United States Patent [19]

Chamouton

[11] **3,798,785**

[45] **Mar. 26, 1974**

[54] **DEVICE FOR DRYING CONTINUOUS WEB MATERIAL**

[76] Inventor: **Daniel Jean Marie Chamouton,** 127 Boulevard Malesherbes 75, Paris, France

[22] Filed: **Sept. 13, 1971**

[21] Appl. No.: **180,001**

[30] **Foreign Application Priority Data**

Sept. 22, 1970 France 70.34228

[52] **U.S. Cl.** **34/54,** 34/40, 34/41, 34/77, 34/86

[51] **Int. Cl.** **F26b 21/00**

[58] **Field of Search** 34/40, 41, 44, 54, 73, 34/75, 77, 86, 48

[56] **References Cited**

UNITED STATES PATENTS

2,148,720 2/1939 Armstrong 34/41

2,933,826 4/1960 Justus ..... 34/75 X

Primary Examiner—Carroll B. Dority, Jr.

Attorney, Agent, or Firm—Linton & Linton

[57] **ABSTRACT**

The improved method according to this invention is characterized essentially in that the water contents of the moist product are rejected in the liquid state by resorting to a thermal cycle which, after having transferred at a predetermined temperature to said moist product the energy necessary for vaporizing the water contained therein, recovers this energy at a considerably lower temperature by condensing the steam thus formed.

