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APPARATUS FOR HEAT SETTING SYNTHETIC FIBRE YARNS

Filed July 10, 1967

Fig. 1.

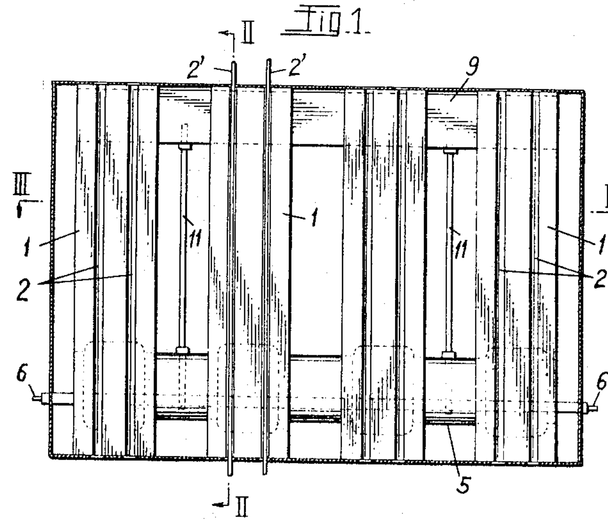


Fig. 2.

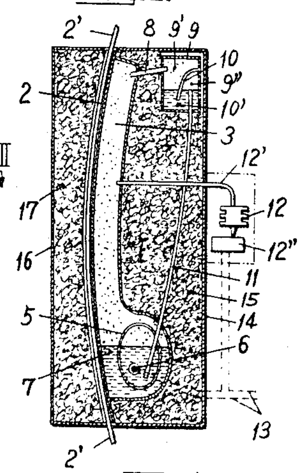


Fig. 3.

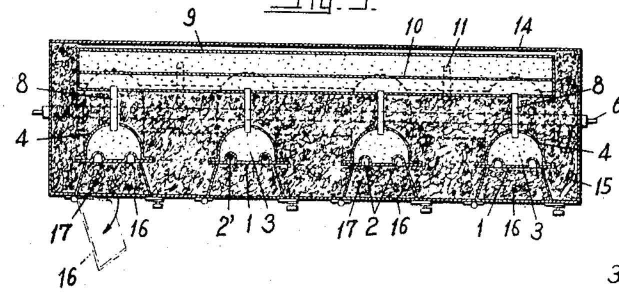


Fig. 4.

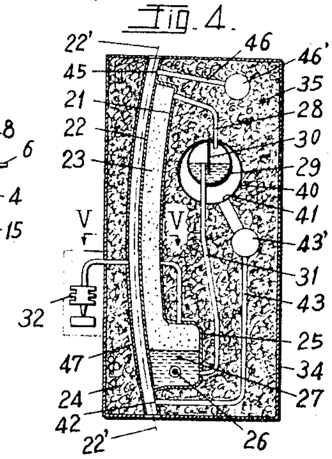


Fig. 5.

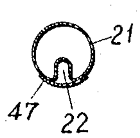


Fig. 7.

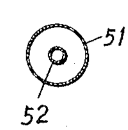


Fig. 8.

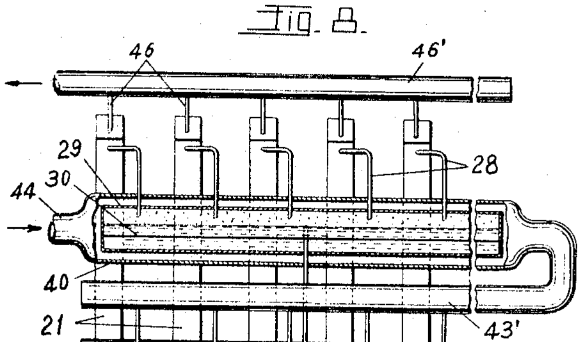
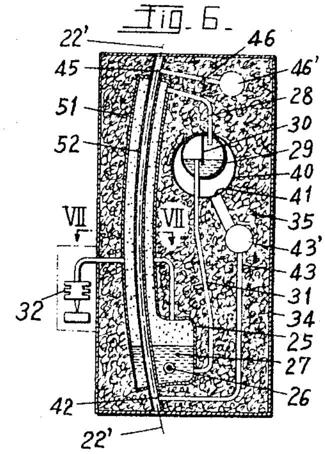


Fig. 6.



