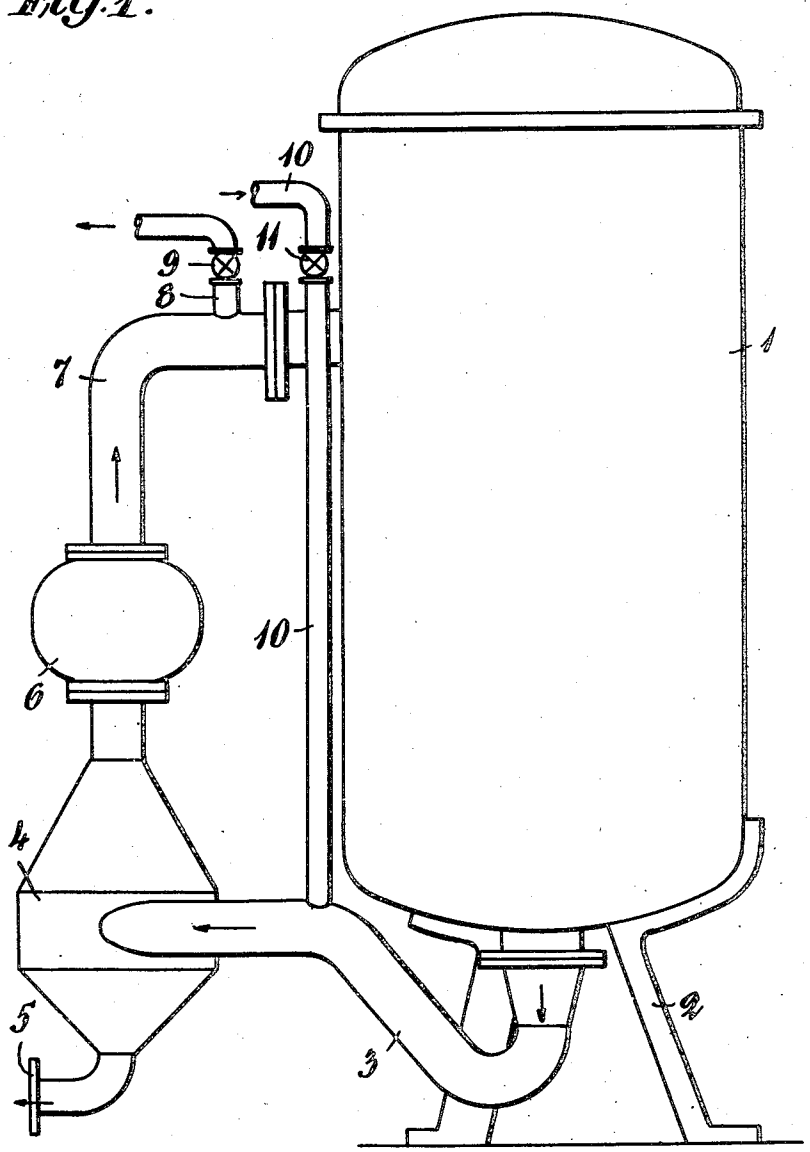
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PROCESS FOR DRYING GRANULAR THREAD AND FIBROUS MATERIALS

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Fig. 1.



