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[54] **AUTOMATIC TEMPERATURE REGULATING DEVICE FOR USE WITH APPARATUSES FOR HEAT TREATMENT OF SYNTHETIC YARN**

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[51] **Int. Cl.** **F27b 9/06**

[58] **Field of Search** ..... 219/325, 326, 388, 530, 219/540; 165/32, 76, 105; 28/62; 57/34 HS; 34/155

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[57] **ABSTRACT**

A plurality of pressure-sensing bellows are communicated with a plurality of heating vessels, respectively, through thin tubes, and a plurality of counter bellows are coupled to said respective pressure-sensing bellows in an opposed relationship thereto. Each of said pressure-sensing bellows is provided with a lever for actuating a micro-switch. Said plurality of counter bellows are communicated with a common constant-pressure chamber, so that the pressures in said plurality of counter bellows may be regulated as a whole by varying the pressure in said common constant-pressure chamber. In accordance with the variation of the pressures in said plurality of counter bellows, the temperatures of the heating vessels are regulated as a whole.

5 Claims, 4 Drawing Figures

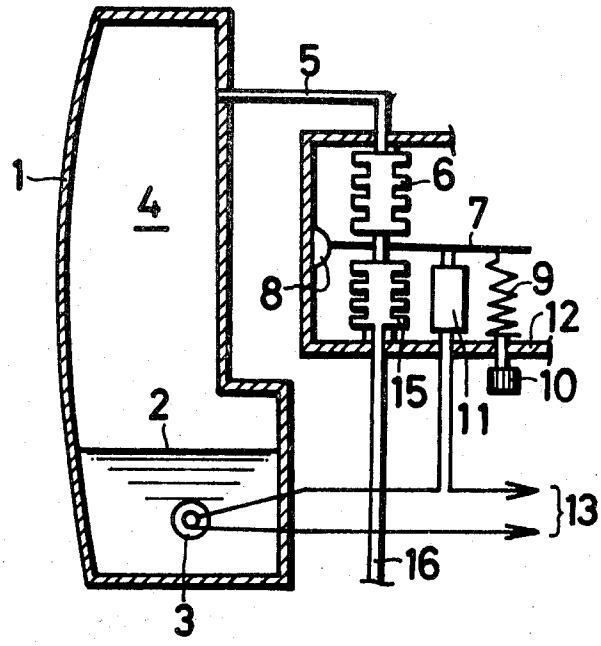


FIG. 1

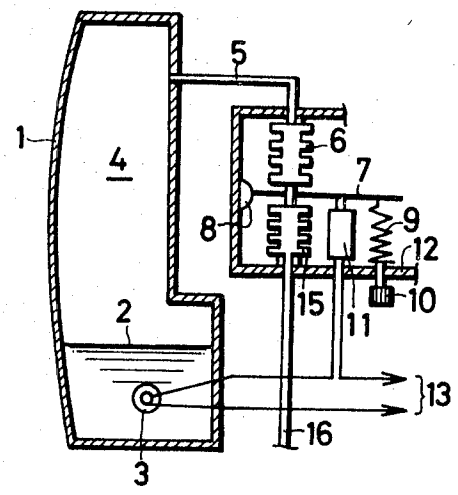

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FIG. 2

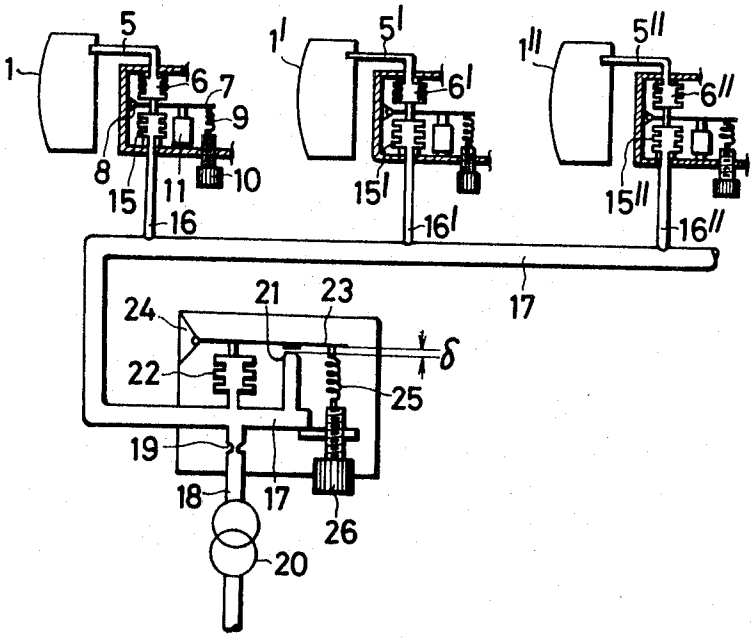

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FIG. 3

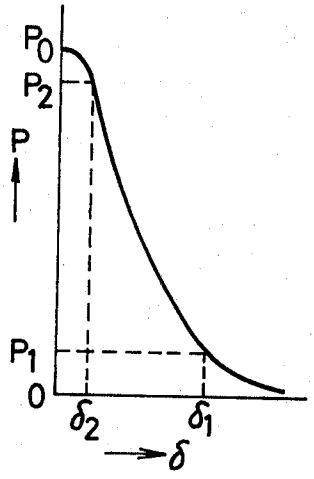
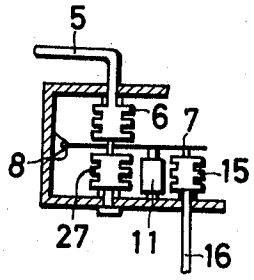


FIG. 4



AUTOMATIC TEMPERATURE REGULATING DEVICE FOR USE WITH APPARATUSES FOR HEAT TREATMENT OF SYNTHETIC YARN

The present invention relates to temperature regulation upon regulating, as a whole, the temperatures of a group of apparatuses for heat treatment of synthetic yarn of unit type making use of heating by heat transfer medium vapor in a system such that the temperature of said apparatus may be maintained at a constant temperature by regulating said heat transfer medium vapor pressure.

