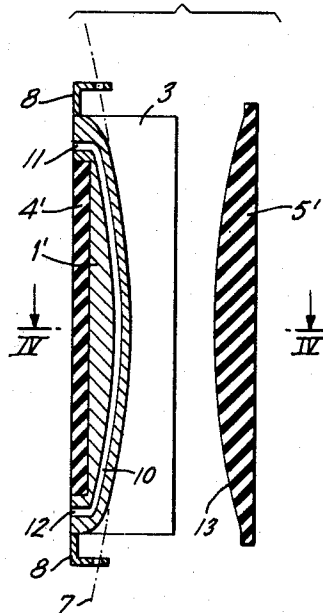


FIG. 2

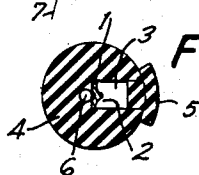


FIG. 4

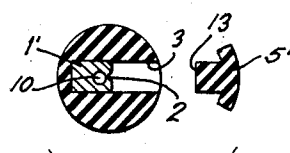


FIG. 5

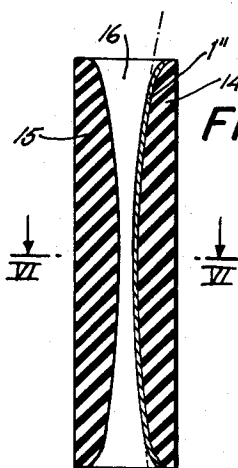
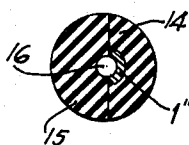


FIG. 6



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APPARATUS FOR HEAT TREATING THERMOPLASTIC YARNS

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Our invention relates to a method and to apparatus for heat treating thermoplastic yarns in a continuous manner, and has for its object the provision of an improved form of heating device for travelling yarns.

Our invention is more particularly concerned with the continuous heat treatment of thermoplastic yarns such as nylon, Orlon, Vinyon, Dacron and the like. In this connection it is known to cause the yarn to traverse, either with or without the application of twist, a heated zone at a predetermined rate, the temperature of the heater being maintained substantially constant so that the yarn reaches a required temperature by the time it leaves the heater, this temperature being such as to affect the molecular structure of the yarn in any required manner, i.e., it may relieve internal stress in the yarn, it may cause the yarn to shrink or allow it to extend its length, or it may set twist in the yarn.

Hitherto, it has mainly been the practice, more particularly when the yarn is heated by radiation from a heated surface without contact with it, to cause the heated zone to have a restricted cross-section. This was thought to be necessary in order both to increase the rate of heat transfer to the yarn and also to reduce heat loss by cooling of the yarn and the heated surface by air currents flowing up the heated tube by convection. Whilst both these effects are of course obtained, we find that an undesirable result also occurs. This effect is the production of fumes in the heated zone from the yarn, these fumes presumably being monomers or breakdown products derived from the surface of the polymer of which the yarn is composed. The fumes tend to condense and collect into a hard black adhesive deposit at the top of the heated zone. This deposit occurs particularly in the case where the heated zone is a tube having substantially uniform circular cross section, of a diameter not greatly exceeding that of the yarns being treated.

We have found that the adoption of a substantially unrestricted form of heat zone, whilst not necessarily being associated with a greatly increased heat loss, does very much reduce the deposition of condensed monomer at the top of the heating zone, and this is thought to be due to an increased rate of convectional air flow upwards over the face of the heated zone.

It is, therefore, an object of the present invention to provide a heating method and heating device for travelling yarns which avoids deposition of fumes in the heated zone.

Another object is the provision of such a method and device which removes fumes from the heated zone by a draft of air.

Yet another object is the provision of a heating device of the type described which holds heat losses from the walls of the heated zone to a minimum.

A further object is the provision of a heating method

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and device for travelling yarns which affords maximum heat transfer to the yarn as it passes through a heated zone.

An additional object is the provision of such a heating method and device in which the temperature of the heated zone increases gradually in the direction of travel of the yarn, so that the yarn is heated slowly to the desired temperature.

It is furthermore an object of this invention to provide such a heating device which is simple in its structure and operation.

With these and other objects in view, the method of the invention for heat treating a travelling yarn of the type described contemplates passing the yarn in an upward direction through a heating zone which has two contiguous portions longitudinally extending in the direction of travel of the yarn. Each of these portions has an end open to the atmosphere and tapers from this end inwardly in the heating zone toward a common plane of minimum cross section. The yarn is heated in the heating zone by conduction. Simultaneously, the air in the heating zone is heated so that a thermally induced current of air is provided in the zone for removing fumes derived from the heated yarn.