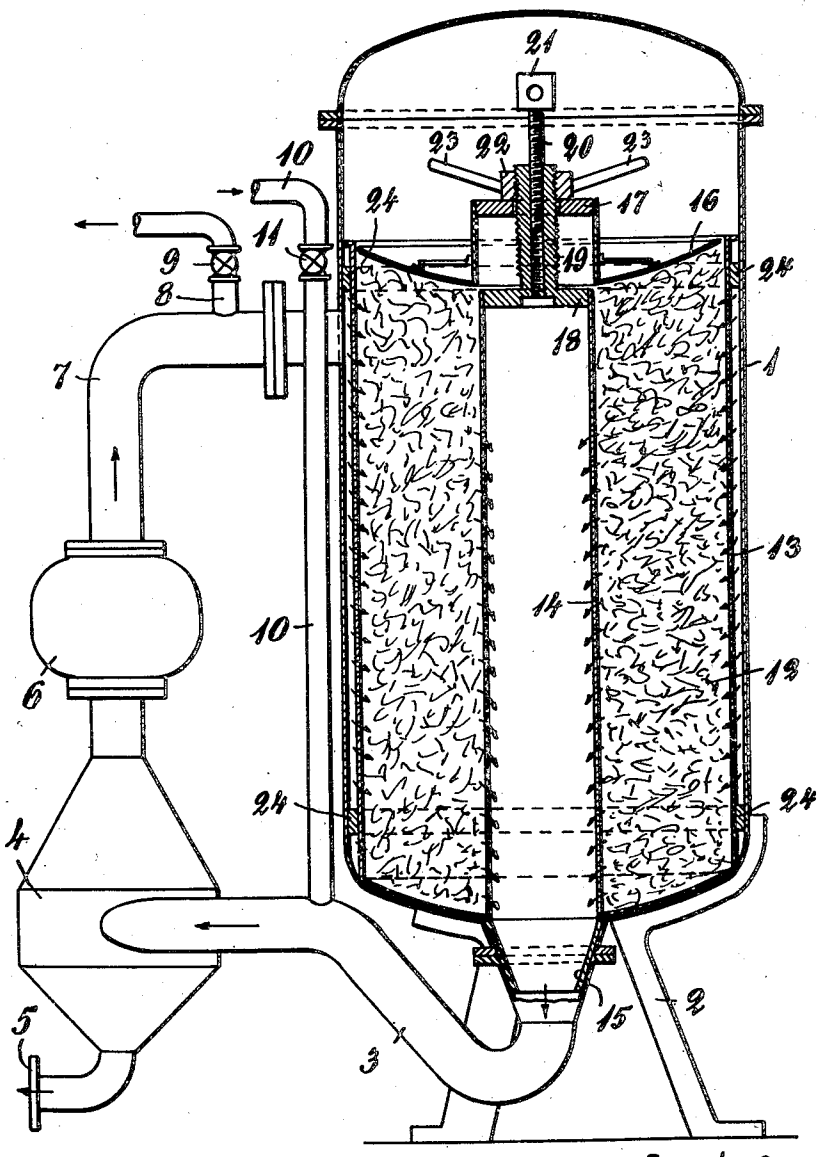
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Fig. 2.



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PROCESS FOR DRYING GRANULAR, THREAD, AND FIBROUS MATERIALS

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1 Claim. (Cl. 34—17)

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Drying of granular, filamentous or fibrous material and the like, for instance textile material in different stages of manufacture, has hitherto generally been performed by passing heated air and/or superheated steam over or through a layer of the wet or moist material to be dried. The escaping drying gas, which has been charged with vapour, has then either been discharged in its entirety, or also partially returned to the process after renewed preheating.

When applying this process using heated air as drying agent the difficulty to recover and utilize the heat contents of the escaping gases has been a great disadvantage. Said disadvantage does not occur in the latter case, when using superheated steam as drying agent, but in that case the low specific heat of the superheated steam requires very high drying temperatures, which often have an injurious effect on the drying goods, as well as great amounts of circulating steam and preposterous dimensions of the drying apparatus. In spite of this the drying according to said known methods has often required a very long time.

As example of a drying process of the above mentioned kind may be mentioned drying of yarns on bobbins. Generally, said drying has been performed by placing the bobbins in drying chambers, through which indirectly heated air has been circulated. Hereby the highest temperature of the air that could be used has been about 70° C., since the air would otherwise have had a detrimental effect on the yarn, due to the formation of oxycellulose. The time required for drying has been considerable, between 8 and 48 hours, dependent on the size of the yarn, the nature of the material and the dimensions of the bobbins.

