

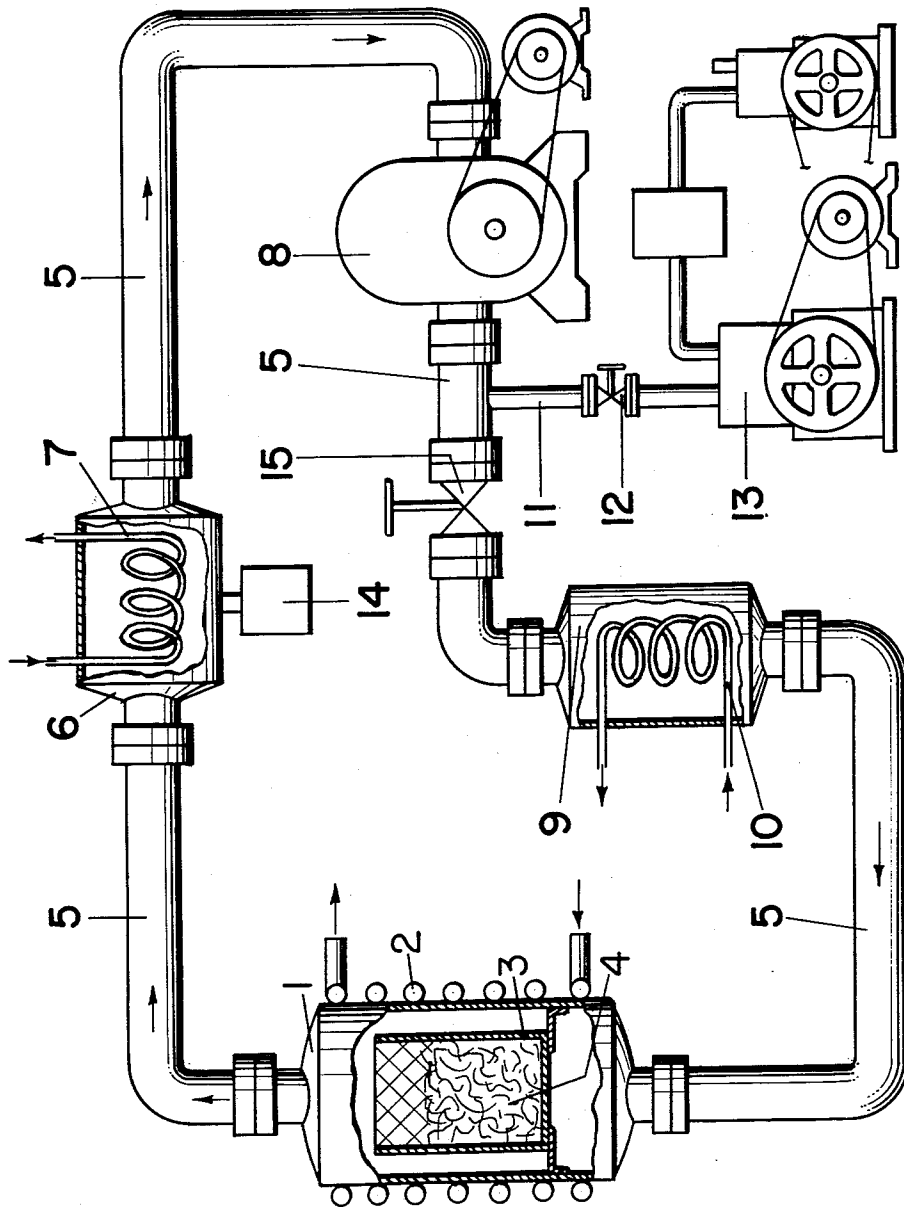
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APPARATUS FOR DRYING HEAT SENSITIVE PRODUCTS

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APPARATUS FOR DRYING HEAT SENSITIVE PRODUCTS

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Devices are already known in which the drying of sensitive substances, for example synthetic fiber raw materials and organic fiber materials, is carried out in a super-heated steam atmosphere. The presently disclosed invention stems from the problem of attaining a specially effective and economical construction of such a drying unit. The unit is made in such a way that first a crude drying is carried out in a current of super-heated steam which is supplemented by a more complete drying under high vacuum.

The present invention is directed to an improved apparatus and process wherein a dehydration unit for the crude and fine drying of sensitive substances employs a drying medium, which is circulated in a continuous manner and serves as a heat carrier which acts on the material to be dried. The circulation of the drying medium is by means of a rotary compressor (blower) which is preferably of the Roots type. This is connected in a continuous circulatory system between a condenser and a steam heater.

A preferred form of such a unit employs the rotary compressor first during the so-called crude drying for circulating the chiefly vapor-phase (e.g. steam) drying medium. The rotary compressor is then connected, after the shift to fine drying, as the high vacuum stage of a multistage pump set-up.

The unit can be further developed in a favorable way so that a heated drying vessel is provided for receiving the material to be dried, this vessel being connected to the rotary compressor through a continuous circuit with a condenser. A super-heater for steam is preferably located in the continuous system between the rotary compressor and drying vessel.

A multistage gas ballast pump is preferably provided for the pre-evacuating of the continuous system and as the fore pump for the high vacuum pump in the fine drying of the material. This pump can be connected to the continuous system between the rotary compressor and the steam superheater.

A unit so constructed in contrast to arrangements with isolated steam generators, perhaps steam boilers, has important advantages. The necessary steam comes from the very material to be dried. For this it is necessary that the material at the start have a satisfactory amount of moisture. This condition, however, always exists when using dehydration in a current of super-heated steam, since this process is mainly considered for crude drying.