To carry out the above-described method, it is proposed to employ a heating device having a body of heat insulating material formed with an elongated conduit there-through for passage of the yarn. Elongated heating plate means are provided in the body. A convexly curved longitudinal face portion on the heating plate means forms a convex longitudinal wall of the conduit so as to define therein two contiguous longitudinal portions each tapering from the outer surface of the body of heat insulating material toward a common plane of minimum cross section in the conduit.

In one specific embodiment of the invention, the heated zone comprises a heated plate which is slightly curved into a convex form, the plate having one or more longitudinal grooves formed in its surface, the yarn being arranged to run in each groove. The heated plate is located at the bottom of a U-shaped channel the sides of which are composed of insulating material, the outer or open end of the U being either uncovered or provided with a flat or curved cover, the shape of the cover being such as to produce or permit an appreciable flow of air over the surface of the heated plate. The cross-sectional area of the U-shaped channel at its minimum is preferably several thousand times as large as that of the normal yarn of say 70 denier being treated by the apparatus concerned.

In an alternative specific embodiment of the invention, a curved heated plate is once more provided, the surface of the plate being continued as by insulating material so as to form a figure of revolution generated from a line in front of the plate and substantially parallel to its major axis, the cross-section of the said figure being a minimum at a point rather above the centre of the curved plate, the curvatures of the plate and the air channel formed by the figure of revolution being so devised as to produce a maximum rate of convectional air flow. If necessary, the upper end of the said channel may be flared so that any monomer fumes produced tend to pass straight out of the top, without touching any relatively cool surface on which condensation may take place.

In the case where a U-shaped figure is adopted for the yarn channel, with an opening to the atmosphere at the open end of the U, the depth of the U is preferably not less than 250 times the diameter of the yarn treated, and its width is preferably not less than 100 times the said diameter.

One advantage of the form of heater described is that a temperature gradient is secured along the surface of the heater. This is desirable not only to ensure gradual heating of the yarn, but also to establish counter-current conditions of heating, i.e., the hotter the yarn becomes, the hotter the surface with which it is in contact. With some known forms of heater having channels of restricted cross-sectional area for the yarn, it has been the practice to establish a uniform temperature throughout the whole of each channel, as for example by grading the heater winding. We have not found such uniformity to be essential or even desirable, so long as the first temperature achieved by the yarn is itself constant and of a predetermined value. In fact, if oil heating of the plate is employed we prefer to cause the oil and yarn to travel in opposite directions from one another.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawings, in which:

FIG. 1 is an elevational sectional view of a preferred embodiment of the invention;

FIG. 2 shows the device of FIG. 1 in transverse section line on line II—II of FIG. 1;

FIG. 3 is an elevational sectional view of another preferred embodiment of the heating device of the invention;

FIG. 4 illustrates the device of FIG. 3 in transverse section on line IV—IV of FIG. 3;

FIG. 5 shows a third embodiment of the invention in elevational section; and

FIG. 6 is a transverse sectional view of the device of FIG. 5 taken on line VI—VI of FIG. 5.

Referring now to the drawings, and more particularly to FIGS. 1 and 2, there is shown an elongated thin heater plate 1 of heat-conductive material longitudinally curved into a convex form. The convex surface of the plate 1 is curved transversely in such a manner as to form two longitudinal channels 2 in the heater plate 1. The heater plate 1 is arranged in a slot 3 of a block of heat-insulating material such as molded asbestos material or a metal shell filled with glass wool. The slot 3 has one convexly curved wall formed by the surface of the heater plate 1 and an open side opposite the convex wall. The open side of the slot 3 is closed by a removable cover 5.

An electric heating element 6 is embedded in the surface of the convex wall of block 4 in the slot 3 in contact with the heater plate 1. The heating element 6 is of conventional construction so as to provide a substantially uniform heat density along the length thereof and receives electric energy through leads 9 passing through the block 4.

Two strands of yarn 7 are guided by means of guides 8 in such a manner that they make tangential contact with the curved heater plate 1 at points slightly inward of the orifices of the channel defined in the slot 3 by the facing surfaces of the heater plate 1 and of the cover 5.

As best seen from FIG. 1, the channel is shaped in such a manner that it is widest at its orifices and gradually tapers towards a middle portion.

The device described above operates as follows:

The strands of yarn 7 are passed through the heating device of the invention from the bottom to the top by suitable means such as paired driven pull rolls. Thermal energy is supplied to the heater plate 1 by the heating ele-

ment 6. The yarn is heated mainly by conduction from the heater plate 1. At the same time, the air in the slot 3 is heated by radiation as well as by conduction and convection and therefore rises in the slot 3 drawing cool outside air into the lower orifice of the slot.