The present invention now relates to a new drying process, especially for carrying out the drying of materials of the above mentioned kind, by means of which the above mentioned disadvantages are completely or substantially obviated or removed. According to the invention steam generated in the drying operation itself is used as drying agent, said steam being cycled through the material to be dried by means of a suitable pump or the like, the heating of the steam being effected by means of heat generated by transformation of the work delivered by the circulation pump in the circulation of the steam through the pump machinery and the drying goods.

When starting the drying process the air in the apparatus is circulated and heated, and hereby

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liquid in the drying goods, generally water, is rapidly evaporated, the steam thus generated being in a short time the main constituent of the circulating gas and finally—after discharge of gas from the circulation conduit, as mentioned below—the only constituent thereof.

In the first stage of the drying process, simultaneously with the drying, there is a mechanical removal of liquid from the drying goods, said liquid being carried away with the circulating gas. Said liquid is then removed from the gas in a separator directly inserted into the closed circulating system, within which the steam is circulated. Consequently, distinctive from the drying processes hitherto applied, it is not necessary first to remove mechanically such liquid attached to the drying goods by centrifugation or suction before the drying process proper can be started. As during the course of the drying operation evaporation consistently takes place, a part of the steam thus generated will generally have to be discharged from the circulation system, for instance through a safety-valve or another pressure regulator. Said steam may be utilized directly for heating purposes or also supplied to an accumulator.

When the drying is accomplished, the temperature of the steam rises. That point and the cutting off of the supply of energy to the circulation device, respectively, is suitably controlled and regulated automatically by means of suitable devices, as known per se.

In case of drying materials sensitive to high temperatures, the air is suitably forced out of the drying apparatus, for avoiding injurious oxidation of the drying goods. There may be used any suitable nonoxidizing gas, for instance nitrogen. Preferably, however, this is effected by means of steam of the same kind as that used as drying agent. The steam thus used for forcing the air out of the drying apparatus, when this is to be done, may be supplied from another similar drying aggregate, which has been started at an earlier point of time. Another way is to supply the steam herefore from an accumulator which has previously been charged with steam from the same or another drying aggregate.

When carrying out the process according to the invention in practice, the drying goods may be introduced into a container, through which the drying steam is circulated. According to a suitable embodiment the goods is placed in a layer on a perforated, substantially horizontal carrier or support, and the circulating steam is hereby preferably conducted in the direction

from above downwards through the material layer, thus facilitating the mechanical removal of liquid from the goods.

As examples of the application of the process according to the invention for drying textile materials may be mentioned drying of yarns on bobbins placed on tubular, perforated carriers, closed at one end, or yarn or textile fabric wound on tubular, perforated beams, closed at one end, suitably arranged in a container for the drying goods. In these cases the steam is suitably conducted through the goods in the direction from outside inwards and is discharged from the inner part of the hollow carrier at the open end thereof. A further example is drying of loose fibrous materials, for instance wool, cellulose, cell-wool or other textile fibres, or yarn placed in the space between the walls of a double walled cylinder with perforated walls, closed at one end, suitably arranged in a container through which the steam is circulated.

As examples of drying of granular materials may be mentioned especially grain, chemical products, gravel and the like.

The process according to the invention possesses, in comparison with prior drying processes, several essential advantages:

1. The time necessary for drying may be reduced to less than the half of what has previously been required.

2. As a consequence hereof the number of drying aggregates in certain cases may also be reduced to less than the half.

3. The usual heating elements for heating the drying agent are superfluous.

4. The drying of material sensitive to high temperatures, for instance textile materials, is more gentle, since the evaporation of the liquid in the drying goods takes place at a low temperature.

5. The separation of liquid, expelled as such from the drying goods, takes place simultaneously with the drying in the closed cycle itself, and on account thereof no centrifugation, suction or the like is required for removal of said liquid before the beginning of the drying process.

6. The process is much more economic than prior drying processes, partly due to the above-mentioned grounds set forth in points 1 to 5, partly due to the fact that the steam generated by evaporation of the liquid in the drying goods is used as drying agent in a closed cycle.