Apparatuses for heat treatment of synthetic yarn in which heating is achieved by making use of heat transfer medium vapor, have been widely used because of the abundance of quantity of heat, readily attainable uniformity in temperature distribution, and extremely good effect of heat treatment. Also the method of temperature regulation in which regulation is made by maintaining the vapor pressure at a constant value is quite favorable, because the regulator is simple and of low cost and yet a high precision can be readily obtained, and because such type of regulator also serves as a safety device for the pressurized vessel. However, in case that a large number of apparatuses for heat treatment of synthetic yarn of the same type are simultaneously brought into the same operating condition as is commonly encountered, this type of apparatuses had a disadvantage in that the temperature regulation therefor must be achieved for each one of the heat treatment units.

An object of the present invention is to provide a novel apparatus for heat treatment of synthetic yarn which overcomes the aforementioned disadvantage, and which can regulate, as a whole, the temperatures of a group of apparatus for heat treatment of synthetic yarn of unit type making use of heating by heat transfer medium vapor in a system such that the temperature of said apparatus may be maintained at a constant temperature by regulating said heat transfer medium vapor.

Another object of the invention is to provide a constant-pressure chamber in which the pressure is varied by the combination of bellows, a nozzle and a flapper positioned opposite to said bellows and said nozzle.

A still another object of the present invention is to provide a constant-pressure chamber of the type just referred to in which constant pressure can be realized by varying the gap clearance between said nozzle and said flapper in accordance with regulation of an attractive force of an associated coil spring.

A further object of the invention is to provide a temperature regulator device which can operate even at a temperature of the heat transfer medium lower than its boiling point under the atmospheric pressure.