As is well known from the design of Venturi tubes and cooling towers for power stations, the shape of the channel the cross-section of which decreases toward the enter of the heater plate 1 and then again increases causes at first an increase in speed of the air entering the slot 3 from the lower end. The cross-section of the air column decreases as its velocity increases. During this period, heat is gained by the air. On passing the area of smallest cross-section in the channel, the air is allowed to expand, thus providing a negative pressure at the narrowest part of the passage.

This design of the channel produces an appreciable current of air upwards through the heater, the said current causing any fumes which may be derived from the heated yarn to be rapidly carried away from the various parts of the heater, which are consequently kept clean. We find that if some such means as the foregoing is not adopted, fumes from the yarn tend to condense as a black highly adhesive deposit on parts of the yarn passage near the top, the said passage becoming obstructed after a period of time.

As regards the dimensions of the various parts concerned, the cross-sectional area of the channel at its minimum is preferably several thousand times the cross-sectional area of the yarn being treated, as otherwise an insufficient draft is created. In spite however of this draft, we find that by careful insulation of the heater the total power consumption can be kept within such bounds that a textile machine fitted with say, 100 heaters can be operated in a relatively small room without undue rise of temperature or serious decrease in the relative humidity of the air in the room. If however trouble from low moisture content of the air is experienced, the yarn may be run through a water bath or wetting tank prior to its heat treatment.

FIGS. 3 and 4 illustrate another embodiment of the invention similar to that of FIG. 1. In the embodiment shown in FIGS. 3 and 4, the heater plate 1' is of substantial thickness and provided with a single channel 2 cut into the convex surface of the heater plate 1'. The plate is cored so as to provide a passage 10 for heating oil which is admitted to the passage 10 at the upper orifice 11 thereof and is returned from a lower orifice 12 to a heating and circulating device which provides thermal energy to the heating oil and causes it to pass through the passage 10 in a downward direction. Such heating and circulating devices are well known and may consist of a tube of heat-conductive material exposed to a flame or another source of heat. Circulation of the oil may be caused by thermal syphoning, or a suitable circulating pump may be included in the oil circuit.

The heater plate 1' of FIGS. 3 and 4 is embedded in a block 4' of insulating material and has a convex surface in a slot 3 which has an open side opposite the heater plate 1'. Guides 8 are provided to guide a single strand of yarn 7 towards and away from the heater plate 1' in the manner described above in connection with the embodiment of the invention shown in FIGS. 1 and 2.

A cover 5' may be inserted in the slot 3 of the block 4'. The cover 5' consists of insulating material and has a convex face portion 13 which when inserted in the slot 3 forms a channel with the convex surface of the heater plate 1' and with the parallel faces of the block 4' in the slot 3. The channel has the sectional shape of a Venturi nozzle.

The device illustrated in FIGS. 3 and 4, when operated with the cover 5' inserted in the slot 3, operates in the same manner as the device of FIGS. 1 and 2. For equal effect on the flow of the air through the slot 3, the heater plate 1' of FIGS. 3 and 4 may have a substantially

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greater radius of curvature than the heater plate 1 of FIGS. 1 and 2. Conversely, for equal radius of curvature of the heater plate 1', the Venturi effect of the device of FIGS. 3 and 4 is enhanced.

Whereas the electric heating element 6 of the first-described embodiment of the invention has a uniform heating rate over the entire length thereof, the oil heating system shown in FIGS. 3 and 4 results in a rate of heat supply which gradually decreases from the top of the heat plate 1' towards the bottom as the temperature of the oil drops in the passage 10 when the oil travels from the upper orifice 11 to the lower orifice 12. In either case, the temperature of the heater plate is highest at the topmost portion thereof because of the upward flow of air from the atmosphere which has a greater cooling effect as it enters the heating device at the bottom than in the higher portions of the heated channel. The yarn 7 thus is in contact first with a portion of a heater plate which is at a temperature lower than the maximum temperature to which it is desired to heat the yarn, and this maximum temperature is only gradually reached. Such relatively slow heating of the yarn during its passage through the heating device has been found desirable in many instances.

The devices illustrated in FIGS. 1-4 may also be operated without the covers 5, 5'. While the devices of FIGS. 1-4 are not as effective without the covers 5 and 5' in creating an air draft over the surface of the heater plate, omission of the cover reduces the first cost of the heating device somewhat, and its operation is nearly as satisfactory as regards removal of yarn fumes from the apparatus. Threading is, of course, greatly simplified. The slot should be large as compared with the yarn, its depth being preferably not less than 250 times the diameter of the yarn treated, and its width preferably not less than 100 times the said diameter.