The invention also relates to an apparatus for carrying out the above mentioned drying process. Said apparatus is characterized by the combination of a container for the drying goods, a circulation pump, ventilator, turbo-compressor or the like connected with the container by means of conduits forming a closed circulation system comprising said container and circulation device as well as a separator for separating liquid mechanically carried away with the gases, said container for the drying goods being preferably provided with or arranged for insertion therein of one or more perforated carriers or supports for the drying goods, and said circulation device being arranged to force the drying steam through said circulation system, suitably in such a direction that the steam passes through the goods in the direction towards the perforated carrier or support, as well as a conduit for discharge of steam formed in the drying operation. Further the circulation conduit is suitably provided with an inlet for supplying steam, nitrogen or other inert gas for forcing the air out of the apparatus before the beginning of the drying operation.

Such an apparatus is shown as example schematically in the annexed drawing.

In the drawing 1 is the container for the drying goods, which is placed on a support 2. The container 1 is connected with a circulation conduit comprising the conduit 3, the separator 4 with a liquid discharge 5, the compressor 6 and a conduit 7, forming together a closed circulation system. From the conduit 7 issues the conduit 8 with a valve 9 for discharge of surplus of drying steam from the circulation conduit. For supplying steam, nitrogen or other suitable medium for forcing air out of the apparatus, if desired, there is a conduit 10 with valve 11 connected with a conduit 3.

Fig. 2 shows the embodiment with the double-walled cylinder. In said figure the references 1 to 11 are the same as in Fig. 1, and 12 is the double-walled cylinder with the perforated outer wall 13 and the perforated inner wall 14, which is inserted into the container 1 with the conically tapering part 15 at the bottom of the cylinder tightly projecting into the conduit 3. The cylinder is provided with a cover 16 having a cap projecting upwards ending in the upper annular piece 17, 18 is a bearing disc secured to the upper end of the inner wall 14 of the cylinder and prolonged upwards by a screwed socket or sleeve 19 passing through said annular piece 17, and 20 is a screw spindle with the catch 21 for lifting the cylinder out of the container. By means of the winged nut 22, 23 the cover is pressed down on to the cylinder. 24 are distance pieces.

In the space between the perforated walls 13 and 14 the loose textile material to be dried, for instance wool, is indicated. The steam passes through said material in the direction from outsides inwards towards the centre of the cylinder, as indicated by the arrows.

A fact of importance is that the whole drying apparatus, including the container for the drying goods, the circulation device, conduits and the like is very well heat insulated.

According to a suitable embodiment of the apparatus, the motor or motors used for driving the circulation device, is placed wholly within the stream of steam, i. e. completely enclosed in the steam space of the apparatus, without any cooling other than that effected by means of the rapidly circulating steam. Hereby the electric and friction losses of the motors are utilized in a very effective manner, thus contributing to a high effect and a good economy of the process.

The drying apparatus according to the invention may suitably be arranged to cooperate with a steam accumulator whereby deficient coordination between the generation of steam in the drying apparatus and the need of steam of the steam consuming apparatus may be equalized.

Having now particularly described the nature of our invention and the manner of its operation, what we claim is:

In a method of drying a mass of wet material in a closed circulation system comprising a drying zone, a compressor, conduits for conducting a gaseous drying medium from the compressor to the drying zone and from the drying zone back to the compressor, and a liquid separation zone in the conduit in advance of the compressor, the improvement which comprises circulating a gaseous drying medium through the closed system and directly through the wet material in the drying zone to remove mechanically, in liquid

form, a part of the liquid in the wet material, separating the liquid from the circulating gaseous medium in the liquid separation zone and removing the separated liquid from the closed system, and continuing the circulation of the drying medium through the closed system and directly through the mass of material to be dried, the remaining portion of the liquid to be removed being converted into vapor by the heat added to the drying medium due to work done by the compressor acting to force the drying medium through the mass of material thereby vaporizing additional amounts of moisture from the material, and withdrawing the vaporized moisture from the closed system, said circulation of drying medium being continued until the drying process is substantially completed.

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