According to the present invention, at the extremities of elastic bellows for sensing a vapor pressure are respectively provided other elastic bellows of the same size as said first bellows in an opposed relationship to the corresponding ones of said first bellows, each of said first bellows for pressure-sensing being communicated with a part of a heating vessel of each apparatus for heat treatment of synthetic fibrous yarn through a thin tube, said opposed bellows are respectively communicated with a constant-pressure chamber in an air pressure regulator through respective thin tubes, said air pressure regulator including a choke, a nozzle and a flapper, and the inner pressure of said constant-

pressure chamber is varied by regulating the load upon said flapper so as to balance the pressure applied to the opposed bellows with the heat transfer medium vapor pressures within the heating vessels in the respective apparatus for heat treatment of synthetic fibrous yarn, whereby said vapor pressure may be maintained at a constant value to keep the temperature of the respective apparatus for heat treatment of synthetic fibrous yarn at a constant temperature.

These and other objects and advantages of the invention will become more apparent from perusal of the following description of its preferred embodiments taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a schematic cross-section view of a unit type of apparatus for heat treatment of synthetic fibrous yarn.

FIG. **2** is a schematic view of a system for regulating, as a whole, a plurality of unit type of apparatuses for heat treatment,

FIG. **3** is a diagram showing the relationship of the inner pressure of the opposed bellows versus the gap clearance between the flapper valve and the nozzle, and

FIG. **4** is a schematic cross-section view of an alternative embodiment of the pressure-sensitive temperature regulator section.

Referring now to the drawings, in FIG. **1** reference numeral **1** designates a heating vessel in an apparatus for heat treatment of synthetic fibrous yarn. While only one heating vessel is shown in this figure, the heating vessel may be constructed in a composite structure consisting of a plurality of individual heating vessels elongated either in the vertical direction or in the horizontal direction which are communicated and integrated with each other through an upper connecting tube (header) and a lower connecting tube (including a combined heating vessel and connecting tube.) Reference numeral **2** designates a small amount of heat transfer liquid medium, numeral **3** designates a heater for heating the heat transfer liquid medium, and numeral **4** designates a chamber containing the heating vapor generated by the heater. Reference numeral **5** designates a thin tube communicating with the heating envelope **1**, and numeral **6** designates a pressure-sensing bellows provided at the extremity of said thin tube **5**. Reference numeral **7** designates a lever adapted to be actuated by the pressure-sensing bellows **6**, and numeral **8** designates a fulcrum point of said lever **7**. Reference numeral **9** designates a coil spring coupled to a part of the lever **7**, numeral **10** designates an adjusting screw for regulating the load upon said coil spring **9**, and numeral **11** designates a microswitch to be actuated by the movement of the lever **7** so as to connect or disconnect a power supply **13** to the heater **3**. In addition, reference numeral **12** designates a frame member for fixedly mounting these component parts thereon. A counter bellows **15** is coupled to the bellows **6** in an opposed relationship thereto. Although the size of the counter bellows **15** need not be the same as that of the pressure-sensing bellows **6**, it will be more convenient for handling to design these bellows members **15** and **6** in the same size.

Referring now to FIG. **2** of the drawings, a plurality of (three in the illustrated embodiment) assemblies each consisting of a heating vessel and a pressure-sensitive temperature regulator are shown. The counter

bellows **15, 15'** and **15''** are communicated with a common tube **17** through the thin tubes **16, 16'** and **16''**, respectively. The common tube **17** constitutes a constant-pressure chamber serving also as a header, and reference numeral **18** designates another tube for supplying pressurized air to said common tube **17,** a choke **19** being provided in the midway of the tube **18.** Reference numeral **20** designates a constant-pressure valve for maintaining the pressure of the supplied pressurized air at a constant value. At the extremity of the constant-pressure chamber **17** is provided a nozzle **21,** and a flapper valve **23** for regulating an air injection rate from said nozzle **21** is disposed at a position opposed to the tip end of said nozzle **21.** Reference numeral **24** designates a fulcrum point of the flapper valve **23.** A bellows member **22** is communicated with the constant-pressure chamber **17** through a tube so that the flapper valve **23** may be pushed by the tip end of the bellows member **22.** Reference numeral **26** designates a coil spring for pulling the flapper valve **23** towards the nozzle **21,** and numeral **26** designates an adjusting screw for regulating the load of the coil spring **25.**

