

Feb. 24, 1959

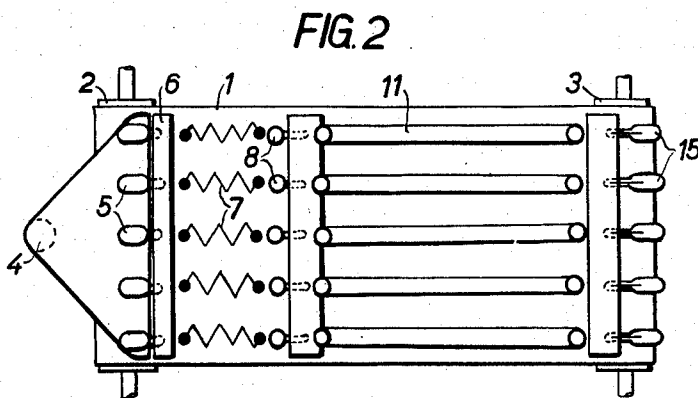
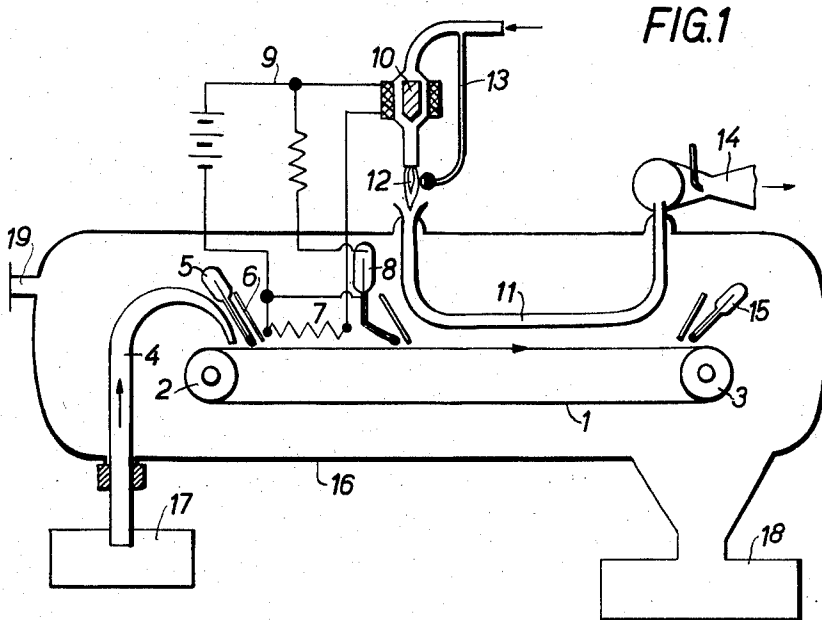
A. HALTMEIER

2,874,482

DRYING OF MOIST MATERIAL

Filed Aug. 9, 1954

2 Sheets-Sheet 1



INVENTOR.
ALFRED HALTMEIER
BY *Burgess & Dinklage*
ATTORNEYS

Feb. 24, 1959

A. HALTMEIER

2,874,482

DRYING OF MOIST MATERIAL

Filed Aug. 9, 1954

2 Sheets-Sheet 2

FIG. 3

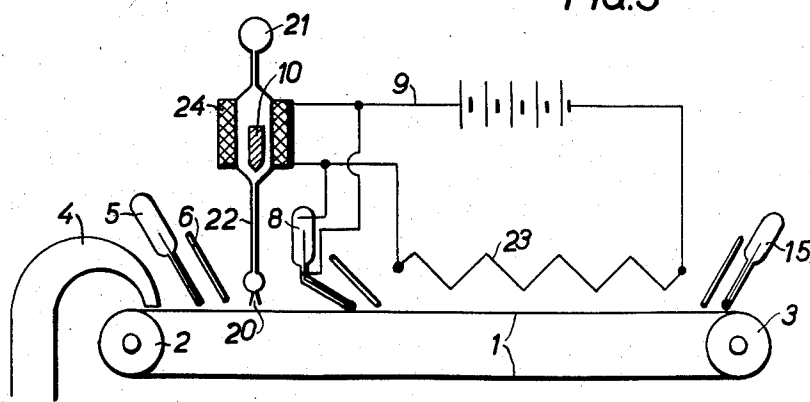
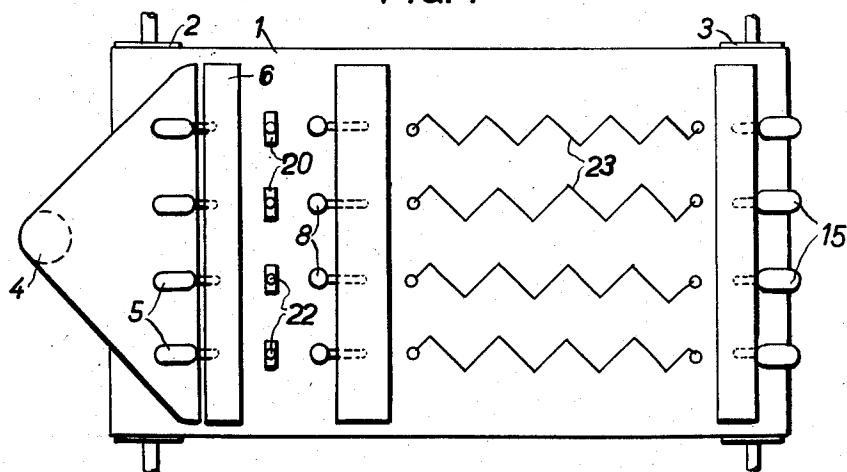