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APPARATUS FOR HEAT SETTING SYNTHETIC FIBRE YARNS

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7 Claims. (Cl. 28—62)

ABSTRACT OF THE DISCLOSURE

This invention comprises a vertical passage through which a crimped synthetic fibre yarn to be heat treated is passed.

Heat is applied to the wall of the passage by means of a liquid in a closed vertical container adjacent the passage wall. Liquid in the container is heated by a heating element to vaporize it. The vapor fills the space of the container, thereby heating the wall of the passage and the fibre yarn therein. An exit pipe at the top of the container conducts the vapor out of the top into a condensing chamber. The chamber contains a baffle divider open at the bottom, which results in separation of the purer phase of the condensate on one side of the baffle. A standpipe in the chamber on one side of the baffle removes the purer phase which is recycled to the bottom of the container.

This invention relates to improvements in vapor heating apparatus for heat setting crimped synthetic fibre yarns.

The apparatus comprises a vertical type of closed vessel adapted to contain a heat medium liquid and its vapor. The outside wall of the vessel is grooved to provide a channel through which yarn after being crimped by a crimping device is continuously fed so as to heat set. In the bottom part of the vessel, an appropriate volume of heat medium liquid and a heater is disposed.

The heat medium liquid is heated by the heater to produce vapor which fills the space in the vessel above the liquid.

Under the normal conditions, the vessel is to be heated uniformly over its full length. However when the apparatus is operated for a long time, vapor produced from low boiling liquids which is contained in trace amounts in the heat medium liquid results in uneven temperature distribution in the upper and lower parts of the vessel. Also when a length of yarn runs through the channel at the side of the vessel, oily substances attached to the yarn dries by the heat transferred thereto and it eventually carbonizes.

The purpose of the present invention is to automatically drive out such gases and low boiling point material, although they be in trace amounts, which are inevitably mixed in Dowtherm E used as a preferred liquid in the apparatus.

Another object of the present invention is to protect yarn from being blurred and to avoid the reduction of heat transfer efficiency to yarn which will be caused by carbonized substances deposited on the inner surface of the channel through which the yarn passes.

Another object of the present invention is to attain better crimping of yarn by heat setting it with increased heat transfer efficiency.

The apparatus of the present invention comprises a plurality of longitudinal closed vessels, the bottom part of each vessel being communicated with the others by lower tubes. Above and outside the vessels there is provided a separating vessel for separating heat medium liquid, the upper portion of which is communicated to the upper portion of each closed vessel through a vapor tube. The bottom portion of the separating vessel is communicated through return standpipes to said lower tubes. One side of each closed vessel is grooved to provide narrow channels for passing yarn. A heat element extends through the bottom portion of each vessel and the lower tubes where a heat medium liquid is disposed in an amount to submerse the heat element. In said separating vessel a baffle is provided in a location between the outlet of said vapor discharging pipe and the inlet of said standpipes. A space is provided between the lower end of said baffle and the bottom of the separating vessel. The inlet of the standpipe is positioned at a higher level than the lower end of said baffle. The separating vessel is housed in a heat exchanger, the inlet of which is communicated through a pipe to the upper part of the channel provided on the side wall of each closed vessel. The outlet of the heat exchanger is communicated through a pipe to the lower part of said channel.

The invention is more particularly described with reference to the accompanying drawings, in which:

FIG. 1 shows schematically a front elevational view of a first embodiment of apparatus of the invention.

FIG. 2 is a cross section taken along the line II—II of FIG. 1.

FIG. 3 is a cross section taken along the line III of FIG. 1.

FIG. 4 is a cross section of a second embodiment, corresponding to the section shown in FIG. 2.

FIG. 5 is a cross section taken along the line V—V of FIG. 4.

FIG. 6 is a cross section of a third embodiment, corresponding to the section shown in FIG. 2.

FIG. 7 is a cross section taken along the line VII—VII in FIG. 6.

FIG. 8 is a piping system of the apparatus shown in FIG. 4 and FIG. 6, partly broken away.

In drawings, the apparatus, generally, comprises a plurality of vertical closed vessels **1**.

The outer surface of the vessels is grooved to provide a desired number of channels **2**. A length of yarn **2'** is to be passed through each channel. Each vessel comprises an upper vapor chamber **3** contiguous with a lower portion which contains a liquid. A jacket **4** is provided on the outside of each vessel **1**. The bottom of the vessels **1** are communicated with each other by lower tubes **5**. A heater **6** is provided in the lower tubes extending through the bottom of the vessels **1** wherein a heat medium liquid **7** is disposed in an amount to submerge the heater.