2 Claims, 2 Drawing Figures

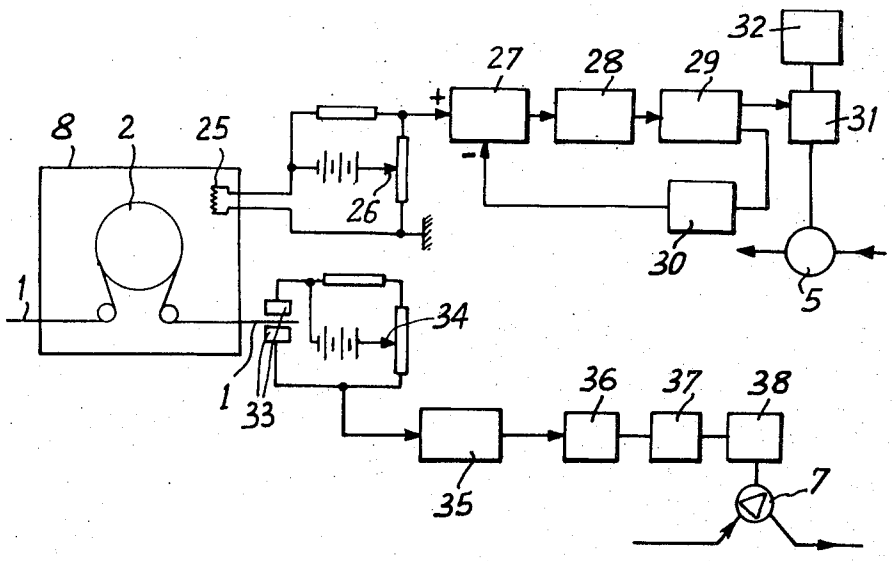


Fig:1

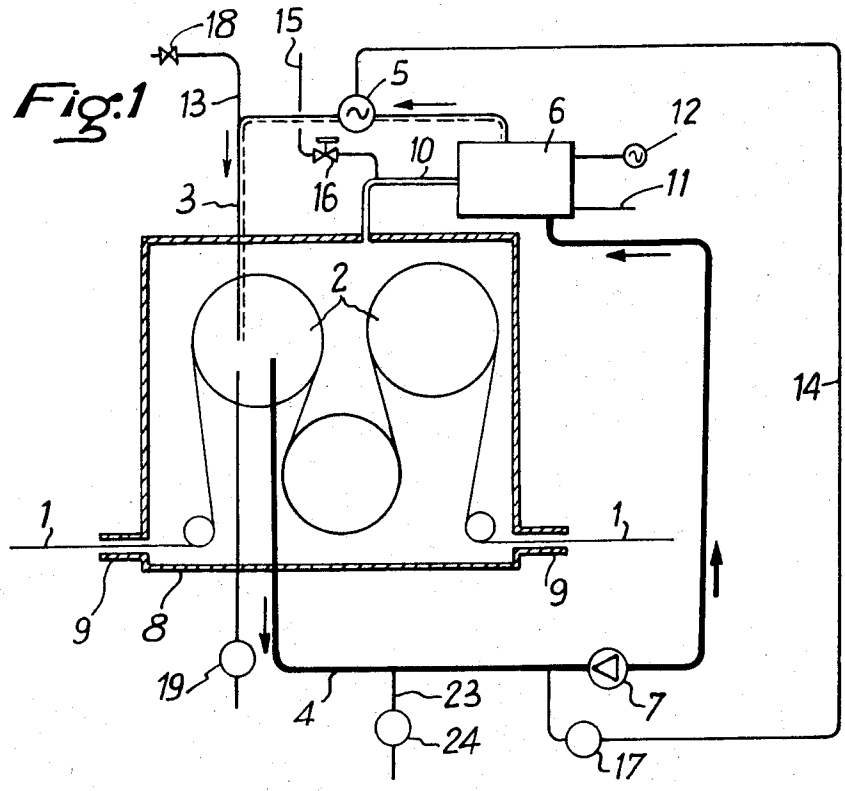
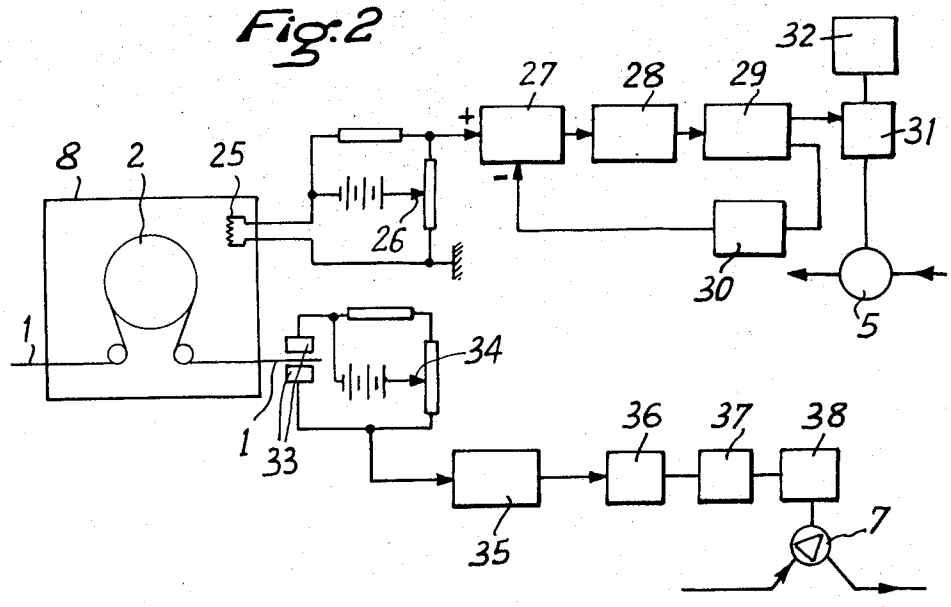


Fig:2



INVENTOR
DANIEL JEAN MARIE CHAMOUTON

By Linton and Linton
ATTORNEYS

DEVICE FOR DRYING CONTINUOUS WEB MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates in general to the drying of continuous webs of products or materials and has specific reference to an improved installation for the continuous drying of webs of products or materials from which moisture is to be removed.

BRIEF DESCRIPTION OF THE PRIOR ART

In many industries it is a frequent requirement to remove the whole or part of the water contained in solutions, mixtures, fibres. More particularly, in the textile industry as well as in the paper-making industry, drying plants are used wherein the moisture-containing product is heated, the vapour thus released being conveyed and removed by a previously heated air stream. Now these known systems are objectionable on account of their high power consumption and it is the chief object of the present invention to provide a method of and an apparatus for reducing considerably the energy necessary for performing such drying operations.

SUMMARY OF THE INVENTION

The improved apparatus according to this invention is characterized essentially in that the water contents of the moist product are rejected in the liquid state by resorting to a thermal cycle which, after having transferred at a predetermined temperature to said moist product the energy necessary for vaporizing the water contained therein, recovers this energy at a considerably lower temperature by condensing the steam thus formed.

This cycle involves only a very limited power expenditure in proportion to the heat energy necessary for vaporizing purposes only, according to the conventional means utilized in hitherto known drying plants.

Such conventional plants have already been described in the art. Now the apparatus according to the present invention provides a regulation system whereby the product can be subjected to a continuous drying action in an air-free vapour atmosphere at a pressure close to the atmospheric value, the residual moisture rate of the product being kept at a predetermined value, without any supply of external heat, notably in the form of vapour, except during the starting period of the apparatus operation. Now none of the hitherto known processes can provide a comparable performance.

