March 29, 1955

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2,705,137

BELT DRIER HEATED BY RADIATION

Filed Dec. 13, 1950

2 Sheets-Sheet 1

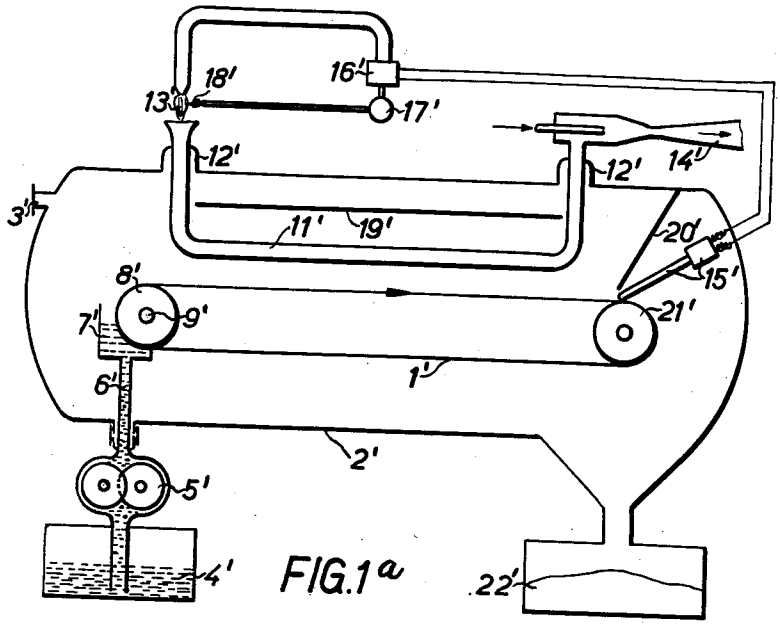


FIG.1a

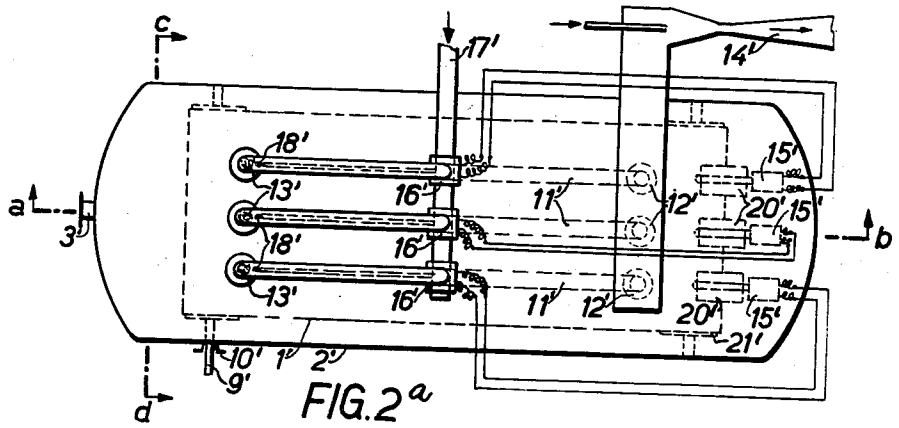


FIG.2a

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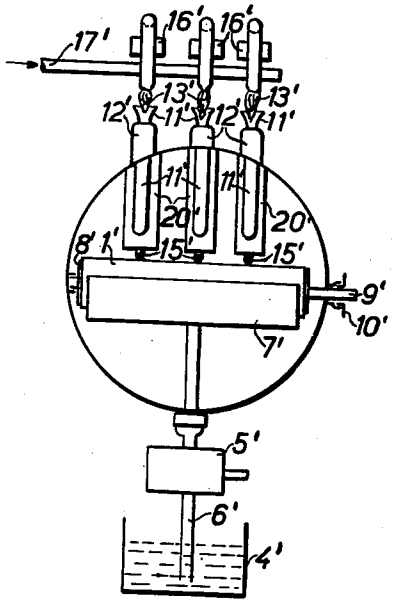


FIG. 3a

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BELT DRIER HEATED BY RADIATION

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Claims priority, application Germany December 16, 1949

4 Claims. (Cl. 263—28)

The present invention relates to belt driers heated by radiation and particularly concerns the drying of wet material distributed on belt driers in vacuo and to the proper application of heat during the drying process.

Sensitive materials may be dried, preferably in vacuo, by distributing these materials on a travelling belt and conducting the belt along radiating surfaces.

The above kind of drying has hitherto surprisingly not come into extensive use. This may be due to the difficulties encountered in attempting to adequately adjust the amount of radiant heat with varying quantities and/or varying moisture contents of the material distributed on the belt.

