

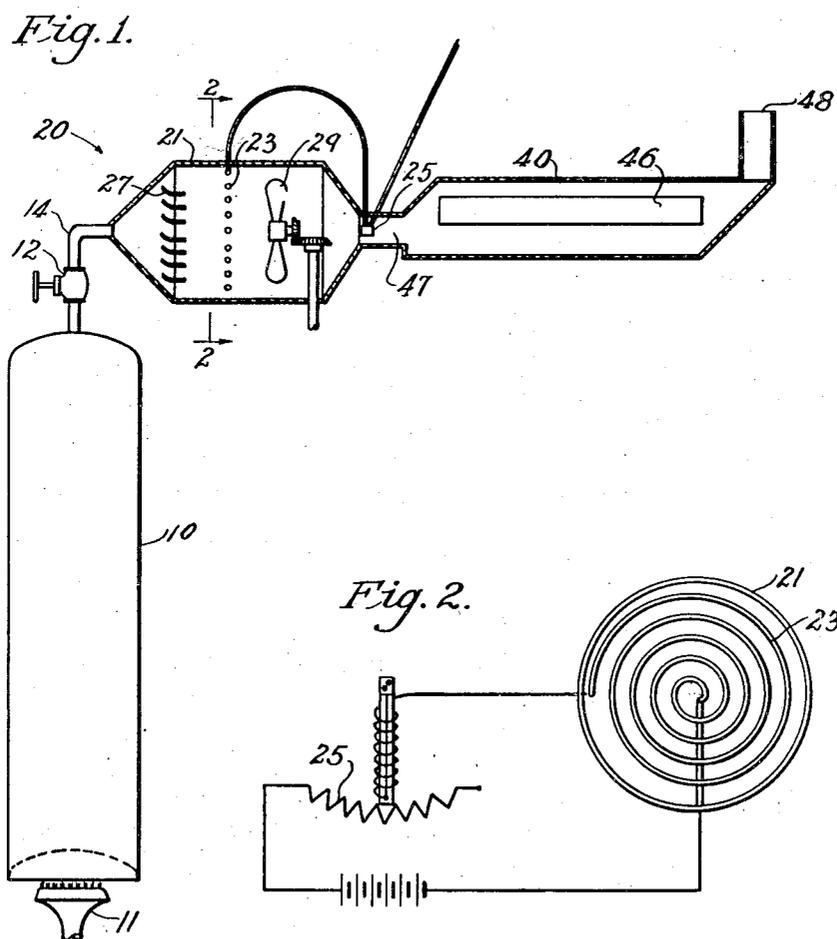
June 22, 1948.

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2,443,610

APPARATUS FOR DRYING WITH LIQUEFIED GAS

Filed Dec. 20, 1944



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# UNITED STATES PATENT OFFICE

2,443,610

## APPARATUS FOR DRYING WITH LIQUEFIED GAS

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Application December 20, 1944, Serial No. 569,025

4 Claims. (Cl. 34-48)

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My invention relates to an improved apparatus for drying or removing surplus moisture from industrial products such as from fabrics, foods, paper, printing and lithographing work, photographic film or prints, and other substances, which might be injured by drying methods employing higher temperatures, or which might be improved in quality or in length of life by such improved drying method, or which might be expedited in processing by such method.

The principal object of my invention is to provide an improved apparatus for drying or removing surplus moisture from various products or substances with a minimum of heat and of drying time, by directly contacting or surrounding said products or substances with gas, such as CO<sub>2</sub>, or a mixture of gases such as air, having a minimum of moisture content, said gases being supplied in liquid form, and then vaporized and heated.

My invention also has for its objects to provide such apparatuses that are positive and automatic in operation, convenient in use, easily installed in a working position and easily disconnected therefrom, economical of manufacture, relatively simple, and of general superiority and serviceability.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawings merely show and the following description merely describes one embodiment of the present invention, which is given by way of illustration or example only.

In the drawings, like reference characters designate similar parts in the several views.

Fig. 1 is a schematic elevational view, partly in section, of an embodiment of my invention.

Fig. 2 is a sectional view on line 2-2 of Fig. 1. The method and apparatus of this application is related to a method and apparatus for drying hair, disclosed and claimed in an application filed by me on the same date, and given Serial Number 569,026, now Patent No. 2,441,138.

The apparatus for carrying out my invention consists in general of a supply tank 10 of liquid gas, said tank being provided with the usual pressure gauges (not shown) and the usual means (not shown) for connecting and disconnecting the tank; a gas heating and mixing means 20; and the drying chamber 40.

The liquified gas in supply tank 10 is released in vapor form by control valve 12 to conduit 14 which conducts it to a heating and mixing cham-

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ber 21 which is substantially an expansion chamber for the drying fluid released from the tank 10. This gas or fluid is preferably a non-oxidizing gas, such as results from the evaporation of Dry Ice, and its use in drying food products is advantageous in avoiding oxidation of the products treated, which in the presence of heat, might deleteriously affect the articles of food in flavor or otherwise. The supply tank 10 may be provided with heating means 11 for preheating the liquified gas, or for accelerating its normal rate of vaporization.