The heat transfer liquid medium **2** is heated up by the heater **3** to generate its vapor, which fills the vapor chamber **4** and thereby heats up the vessel **1.** When the vapor pressure becomes higher, said vapor pressure serves to extend the elastic bellows **6** via the thin tube **5** communicating with the heating vessel **1,** and thereby move the lever **7** downwardly so as to depress the micro-switch **11** to cut off the power supply for the heater **3.** On the contrary, when the vapor pressure becomes lower, the elastic bellows **6** contracts, so that the lever **7** pulls the micro-switch **11** to switch on the power supply for the heater **3.** While repeating the above-described operations, the vapor pressure is maintained at a constant value and thereby the temperature is kept at a constant temperature.

FIG. **3** is a diagram showing the relationship of the pressure P within the constant-pressure chamber **17** versus the gap clearance δ between the nozzle **21** and the flapper valve **23,** and from this diagram it is apparent that when the gap clearance δ_1 is larger, the pressure P_1 is lower, whereas when the gap clearance δ_2 is smaller, the pressure P_2 is higher. In order to regulate the gap clearance δ, it is only necessary to adjust the load upon the coil spring **25.** In more particular, if the load upon the coil spring **25** is increased, then the nozzle **21** and the flapper valve **23** approach to each other, resulting in a smaller gap clearance δ, which in turn increases the pressure within the constant-pressure chamber **17** to a higher value, so that the pressure within the bellows member **22** communicating with the constant-pressure chamber **17** is increased to push the flapper valve **23** upwardly, until the pushing force of the bellows member **22** is balanced with the pulling force of the coil spring **25** to maintain the flapper valve **23** stationary at a position for retaining an appropriate gap clearance δ, when the pressure within the constant-pressure chamber **17** can be maintained at the balanced value. On the other hand, if the load upon the coil spring **25** is decreased, then the flapper valve **23** is separated further from the nozzle **21,** resulting in a lower pressure within the constant-pressure chamber **17,** which in turn lowers the pressure within the bellows member **22** communicating therewith, until the flapper valve **23** is balanced at a position separated from the nozzle **21** by a larger gap clearance δ, when the pressure within the constant-pressure chamber **17** can be maintained at the balanced value.

Here, if the adjusting screw **26** is adjusted to a certain different position, then the coil spring **25** pulls the flapper valve **23** while applying the corresponding different load thereupon, so that the flapper valve **23** is maintained at a position where the pulling force of said coil spring **25** is balanced with the pushing force caused by the inner pressure of the bellows member **22,** and thereby the pressure within the constant-pressure chamber **17** can be maintained at the balanced value. This pressure is applied to each one of the plurality of the counter bellows **15, 15'** and **15''**, and thereby the temperature of the heat transfer medium in the heating chambers of the respective apparatuses for heat treatment can be maintained at a constant temperature such that the vapor pressure of the heat transfer medium at said temperature may be balanced with the pushing force of the respective extended bellows members **22.** If the temperature of the heat transfer medium vapor is lowered, then the vapor pressure of the same is also lowered, so that the lever **7** actuates the micro-switch **11** to energize the heater **3.** Whereas, if the temperature of the vapor is raised resulting in a vapor pressure higher than a preset value, then the lever **7** releases the micro-switch **11** to disable the heater **3,** and thereby the temperature of the heat transfer medium vapor may be maintained at a constant value. Thus, all the temperatures of the plurality of apparatuses for heat treatment can be regulated so as to be at the temperature preset by the single adjusting screw **26.**