In the drawing there is a diagram of an example of the invention. Of course, other arrangements can be advantageously made by application of the idea in the invention.

In a drying chamber 1, which is provided with a heater 2 preferably in the form of a super-heated steam coil, there is located the material 4 to be dried on a perforated support 3. From the drying chamber 1 a continuous conduit 5 leads next to a steam condenser 6 which has on the inside corresponding cooling surfaces in the form of a condenser coil 7. At the steam condenser there is attached, in a known manner, a trap 14.

The continuous conduit 5 leads further to a Roots type rotary compressor 8 and from there into a steam super-

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heater 9 where a heating medium in a heating coil 10 can be introduced. From the steam heater 9 the continuous conduit 5 can finally be brought again to the drying chamber 1 from which it started. Thus, there exists a closed circuit for the gaseous drying medium. Between the rotary compressor 8 and the steam superheater 9, there is inserted into the continuous conduit 5 a further supply line 11 which, by means of valve 12, is connected with a pump for removal of the vapor-containing mixture, preferably a gas ballast pump 13 which is preferably two-stage. Between the Roots compressor 8 and the steam superheater there is a valve 15 in the continuous conduit 5.

The operation of the unit is as follows: First the material to be dried 4 is placed on the perforated support 3 and introduced into the drying chamber 1. The heating device 2 on the drying chamber 1 as well as the condenser coils 7 in the condenser 6 and the heating coils 10 in the steam superheater 9 are still not yet in operation. The rotary compressor 8 likewise is not operating. The valves 15 and 12 are opened, the gas ballast pump 13 is placed in operation and there is a pre-evacuation of the entire system (i.e., drying chamber 1, continuous conduit 5, condenser 6, rotary compressor 8, and steam superheater 9). After correspondingly lower pressure values, for example a few mm. Hg Abs. are obtained, the valve 12 is closed and the two-stage gas ballast pump 13 stopped. Now the material to be dried, which lies on the perforated support 3, is heated by bringing steam to the heater 2 so that an adequate amount of steam is formed. At the same time, the condenser 6 and the steam superheater 9 are put into operation, while through the cooling coils 7 of the condenser 6 is circulated a coolant of appropriate temperature, preferably cold water. Likewise, a suitable heating medium is circulating through the heating coil 10 of the steam superheater. Now, too, the rotary compressor 8 is switched on and there begins a circulation of the gaseous drying medium which originates in the charging material. The saturated steam leaves the drying chamber 1 and is deposited in part on the condenser 6. The steam leaving condenser 6 now travels through the continuous circuit into the rotary compressor 8, which causes the circulation to occur. From there the steam is circulated into the steam superheater 9 and is superheated by the heating coil 10. The super-heated steam enters anew into the drying chamber and can again remove moisture from the material being dried. The circulating process described is continued until the desired crude drying is finished.

At this point the crude drying is interrupted and the unit now switched to fine drying. This is accomplished by shutting off trap 14 and closing valve 15, while at the same time opening valve 12. The rotary compressor 8, which has been up to this point causing the circulation of the current of steam, now serves as the high vacuum pump to which is connected the two-stage gas ballast pump 13 through feed line 11. Thereby there occurs evacuation of the inner chamber of the drying area 1 to lower pressures so that the existing steam is now removed from the system. Thus, under further pumping with increasing vacuum a fine drying occurs. To this end an additional heating of the material being dried can be accomplished for which it is possible to utilize in the fine drying the heat generated during the crude drying so that further heating need not be used.

Especially advantageous is the use in the present arrangement of the rotary compressor which during the crude drying process causes the circulation of the steam current and after the switch to fine drying serves as high vacuum pump. When the gas ballast pump inserted is two-stage very low final pressures in the micron range

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(of the order of magnitude of 10^{-3} mm. Hg Abs.) can be attained.

The heating of the drying chamber 1 in the crude drying process and the cooling action of the condenser 6 must be so related to each other in the operation of the unit during the crude drying that the desired steam partial pressure (e.g. 1 mm. Hg Abs.) exists in the system. During the subsequent fine drying the condenser 6 and steam superheater 9 can be disconnected by interruption of the corresponding operating mechanism for the cooling coils 7 and for the heating coils 10.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description, and shown in the accompanying drawing, shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A vacuum drying apparatus for drying heat-sensitive products, said drying apparatus being of the type wherein continuously recirculating steam at subatmospheric pressure is employed for heating the product to be dried, said apparatus comprising means defining a drying chamber for holding the product to be dried, a condenser, a blower for circulating steam, a steam superheater, a first conduit means for connecting the drying chamber, the condenser, the blower and the superheater in series so that the blower can circulate superheated steam across the product to be

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dried, through the condenser, through the blower and back through the superheater, a first valve means in said first conduit means between the blower and drying chamber on the exit side of the blower, a second conduit means connected to the first conduit means between the blower and the first valve means, a backing vacuum pump connected to said second conduit means and a second valve means for isolating said backing pump from said first conduit means, whereby said first and second valves when open permit pre-evacuation of said drying apparatus by the backing vacuum pump and permit connection of said blower and backing vacuum pump in series to provide a pressure on the order of 10^{-3} mm. Hg Abs. at the inlet of the blower and a correspondingly low pressure over the product to be dried when said first valve is closed and said second valve is open.

2. The drying unit of claim 1 wherein the compressor is a positive displacement blower of the Roots type.

3. The drying unit of claim 1 wherein the backing vacuum pump is a gas ballast pump.

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