Since the normal vaporization of a liquid gas produces a gas of relatively low temperature which would not be efficient or suitable for drying most materials, chamber 21 is provided with means for heating the vaporized gas when desired, for agitating the heated gas, and for regulating the temperature of the heated gas.

The heating means may be of any suitable type, such as the electric resistance heating coil 23 connected with an automatically controlled thermostat 25, which is located in the path taken by the heated gas in its flow between the heating and mixing chamber 21 and the drying chamber 40. Vanes 27, of any suitable design, are arranged in the path of flow of the cold vaporized gas for deflecting the cold gas uniformly to the heating coil 23, while a fan 29 is located between the coil 23 and thermostat 25, for agitating and mixing the heated gas to a uniform temperature before it reaches the thermostat 25 or the material to be dried in chamber 40.

The drying chamber 40 will vary in size, shape and construction in accordance with the requirements for the specific material being dried. It may be supplied with a closure 46, an inlet 47 for the heated gas, an outlet 48 for the moisture-laden gas, and with various racks, conveyor means, and tracks (not shown).

### Method of operation

My invention brings the substance or material to be dried into contact with substantially 100% moisture-free gas, such as CO<sub>2</sub>, or a mixture of gases, such as air. The dry gas is, therefore, able to pick up and carry away a larger proportion of moisture than would the partially saturated natural atmosphere at any specific temperature or pressure. The efficiency of my method of drying is, therefore, independent of the humidity, temperature or pressure of the atmosphere.

The moisture-free liquified gas in supply tank 10, which may be preheated by any suitable means 11, is released in vaporized form by con-

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trol valve 12, deflected by vanes 27 to the heating coil 23, and mixed or agitated to a uniform temperature by fan 29, and the temperature maintained at the desired degree by the automatic thermostat 25. The dry, vaporized and uniformly heated gas is then conducted through inlet 47 into intimate contact with the material or substances to be dried in chamber 40, and the moisture laden gas is then discharged to the atmosphere through outlet 48.

In drying some materials or substances, which it is desired to maintain at a low temperature while being dried, either the preheating means 11 or the heating coil 23, or both, may be either turned off or omitted from the installation.

My invention is especially valuable when the material or substance being dried has a critical temperature, or time, beyond which damage or deterioration in quality would result.

While I have illustrated and described what I now regard as the preferred embodiments of my invention, the steps and sequences of steps are, of course, subject to modifications without departing from the spirit and scope of my invention, I therefore, do not wish to restrict myself to the particular steps or sequences of steps described hereinbefore, but desire to avail myself of all modifications that may fall within the scope of the claims.

Having thus described my invention, what I claim and desire to secure by Letters Patent is:

1. Drying apparatus comprising a source of liquified gas, an expansion chamber for said gas having a connection with said source; a transversely disposed coil in said expansion chamber; a deflecting means in said expansion chamber for distributing said gas uniformly to and over said coil to heat the gas; thermostatic means to regulate said heating coil; a treating chamber, a conduit connecting said treating chamber with said expansion chamber, blower means for withdrawing the heated gas from said expansion chamber and forcing it into said treating chamber and directing the gas thus heated directly into contact with the material to be dried; said treating chamber having means for continuously discharging the moisture-laden gas.

2. Drying apparatus comprising a supply tank for a liquefied gas substantially free of moisture; an expansion chamber connected to said supply tank; an electric resistance heating coil in said chamber; a series of vanes in said chamber to deflect the gas from said tank in streams to said heating coil; a drying chamber, a conduit con-

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necting said drying chamber with said expansion chamber; a fan for drawing the gas through and in contact with said coil to agitate and heat the same to a uniform temperature and to force the gas thus heated into said drying chamber and into direct contact with the material therein to be dried, and a thermostat in said conduit to regulate the heat of said coil.

3. Drying apparatus comprising a source of anhydrous gas under pressure, an expansion chamber for said gas connected with said source; a heating means in said expansion chamber; means for dividing gas from said source into streams and distributing said gas uniformly to and through said heating means to heat the gas, a treating chamber; a connection between said expansion chamber and treating chamber, means in said connection to regulate said heating means and control the temperature of the gas; means for forcing the heated gas into said treating chamber and into direct contact with the material to be dried, and a discharge means on said treating chamber for the moisture-laden gas.

4. In a drying apparatus, the combination of: a supply tank for a gas under pressure; an expansion chamber for said gas connected to said supply tank; means in said chamber to divide the gas as it is delivered thereto to accelerate the expansion thereof; means in said expansion chamber and in the path of said divided gas to heat the gas to drying temperature; a treating chamber connected with said expansion chamber; means within said chamber continuously to withdraw the heated gas therefrom and direct it into contact with the material to be dried, and means between said expansion chamber and treating chamber and controllable by the temperature of the gas flowing from the expansion chamber to control said heating means.

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