A third embodiment of the invention is illustrated in elevational and transverse section respectively in FIGS. 5 and 6. In this embodiment, a heater plate 1" having a convexly curved front surface is fitted into a rear heat insulating member 14. The heating device furthermore includes a front insulating member 15 having a channel 16 formed therein. The edges of the channel are in contact with the heater plate 1". The shape of the interior surface of the channel 16 is that of a figure of revolution generated from a line in front of the heater plate 1" and substantially parallel to its general direction. The cross-section of the figure is generally circular and is at a minimum just above the center of the heater. The inner surface of the channel 16 is smoothly curved. An electric heating element substantially identical with that illustrated in FIGS. 1 and 2 is embedded in the rear heat-insulating member 14 in contact with the heater plate 1 (not shown).

The embodiment of the invention illustrated in FIGS. 5 and 6 operates in the same manner as those of FIGS. 1-4 when equipped with their respective covers 5 and 5'. The specific form of the device illustrated in FIGS. 5 and 6 encourages the maximum flow of air over the surface of the heater for a given cross-sectional area of channel.

All of the foregoing embodiments are devised in order not only to give minimum radiation heat loss from the metal heater plate, but also maximum heat transfer by conduction from the plate to the yarn travelling over it, and maximum induced air flow through the channel so as to cause removal of any fumes formed from the yarn during its passage over the plate.

In view of the fact that fumes are emitted constantly from the top of the assembly, it is advisable to construct the rest of the machine in such a fashion that no cool metal surfaces are located immediately above the said channel. On the other hand, it may be found advisable to hang a readily removable or cleanable screen above the said channel but at such a distance from it as not

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appreciably to affect the flow of air through the said channel. The heat lost to the air flowing through the channel is of course appreciable but we find that the freedom from obstruction and continuity of service enjoyed by the particular apparatus described makes the loss worthwhile.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of heating devices differing from the types described above.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. In a heating apparatus for heating travelling yarns, in combination, an elongated heating member having a longitudinal, convexly curved heating surface adapted to be contacted by yarn travelling longitudinally of said surface; and elongated heat insulating means at least as long as said heating member formed with a longitudinal cutout in which the entire heating member is located extending longitudinally of said insulating means, the latter having at said cutout thereof a configuration which forms with said heating surface an elongated passage which from one to the other of the ends of said heat insulating means becomes first gradually smaller in cross-section and then gradually larger in cross-section, said passage having its minimum cross-section between the ends of said heat insulating means, all of the cross-sections of said passage being circular.

2. In a heating apparatus for heating travelling yarns, in combination, an elongated heating member having a longitudinal, convexly curved heating surface adapted to be contacted by yarn travelling longitudinally of said surface; and elongated heat insulating means at least as long as said heating member formed with a longitudinal groove open at one side of said insulating means and in which the entire heating member is located extending longitudinally of said insulating means with said heating surface directed toward said one side of said insulating means, the latter having at said groove thereof a configuration which forms with said heating surface an elongated passage which from one to the other of the ends of said heat insulating means becomes first gradually smaller in cross-section and then gradually larger in cross-section, said passage having its minimum cross-section between the ends of said heat insulating means, and an elongated closure member closing said groove at said one side of said insulating means and having a longitudinal convexly curved surface directed toward said heating surface.

3. In a heating apparatus for heating travelling yarns, in combination, an elongated heating member having a longitudinal, convexly curved heating surface adapted to be contacted by yarn travelling longitudinally of said surface; and elongated heat insulating means at least as long as said heating member formed with a longitudinal groove open at one side of said insulating means and in which the entire heating member is located extending longitudinally of said insulating means with said heating surface directed toward said one side of said insulating means, the latter having at said groove thereof a configuration which forms with said heating surface an elongated passage which from one to the other of the ends of said heat insulating means becomes first gradually smaller in cross-section and then gradually larger in cross-section, said passage having its minimum cross-section between the ends of said heat insulating means, and an elongated closure member closing said groove at said one side of said insulating means and

having a longitudinal convexly curved surface of substantially the same curvature as said heating surface directed toward the latter.

References Cited in the file of this patent

UNITED STATES PATENTS

2,204,603	Kline et al.	June 18, 1940
2,211,141	Lobasso	Aug. 13, 1940

5

2,673,546
2,761,272
2,780,047
2,864,229
2,864,931
3,015,872

773,816

Newton	Mar. 30, 1954
Vandamme et al.	Sept. 4, 1956
Vandamme et al.	Feb. 5, 1957
Seem et al.	Dec. 16, 1958
Stoddard et al.	Dec. 16, 1958
Jones	Jan. 9, 1962

FOREIGN PATENTS

Great Britain	May 1, 1957
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