The apparatus of this invention is further characterized by an original feature : in fact, in drying operations it is a frequent occurence that the dryness of the product, for instance a paper web or sheet, varies in a direction perpendicular to its direction of travel. As a rule, the vapour tension of the moist product varies as a function of its dryness : now the continuous drying pure vapour atmosphere according to this invention makes this dryness uniform or regular both transversely and longitudinally of the sheet or web.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to afford a clearer understanding of this invention a typical form of embodiment thereof will now be described in detail with reference to the accompanying drawing, in which :

FIG. 1 is a diagrammatic illustration of a drying apparatus according to this invention, as applied to a textile or paper production plant, and

FIG. 2 is a block diagram illustrating the regulation means associated with the plant of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In the example illustrated in the drawing the product to be dried, in the form of a continuous web of textile or paper product 1, is caused to pass over a set of rotary cylinders 2 heated internally by means of steam supplied through a pipe line 3 (shown only in connection with one of such cylinders), this steam condensing in the cylinders while the condensation water is removed via another pipe line 4. As described so far, this section of the plant is well known in all drying plants utilizing rotary heating cylinders, the steam being generated by a boiler to which the condensation water is recycled while the steam extracted from the product proper is usually dissipated in the surrounding atmosphere.

Although this invention does not change the arrangement and mode of operation of these heating cylinders, it provides a completely different steam circuit arrangement.

According to this invention, the heating steam circuit is closed and operates as a heat pump. It comprises a compressor 5 driven from a steam turbine, a thermal engine or an electric motor (not shown) for delivering compressed steam to the cylinders 2 via pipe lines 3, and a boiler 6 inserted in the closed circuit upstream of the compressor for vaporizing the condensation water from cylinders 2 after its passage through a pressure-reducing device 7. A vacuum pump 19 (or a water pump) is provided for eliminating the non-condensable products from cylinders 2.

The closed circuit path followed by the water firstly in the liquid state and then in the vapour state is illustrated by the arrows in FIG. 1.

On the other hand, the set of heating cylinders 2 is housed in a fluid-tight housing 8, provided however with a pair of slits 9 to permit the ingress and egress of the product to be dried. An exhaust chimney 10 directs the steam generated by the heating of the moist product into the boiler 6 where it is condensed. The condensation product is collected by a pipe 11. A vacuum pump or water or steam pump 12 removes air and other non-condensable gases from the housing 8. The air intake of this ejector is located at the output of the condenser section of boiler 6. The paths of fluid from 7 to 5 and from 10 to 11 are separate and heat is transferred in a well known manner from the path 10-11 to the path 7-5. Steam is generated in the boiler 6 by the heat of the steam exhausted from the housing 8 and the latter is condensed because temperature To of the fluid from the pressure reducer 7 is below the temperature T2 of the steam exhausted from the housing. The steam pump 12 is in communication with pipe 10, whereas the compressor 5 is in communication with the other path from the pressure reducer 7.

The above-described plant operates as follows :

The closed circuit comprising the compressor 5, boiler 6, pressure-reducing device 7 and heating cylinders 2 is similar to the closed circuit of a refrigerator. It discharges via pipe 3, at a temperature T_1, steam utilized in this case for heating the rotary cylinders 2 and absorbs in the boiler 6 heat at a temperature T_0 lower

than T_1. The heat applied to the cylinders causes the water contained in the paper or textile web **1** to evaporate at a temperature T_2 ; this steam is condensed in boiler **6** to provide the heat necessary for operating the refrigeration cycle. To operate the system, the temperature T_2 should lie within the range from T_1 to T_0. The values of T_1 and T_0 are determined by the pressure-reducing device **7** together with the compression rate.

The temperature T_2 is very slightly higher than **100°C** and the pressure within the housing **8** is slightly above the atmospheric value. The energy supplied by the compressor is such that the drying cylinders vaporize more water than the boiler condenses steam ; therefore, there is an excess of steam in the housing, one fraction of this excess steam condensing on the walls of the boiler, the other fraction escaping through the slits **9,** thus precluding any ingress of air. Under these conditions, there is no air admission and a certain steam leak takes place.

On the other hand, the compressor **5** supplies overheated steam ; it is advantageous to supply saturating steam to the drying cylinders ; therefore, water is tapped from the high-pressure circuit via pipe line **14,** this water forced by pump **17** being re-injected either directly into compressor **5** or down-stream thereof through an atomiser.