Heater **6** is preferably electrical and vapor from the liquid **7** fills the vapor chamber **3** thereby yarn passing through the channel **2** is heated. Thus the yarn is heat set in its crimped state.

The upper part of each vessel **1** is communicated by upper tubes **8** to a laterally extending separating vessel **9** in which is provided a baffle wall **10** to delineate two portions **9'** and **9''** respectively. Between the lower end of this baffle wall **10** and the bottom of the separating vessel, there is provided a space **10'**. At the upper part of one of the portions **9'** in said separating chamber, one end of an upper tube **8** is open and the lower part of the other portion **9''** is communicated to the top end of a return standpipe **11**. The top end of said standpipe is positioned above the lower end of said baffle **10**. The lower end of pipe **11** is communicated to the lower tube **5**.

Vapor chamber **3** in closed vessel **1** is communicated with a bellows **12** through a tube **12'**. The end of the bellows is provided with a micro-switch **12''** connected to the closed vessel. The bellows actuates the switch by the vapor pressure in chamber **3** and switches on and off a connection between a power source **13** and the heater **6**. Due to the pressure variation, said bellows extends or contracts whereby said micro-switch controls current to the heater **6** whereby liquid in the closed vessel is automatically maintained at a predetermined temperature.

The housing of the heating apparatus is designated by the numeral **14**. A heat insulating material **15** is disposed between the housing and the vessel. A cover **16** is opened or closed for inserting yarn into the channel **2**. Heat insulating material **17** forms an inner layer of the cover **16**. The separating vessel **9** is disposed directly adjacent the inner wall of case **14** without any heat insulating material, thus providing cooling surface for vapor coming through upper tube **8** into the separating vessel **9**.

When heater **6** is energized to liquid **7**, vapor is produced from the surface of the liquid and chamber **3** is filled with saturated vapor.

A length of crimped yarn passing through the channel **2** is heat set by the heat delivered through the wall of vessel. Saturated vapor condsensing on the inner wall of the vessel **1** drains back into liquid **7** and is again heated and again evaporated. When this cycle of evaporation and condensation is repeated for a long time, vapor containing the low boiling point phase, which is unavoidably involved in heat medium liquids tends to delay its condensation relative to other materials present. Such low boiling point vapor will tend to localize it in the upper part of the closed vessel **1**. If such low boiling point vapor is permitted to thus localize the temperature in the upper part of the closed vessel **1** will become lower than that of the bottom part.

The apparatus of the present invention is provided with the tube **8** in the upper part of the vessel, whereby such low boiling point vapor enters into the separating vessel **9**.

Since portions of the walls of this separating vessel are not heat insulated, vapor therein is cooled by these portions and such low boiling point vapor is condensed and falls to the bottom of chamber **9′**.

Thus accumulated liquid enters to the other chamber **9″** through the space **10′** beneath the lower end of baffle **10**.

When the liquid level rises higher than the top of the standpipe **11**, it overflows thereinto. However it takes some time before liquid overflows into said return pipe **11**.

Liquid therein consists of the condensed liquid from the pure phase of the heat medium liquid vapor and that from the low boiling point vapor phase. Generally the specific garvity of low boiling point phase (water) is less than that of the pure phase. Therefore, in the separating vessel, the low boiling point phase will float on the pure phase as upper and lower layers, respectively. Therefore the liquid passing through the space **10′** beneath the lower end of baffle **10** into the other chamber **9″** is substantially of the pure phase.

Thus liquid in this vessel gradually increases and when its level rises higher than the opening at the end of pipe **11**, the pure phase liquid therein returns through the pipe **11** into the lower communicating tube **5** and then into the bottom of closed vessel **1** where it is again heated and recycled.

As the operation continues, the heat medium liquid in vessel **1** becomes more purified resulting in the temperature all along the length of the vessel being maintained at a uniform temperature because of the absence of low boiling point vapor more and more in the upper part of vessel **1**.

Also as the separating vessel **9** is naturally cooled, the pressure therein is somewhat lowered. As a result vapor from the closed vessel **1** flows more freely in the upward direction whereby the temperature along the length of the vessel is more uniformly maintained. Even when the vessel is to be utilized with a lower temperature, the temperature distribution will be maintained evenly. Thus, temperature range is greatly widened.