FIG. 4



INVENTOR.

ALFRED HALTMEIER

BY

Burgess and Dicklage

ATTORNEYS

1

2,874,482

DRYING OF MOIST MATERIAL

Alfred Haltmeier, Leverkusen-Bayerwerk, Germany, assignor to Farbenfabriken Bayer Aktiengesellschaft, Leverkusen, Germany, a corporation of Germany

Application August 9, 1954, Serial No. 448,683

Claims priority, application Germany August 17, 1953

9 Claims. (Cl. 34—31)

The present invention relates to an improved method of, and apparatus for, drying material on a belt drier by radiation.

When material on a belt drier is to be dried by radiation it is essential to adapt the amount of radiation to the amount of moisture to be removed from the material. If the amount of radiated energy absorbed is greater than the sum of the latent and sensible heat capacity of the moist material, the material being dried becomes overheated and, if the said material is sensitive to temperature, valuable properties may be deleteriously affected.

An indication of the amount of moisture still remaining in the material being dried is given by the temperature of the material at the end of the radiation drying zone; this temperature may, for example, be determined by means of thermometers, protected against the radiation, which contact the belt at this position. The more this final temperature exceeds the temperature at which the moisture evaporates from the material being dried, the less is the amount of moisture remaining; it is thus possible to take advantage of the temperatures of the dried material at the end of the radiation zone for regulating the amount of residual moisture in the undried material. If the material is dried under reduced pressure, the temperature at which the moisture evaporates depends on the pressure used.

It is unfortunate, however, that the regulating impulses which can be obtained by making use of the variations in temperature of the material undergoing drying usually come too late, as materials which are sensitive to temperature may already have been damaged before they have reached the end of the radiation zone.

In accordance with the present invention it has now been found that variations in the temperature of the moist material spread on the belt, before the material enters the radiation drying zone, can be utilised for regulating the amount of radiated heat supplied. Accordingly the present invention provides a method of drying moist material by spreading the moist material on the belt of a belt drier and drying the material by radiation, wherein the moist material on the belt is pre-heated or pre-cooled and the resulting variations in temperature of the material are used to control the amount of radiated heat supplied to the material to dry it. This preheating and/or precooling of the moist material is referred to in the claims as "thermally varying the temperature of the moist material." These variations in the temperature of the moist material spread on the belt may be obtained either by heating by preliminary irradiation or by a current of vapour being blown thereon, or by cooling by blowing on air.

The amount of radiated heat supplied may be controlled by the variations in temperature of the heated or cooled material in various ways. If the rate at which radiated heat is supplied to the moist material is kept constant for a time, the material is heated more as its heat capacity in unit time is smaller, i. e. the smaller is the thickness of the layer of material, the less is its moisture content, or the smaller is the speed of travel of the belt on which the

2

moist material is spread. If the rate of preliminary heating or preliminary cooling is kept constant for a time, the rise or fall thus produced in the temperature of the material on the belt may be used to control the rate at which radiation energy is supplied to the drying zone, for example by using electrical or perhaps pneumatic transmission devices to supply to the radiation heaters an amount of fuel or electric power which is proportional to the rise or fall in the temperature of the moist material resulting from the pre-heating or pre-cooling.

This result may be simply obtained if the pre-heating or pre-cooling is so regulated that the rate of rise or fall in the temperature of the moist material spread on the belt remains constant over a period of time. Controlling impulses may be supplied by temperature governors or differential governors; these impulses may then be used simultaneously to regulate the pre-heating or pre-cooling of the material and to control the radiation to be subsequently used for drying purposes. Owing to the high thermal inertia of heating systems operated with gas, oil or electricity, it is possible to operate with simple limiting contact regulators.