At a temperature lower than the boiling point of the heat transfer medium under the atmospheric pressure, the vapor pressure of the heat transfer medium is lower than the atmospheric pressure. Thus, in case that the apparatus for heat treatment is used at a temperature lower than the boiling point of the heat transfer medium, the balanced condition is not realized because the pressure-sensing bellows **6** takes a negative pressure while the pressure of the pressurized air in the counter bellows **15** is always positive, and so the temperature regulation cannot be achieved. Therefore, the lever **7** is provided with a coil spring **9** which exerts a resilient force upon the lever **7** in the direction for pulling the pressure-sensing bellows **6,** and a balanced condition can be realized by adjusting the load upon the coil spring **9** by means of the adjusting screw **10.** Alternatively, if a vacuum bellows **27** of the same size having its inner space evacuated is provided so as to be coupled to the pressure-sensing bellows **6** in an opposed relationship thereto, in place of the coil spring **9** as shown in FIG. **4,** then the vapor pressure within the heating vessel is compensated for so as to express an absolute pressure rather than a gauge pressure (a pressure relative to the atmospheric pressure), so that said vapor pressure may be considered always positive, and therefore, the counter bellows **15** opposed to said pressure-sensing bellows **6** could be maintained at a positive pressure and no auxiliary spring is necessary. If the counter bellows is located at a larger distance from the fulcrum point, for example at a distance twice as far as the distance between the fulcrum point and the pressure-sensing bellows **6** as shown in FIG. **4,** then the balanced condition can be conveniently realized with a pressure of the counter bellows one-half times as low as the heat transfer medium vapor pressure (an absolute pressure). While an elastic bellows was employed

in the foregoing description and the accompanying drawings, a diaphragm can be equally used in the pressure-sensing section.

What is claimed is:

1. In an automatic temperature regulating apparatus for heat treatment of synthetic fibrous yarn including a plurality of heat treatment means, each means including a heating vessel (**1**) having a chamber;

a frame;

a pressure sensing bellows (**6**) suspended within the frame and responsive to vapor pressure in said vessel;

a tube (**5**) interconnecting said chamber and bellows;

a lever (**7**) fulcrumed on said frame connected to and moved by said pressure sensing bellows;

biasing means (**9**) connected to said lever;

an electric heater (**3**) emersed within the fluid in said vessel, including an electrical circuit to a power source;

a micro-switch (**11**) in said circuit mounted on said frame and engagable by said lever;

a counter-bellows (**15**) coupled respectively to each pressure sensing bellows, and anchored within said frame;

a common pressure chamber (**17**) in communication with each of said counter-bellows, the pressure of said pressure chamber being desirably regulated with pressure variations therein, wherein the temperatures in said heat treating vessels are uniformly adjusted.

2. In the temperature regulating apparatus of claim **1,** said biasing means being a spring.

3. In the automatic temperature regulating apparatus of claim **1,** said biasing means being a vacuum bellows anchored in said frame and connected to said lever.

4. In an automatic temperature regulating apparatus for heat treatment of synthetic fibrous yarn including a plurality of heat treatment means, each means including a heating vessel (**1**) having a chamber;

a frame (**12**);

a pressure sensing bellows (**6**) suspended within the frame and responsive to vapor pressure in said vessel;

a tube (**5**) interconnecting said chamber and bellows;

a vacuum bellows (**27**) arranged in opposed relation and connected to said pressure sensitive bellows respectively, and anchored within said frame;

a lever (**7**) fulcrumed on said frame and connected to and moved by said pressure sensing bellows;

an electric heater (**3**) emersed within the fluid in said vessel, including and electrical circuit (**13**) to a power source;

a micro-switch (**11**) in said circuit mounted on said frame and connected to said lever;

a counter-bellows connected to each lever, outwardly of said vacuum bellows;

a common pressure chamber (**17**) in communication with each of said counter-bellows, the pressure of said pressure chamber being desirably regulated and with pressure variations therein, whereby the temperatures in said heat treating vessels are uniformly adjusted.

5. In the temperature regulating apparatus of claim **1,** the means for regulating pressure in the pressure chamber including an intake pipe (**18**) connected to said pressure chamber and to a source of compressed air (**20**); an air outlet nozzle (**21**) connected to said pressure chamber; a frame (**24**); a spring biased lever (**23–25**) pivoted on said frame; a bellows (**22**) in communication with said pressure chamber and connected to said latter lever; a flapper valve on said latter lever in registry with said nozzle to variably regulate the flow of air therethrough, in turn, regulating the pressure within said pressure chamber.

* * * * *