A second embodiment is shown in FIGS. 4 and 5 wherein a closed vessel **21**, like vessel **1** of the first embodiment, is pipe-shaped and both ends are closed. The side **22**, like side **2** of the first embodiment, thereof is grooved to provide a yarn passing channel. A vapor chamber **23**, heat insulating material **2**, a lower communicating tube **25**, a heater **26**, a heat medium liquid **27**, an upper communicating tube **28**, a separating vessel **29**, a baffle **30**, a standpipe **31**, bellows **32**, a housing **34** and heat insulating material **35** correspond to members **3** to **15**, respectively, of the first embodiment.

The differences between the first and second embodiments are such that in the latter, a separating vessel **29** is housed in a heat exchanger **40** and a vapor or air outlet **41** in this heat exchanger **40** is communicated to the vapor or air port **42** at the bottom of closed vessel **21** through a tube **43** extending downwardly and a header **43′**. Also, vapor or air inlet **44** of heat exchanger **40** is communicated to vapor or air suction port **45** in the upper part of the vessel **21** through upper vapor or air tube **46** and upper header **46′**. Channel **22** is covered by a cover **47**.

Vapor or air is let into heat exchanger **40** from vapor or air inlet **44** which vapor or air is heated by the heat medium vapor in separating vessel **29**. Thus, the temperature of such vapor or air is raised while the temperature of the heat medium vapor itself is lowered sufficiently to be condensed.

The condensed heat medium will circulate as in the first embodiment. On the other hand, vapor or air thus heated flows down through a lower vapor tube **43** and header **43′** to vapor discharge port **42** adjacent the bottom of the closed vessel **21**. Therefrom a high temperature vapor is jetted into channel **22** and further flows upward whereby a length of yarn therein is vapor heated.

Oily vapor attached to the surface of yarn flows up together with other vapors and is introduced into the vapor suction inlet **45**. Thence, it flows through upper vapor tube **46** and upper header **46′** and is vented from the apparatus.

Either vapor or air may enter the inlet **44** to the heat exchanger **40**. Using vapor, for example, it is heated in the heat exchanger **40** with the heat delivered from heat medium vapor in the separating vessel. Yarn is heated with this heated vapor with nearly no heat loss. Thus very good thermal efficiency is effected.

FIG. 7 shows a third embodiment wherein a closed vessel is pipe-shaped. A channel **52** is provided in the center to pass yarn therethrough. This is the only variation from the second embodiment.

From the foregoing, it will be apparent that the apparatus for heat setting synthetic fibre yarns of this invention automatically eliminates unfavorable influence caused by a low boiling point material, which is inevitably included in a heat medium liquid and to operate with high thermal efficiency.

The three described embodiments of this invention are disclosed specifically with reference to the drawings. However it is to be understood that the invention is not limited to these embodiments but any change or modification in the construction may be made within the scope of the appended claims without departing from the spirit of this invention.

We claim:

1. Apparatus for heat setting synthetic fibre yarns which comprises a plurality of vertical type of closed vessels, each of the vessels having a predetermined number of narrow channels for letting yarn pass therethrough, said vessels being connected and communicated to one another by lower tubes, a separating vessel provided with a partition therein positioned to leave a space beneath the lower end of the partition and divide the separating vessel into two chambers, a heater immersed in a heat medium liquid filled in the bottom part of the vessels, upper communicating tubes extending from said vessels to said separating vessel and a return tube communicating from said separating vessel to the lower part of each of said closed vessels.

2. The apparatus of claim 1 further characterized by: the upper communicating tubes open to one of the chambers partitioned by a partition plate in said separating vessel and the return tube is open to the other chamber in said separating vessel.

3. The apparatus of claim 1 further characterized by: in said separating vessel, the top end of said return tube is positioned at a higher level than the lowest end of said partition.

4. The apparatus of claim 1 further characterized by: each closed vessel is surrounded by heat insulating material and a cooling section is provided around the separating vessel.

5. Apparatus for heat setting synthetic fibre yarns as claimed in claim 1 comprising a heat exchanger housing said separating vessel, an upper vapor pipe communicating from a vapor suction inlet in the upper part of said closed vessel to the vapor inlet of said heat exchanger, lower vapor tubes leading from a vapor outlet in said heat exchanger to a vapor jet port in the lower part of said closed vessel.

6. Apparatus of claim 5 further characterized by: the vertical type of a closed vessel is constructed with a plurality of pipes.

7. Apparatus of claim 6 further characterized by; the narrow channel to pass yarn through is housed in the vertical vessel.

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