According to the present invention these difficulties are overcome by correlating the rate at which the wet material is fed to the vacuum chamber with the speed of the belt drier. This is preferably accomplished by means of pipes filled with wet material, said pipes connecting the drying chamber with an outside tank containing the wet material; the rate of flow of the wet material through said pipes is correlated with the speed of the belt drier. For this purpose, in the pipes feeding the wet material transporters, gear driven pumps, rotating worms, etc. may be used, the driving gears of which are coupled with the driving gear of the belt. In order to prevent air from entering these pipes the passages for the rotating shafts of the transporters through the walls of the pipes feeding the wet material are preferably provided within the vacuum chamber.

The pipes feeding the wet material may be extended through the walls of the vacuum chamber so as to project outwardly by means of elastic devices which render the pipes movable. These pipes are preferably terminated within the drying chamber by a slit from which the material to be dried emerges at the rate of the velocity of the belt. Means may be provided to prevent clogging of the slit (e. g., vibratory means) and to supply a uniform amount of material for drying (e. g., pressure means).

Variations in feed resulting from variation of the velocity of the travelling belt require an adequate adjustment of the quantity of radiation supplied for the drying process. For example, when the radiating surfaces are electrically heated, control means of the heating current is preferably coupled with means of controlling the velocity of the conveyor belt. This may be done, for example, by means of a controller cylinder connected to the driving gear of the belt drier. When heating with gaseous, liquid or powdered fuel apportioning devices coupled with the driving gear of the belt drier are advantageously arranged in the fuel supply pipes. These apportioning devices may be, for instance, apportioning drums, bucket wheels, rotary blast apparatus, pumps or worms.

In addition to the above-described control devices, means must also be provided to accurately control the radiation emitted from the radiating surfaces in such a manner that the dried material has the desired final moisture content. For this purpose devices may be installed which automatically shut off the heating in sections of the radiating surfaces when temperatures in these sections within the drying chamber exceed adjustable limits. This may be effected by temperature control devices arranged at radiation guarded sections within the drying chamber, for instance, above or beneath the travelling belt. It is of advantage to shut off, in the first line, those sections of the heating appliance of the radiating surfaces which are principally responsible for the temperatures acting on the control devices arranged in that section.

The radiating surfaces are preferably mounted in form of pipes lying above the belt drier to carry alternately hot and cool gases. For reducing the heat stresses, these alternately heated and cooled pipes may be extended through the wall of the drying chamber so as to project outwardly. This may be achieved by means of elastic expansion compensators, for instance, expansion pipes. For increasing the elasticity the radiating pipes may be U-shaped or may be installed in form of a plain coil. The wall of the drying chamber is advantageously protected from the radiant heat by means of protective screens, for instance, aluminum sheets. Furthermore, it is of advantage to arrange the radiating pipes parallel to the belt drier.

When the pipes carrying the source of radiant energy are arranged closely side by side it is advisable to unite the pipes leading through the wall of the drying chamber in a flat box, preferably provided with bars between the radiating pipes. If these bars are fixed to one of the walls of the box, the box is protected from being compressed by the external atmospheric pressure without affecting the elasticity desired to take care of thermal expansion.

For heating the radiating pipes, flames are preferably arranged at the inlet side of the drier and suction apparatus are provided at the outlet side for removing the gases coming out of the pipes. When the temperatures within the drying chamber exceed adjustable limits, the heating is automatically reduced and when temperatures fall below the desired limits, the heating is increased. For this purpose, throttling or closing devices may be provided in the fuel supply pipes, operation of which is started by the radiation guarded temperature control devices. By closing a membrane valve which may be installed in one of the fuel supply pipes, the gas supply is cut off and cool air is sent through the pipe in place of the hot combustion gases; on opening the membrane valve, the flow of gas is resumed and, on ignition by a pilot flame, again supplies heat for the drying operation.

A selectively absorbing layer may be formed as a result of the initial evaporation of moisture from the material being dried. Since such layer tends to handicap the drying process, means such as a speed ventilator may be provided for rapid removal of this layer. It is advisable to remove the vapors in the opposite direction to that of the motion of the belt. When corroding vapors are formed in the drying process, it is of advantage to employ corrosion-resistant jet blowers.

The accompanying drawings illustrate some possible modes of execution of the present invention by way of example.

In these drawings Fig. 1A diagrammatically indicates a side sectional view of another drier built in accordance with this invention taken along line *a—b* in Fig. 2A; Fig. 2A shows a top view of this drier in Fig. 1A; and Fig. 3A shows a section of the drier of Fig. 1A taken at lines *c—d* in Fig. 2A.