To ensure a rapid starting of the plant operation steam is introduced into the housing **8** via pipe line **15** and valve **16** ; thus, air is scavenged from the housing. Then steam is introduced via pipe line **13** and valve **18** into pipe line **3.** These two steam supplies are discontinued when, during the compressor operation, the steam pressure measured upstream of the compressor has reached the rated value. The additional water brought by the steam into pipe line **3** is tapped off via a conduit **23** controlled by a valve **24.**

The regulation system illustrated in FIG. **2** of the drawing is adapted to perform the following two functions :

1. keeping the steam pressure in the housing **8** at a value very slightly greater than the surrounding atmospheric value ;

2. maintaining at a predetermined value the residual moisture rate of the product issuing from the drying plant.

Under these conditions, this regulation system comprises two servo-action loops.

The pressure control loop comprises a temperature detector **25** (such as a resistance, thermocouple or any other means capable of giving an electrical measurement of the temperature) disposed within the housing **8** and inserted in a Wheatstone bridge. A potentiometer **26** displays in said bridge the control value corresponding to a temperature very close to 100°C. The output signal of said bridge is the input signal of an amplifier **27** to which the return servo-signal is also fed. This amplified signal actuates the control relays **28** of an electric servo-motor **29,** for example an asynchronous three-phase motor. A tachometric generator **30** measures the rotational speed of servo-motor **29** and the signal delivered by this generator is the servo-return signal fed to amplifier **27.** The servo-motor **29** controls either the rotational speed of the compressor driving motor or, as illustrated diagrammatically in FIG. **2,** a variable-speed gearing **31** coupling the compressor **5** to a driving motor **32** revolving at a substantially constant speed, such as an asynchronous three-phase electric motor. The adjustment of the servo-return signal permits of obtaining a stable regulation under all circumstances.

The servo-loop controlling the residual moisture rate is operatively connected to the pressure-reducing device ; it is used for pre-setting the compression rate in the water closed-circuit. It comprises a moisture detector **33** inserted in a bridge, a potentiometer **34** of this bridge setting the rated value of the residual moisture content. The output signal of the bridge is used for monitoring a modulator amplifier **35** delivering square-wave control signals having a time characteristic proportional to the measured discrepancy and a very low frequency in relation to the inherent frequency of the pressure control loop. These signals are adapted to control the opening or closing of control relays **36** of servo-motor **37** monitoring through a reduction gearing **38** the movement of the needle valve of pressure-reducing device **7.**

The modulator-amplifier **35** is adapted to deliver any other kinds of signals as may prove necessary and the servo-motors **29** and **37** may be controlled linearly, either electrically or pneumatically or hydraulically. The only requirement to be met is that the time constant of the relative moisture rate control loop be at least five times greater than the time constant of the loop controlling the pressure in housing **8.**

Although a specific form of embodiment of this invention has been described and illustrated herein, it will readily occur to those conversant with the art that various modifications and changes may be brought in the practical embodiment thereof without departing from the basic principles of the invention as set forth in the appended claims.

What I claim as new is:

1. A control system for the continuous drying of wet products such as textiles or paper webs, comprising drums for receiving said products therebetween, a steam compressor connected for supplying steam to one of said drums, a pressure reducing device in a condensate return circuit from said drum, a boiler in said circuit capable of vaporizing low pressure condensate and feeding said one drum through said compressor,

an enclosure for said drums, connected to said boiler for transferring the the heat of the water vapor from said products to said boiler for heating said condensate, a control system capable of maintaining the vapor pressure in said enclosure at a level slightly higher than the atmospheric pressure and comprising a temperature probe in said enclosure, a Wheatstone bridge connected to said probe for receiving the output signal of said probe, an adjustable resistance in said bridge being fixed for a temperature slightly higher than 212°F and of which the output is fed to an amplifier and after amplification controls the opening and closing of a control relays of a servomotor piloting the speed of a motor driving said compressor, and a tachometric generator fixed on a shaft of said servomotor and connected to said amplifier to add its feedback signal to the input signal of said amplifier.

2. A control system as claimed in claim **1,** comprising a moisture detector positioned at the exit point of said products from said enclosure and connected to a Wheatstone bridge with the signal of said detector being the input of said bridge whose adjustable resistance is fixed at the desired moisture level and of which the output is fed to an amplifier and after amplification is fed to a control relay which controls a servomotor coupled with the pressure reducing device by a gearing having a large reduction ratio.

* * * * *