Thermal impulse emitters such as thermo-elements, resistance thermometers or contact thermometers, arranged to slide on the belt, or total radiation pyrometers if the layer of material is not to be damaged, are arranged between the pre-heating or pre-cooling zone and the drying zone. When the temperatures exceed or fall below a predetermined, and adjustable, limiting temperature, the pre-heating (or pre-cooling) is wholly or partially cut off by the impulses derived from the said thermal impulse emitters. These regulating impulses may also be used to cut off or reduce the radiation supplied for drying purposes, for example by shutting off or throttling the supply of fuel or by switching off electric heating coils or infrared lamps.

In order to allow for local fluctuations in the thickness of the layer of the moist material, such as are caused by the distributing slot which feeds the moist material on to the belt becoming clogged at one side, a number of thermal impulse emitters may be arranged across the width of the belt. Each of these emitters affects only the longitudinal strip of the belt on which it is mounted, i. e. only cuts off or reduces that portion of the pre-heating or pre-cooling means, and if desired of the drying radiation, which is arranged above the said longitudinal strip.

A belt drier for carrying out the process of the present invention must have a pre-treatment zone, in which the heating or cooling means for the material are arranged, in advance of the drying zone and also have one or more thermal impulse emitters arranged between the two zones, which may simultaneously control the heating or cooling means of the two zones. Accordingly, the invention also provides an apparatus for the drying by radiation of moist material spread on a drying belt, which comprises means for pre-heating or pre-cooling the material on the belt, one or more thermal impulse emitters, adjustable to a desired limiting temperature, arranged above the belt, and one or more radiation heaters for drying the material, the said thermal impulse emitter or emitters controlling the amount of heat supplied to the material by the radiation heater or heaters and if desired also controlling the amount of pre-heating or pre-cooling. The thermal impulse emitters are mounted at such a distance from the drying radiation zone that their controlling impulses are received in sufficient time, allowing for the heat inertia of the heat-radiating elements, to bring the radiation energy to the correct value necessary to dry that part of the layer of moist material which is just entering the drying zone. With a belt travelling at a relatively high speed, this distance must be greater than when the belt is travel-

3

ling more slowly. Consequently, it is advisable for the thermal impulse emitters, and possibly also the pre-heating or pre-cooling zones, to be arranged so that they are movable longitudinally of the belt, so that they may be brought closer to the drying zone when the belt velocity is small and moved further away from the drying zone when the belt velocity is high.

In the accompanying diagrammatic drawings:

Figure 1 is a side elevation of a vacuum belt drier suitable for carrying out the method according to the invention and having a pre-heating zone in which the heating is effected by radiation,

Figure 2 is a plan view of the drier,

Figure 3 is a side elevation of a belt drier in which the pre-heating or pre-cooling in the regulating zone is effected by blowing steam or air on to the moist material, and

Figure 4 is a plan view of the drier illustrated in Figure 3.

Referring to Figure 1, moist material which is to be dried is spread by means of a distributor means 4 on a drying belt 1, which travels over rollers 2 and 3 in the direction of the arrow. The temperature of this layer of moist material is determined by means of thermometers 5, which are slidably arranged on the belt 1 and are protected by a radiation screen 6. The material then passes through a pre-heating zone which is formed by electric heat-radiating elements 7. As a result of the initial radiation the temperature of the moist material spread on the belt rises; this rise in temperature depends on the heat capacity of the moist material if the amount of radiation is kept constant or, as assumed in the drawing, is so controlled that it undergoes relatively large or small fluctuations on either side of a constant value. Variations in the temperature of the material entering the pretreatment zone at the thermometers 5 may be allowed for either manually or automatically. Thermal impulse emitters in the form of contact thermometers 8 are slidably arranged on the belt at the end of the pre-heating zone. The limiting temperature is adjustable; if this temperature is exceeded a circuit 9 is briefly closed or opened so that the irradiation of the heating element 7 is reduced and at the same time an electromagnetically operated valve 10 is closed and interrupts the supply of fuel to the drying zone. In the form of apparatus shown in the figure the heating of the drying zone is effected by radiation tubes 11, which are heated by means of gas flames 12.