Fig. 1A shows the belt-drier 1′ arranged in the evacuated drying chamber 2′. Numeral 3′ designates a withdrawal conduit for removal of gases from the vacuum chamber 2′. The conduit is connected to evacuating pump (not shown in the drawing). The material to be dried is placed in container 4′, from which it is pressed by a gear-driven pump 5′ through pipe 6′ into the tank 7′. The driving shaft 8′ for the belt 1′ is immersed in the tank 7′. The axis 9′ of the shaft 8′ is extended through the stuffing box 10′ of the casing 2′ to the drive (not shown). The material to be dried is conveyed on belt 1′ into the drying zone in the direction of the arrow. The material is irradiated in the drying zone by means of the radiating tubes 11′ heated by combustion gases, said radiating tubes being installed in some distance above and parallel to the moving direction of the belt 1′. The combustion gases flow in the direction of the belt 1′. The radiating tubes 11′ are U-shaped. For reducing the heat stresses the radiating tubes 11′ are extended through the wall of the vacuum chamber 2′ so as to project outwardly. The parts of radiating tubes 11′ projecting outwardly are surrounded by wider tubes 12′. One end of

the wider tubes 12' is fastened to said radiating tubes 11', the other end of the wider tubes 12' to the wall of the vacuum chamber 2'.

Hot combustion gases or cooling air respectively flow through the radiating tubes 11'. For this purpose there are provided gas flames 13' installed at the inlet of the radiating tubes 11'. The combustion gases or gas flames 13' are removed by suction devices, for instance, an ejector 14', installed at the outlet of the radiating tubes 11'. Radiation guarded spots in the drier at the dry end of the belt 1' are provided with temperature control devices, for instance, resistance thermometer 15', which glide upon the drying surface of the traveling belt 1' and influence other devices, for instance, change-over-switches 16', adapted to adjust the supply of fuel. When the wanted temperature is exceeded the change-over-switches 16' bar the supply of fuel from gas pipe 17' to flame 13', so that the latter extinguishes. The heating of the radiating tube 11' is now cut and the tube is simultaneously changed to cooling, since instead of the combustion gases cooling air is sucked into the radiating tube 11' by means of ejector 14'. When the temperature drops again at the control device 14', the gas supply to burner 13' is released again and the gas streaming out is lighted by pilot flame 18'. The radiating tube 11' is now heated again. Thus heating is followed by cooling in turns. Since several radiating tubes are arranged above the belt all over the band-width it is of advantage to provide for changing over each radiating tube 11' separately in order to produce uniform temperatures all over the belt 1'. For this purpose each of said radiating tubes 11' is provided with a temperature control device 15' gliding upon the drying surface of the belt 1'. Each temperature control device 15' influences a change-over-switch 16'. One pilot flame 18' is provided for each flame 13'. Radiation protective screens 19' and 20' made, for instance, of sheet aluminum, are arranged for reducing the radiation power of the radiation tubes 11' in undesired directions. The dried material drops off at the roll 21' of the belt 1' into collector 22', from which it is removed from time to time.

The invention may be variously otherwise embodied within the scope of the appended claims.

I claim:

1. Vacuum drying apparatus comprising walls forming a chamber, means for evacuating said chamber, a horizontal belt conveyor in said chamber, means at one end of said chamber for feeding material to the upper run of said belt conveyor, a plurality of heat radiating tubes adapted to be heated by combustion gases, said tubes being positioned above and parallel to the belt in said chamber having inlets and outlets projecting through the top of said chamber, burners positioned adjacent the inlets of said radiating tubes, and means for withdrawing the combustion gases from the outlets of said tubes, said inlets of said radiating tubes being positioned at the inlet side of said chamber above the material feeding the inlets.

2. Vacuum drying apparatus comprising walls forming a chamber, means for evacuating said chamber, a horizontal belt conveyor in said chamber, means for feeding material to the upper run of said belt conveyor, a plurality of U-shaped tubes having vertical and horizontal portions, said horizontal portions being spaced above and parallel to the upper run of said belt, the vertical portions of said U-shaped tubes extending through the top wall of said chamber so as to project towards the belt in said drier, said tubes being surrounded by wider tubes, one end of each of said wider tubes being fastened to one of said radiating tubes, the other ends of each of said wider tubes being attached to the wall of the vacuum chamber, burners positioned adjacent the inlets of said U-shaped tubes, and means for withdrawing combustion gases from the outlets of said tubes, said inlets of the radiating tubes being positioned at the inlet side of said chamber above the material feeding the inlets.

3. Vacuum drying apparatus as defined in claim 2, including temperature control means positioned closely adjacent the upper surface of said travelling belt, and means connected to said temperature-control means to adjust the calorific content of the gases passed through said radiating tubes.

4. Vacuum drying apparatus as defined in claim 3 in which a series of said radiating tubes is arranged covering the entire width of said belt.

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