When the temperature registered by the contact thermometer 8 drops again, the pre-heating coil 7 is switched on again and at the same time the electromagnetic valve 10 is lifted, so that gas again flows and, after being ignited by a pilot light 13, heats the radiation tubes 11. The combustion gases are exhausted through an ejector 14. The dried material falls down at the rear reversing roller 3, and may then be finally treated in a further drying device. The temperature at this point, here determined by a thermometer 15 which is protected against radiation, serves to indicate the residual moisture content of the material at the end of the radiation drying zone. According to the value which is measured here, the limit contacts of the contact thermometer 8 may be adjusted manually or automatically. A discharge pipe 19 is provided for withdrawing gases from a vacuum chamber 16. The pipe 19 is connected to a vacuum pump (not shown). The outside air pressure forces the moist material from a container 17 by way of the pipe 4 to one end of the belt 1. The dried material drops from the other end of the belt into a container 18, from which it is removed at intervals.

The drier shown in Figures 3 and 4 differs from that shown in Figures 1 and 2 in that the radiation heating element 7 (Figures 1 and 2), in the zone following the radiation screen 6, is replaced by discharge openings 20 from which vapours for heating the material spread on

the belt 1 or air for cooling the said material may be discharged as required. The vapours or the air pass from a main pipe 21 to discharge openings 20 by way of pipes 22. Electric heating elements 23 are provided as radiators for the drying zone in the form of apparatus shown in Figures 3 and 4, instead of the radiation tubes 11 provided in the apparatus shown in Figures 1 and 2.

The vapour or air blown on to the material raises or lowers the temperature of the moist material spread out on the belt; the resulting variation in temperature depends either on the heat capacity of the moist material, if the blowing action is kept constant over a period of time, or, as in the form of apparatus shown, is so controlled that it experiences relatively large or small fluctuations about a constant value. Variations in the temperatures of admission at the thermometers 5 may be allowed for manually or automatically. Thermal impulse emitters in the form of contact thermometers 8 are slidably arranged on the belt between the pre-heating or pre-cooling zone and the drying zone. The limit temperature is adjustable; if this temperature is exceeded the circuit 9 is short-circuited or otherwise interrupted so that the radiation of the electrical heating elements 23 is reduced and at the same time the valve 10 is closed. This valve is here shown electromagnetically actuated by means of a magnet winding 24. The closing of the valve 10 causes the supply of vapour or air from the main pipe 21 to the discharge openings or nozzles 20 to be shut off. When the temperature registered by the contact thermometer 8 drops again the radiation heating system 23, and the supply of vapour or air through the nozzles 20, are switched on again.

The term, "thermal contact," as used in the claims, indicates both physical contact and heat or thermal contact which is not physical contact.

I claim:

1. Method for drying moist material which comprises substantially continuously passing a layer of moist material through a regulation zone and thereafter passing said material through a drying zone, subjecting said material to radiant heat in said drying zone to dry the same; subjecting the material to a predetermined caloric change in said regulation zone determining the temperature differential caused by said caloric change and varying the amount of radiant heat supplied in said drying zone in proportion to said temperature differential occurring in said regulation zone.

2. Method according to claim 1 in which caloric change is effected by heat radiation.

3. Method according to claim 1 in which caloric change is effected by blowing heating vapors thereon.

4. Method according to claim 1 in which caloric change is effected by blowing cooling gas thereon.

5. Method according to claim 1 which includes varying said predetermined caloric change and said radiant heat supply to said drying zone in accordance with the temperature of the material located between said zones.

6. Method according to claim 1 in which said caloric change and said radiant heat supply to said drying zone are simultaneously varied in accordance with the temperature of the material located between said zones.

7. In combination with a radiant heat drier for drying moist material having means for passing moist material to and through a drying zone containing a radiant heater; a regulation zone positioned for passage of a layer of moist material therethrough prior to passage into said drying zone, heat exchange means positioned in said regulation zone for imparting a caloric change to the material passing therethrough, temperature sensitive means responsive to temperature differential imparted to the moist material by said heat exchange means, and means actuated by said temperature sensitive means for varying the heat output of said radiant heater in proportion to said temperature differential.

8. Combination in accordance with claim 7 including

means for varying the thermal output of said heat exchange means controlled by said temperature sensitive means.

9. Combination in accordance with claim 7 in which said means for passing a layer of moist material to be dried to and through said drying zone is an endless belt.

1,580,658
1,671,493
2,349,300
2,391,195
2,420,399
2,674,809
2,705,137

Field ----- Apr. 13, 1926
Staeger ----- May 29, 1928
Olsen ----- May 23, 1944
Ross et al. ----- Dec. 18, 1945
New ----- May 13, 1947
Meienhofer ----- Apr. 13, 1954
Haltmeier ----- Mar. 29, 1955

References Cited in the file of this patent

UNITED STATES PATENTS

1,508,516 Harvey ----- Sept. 16, 1924 ¹⁰