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METHOD FOR DRYING MATERIAL SENSITIVE TO OVERHEATING

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Fig. 1.

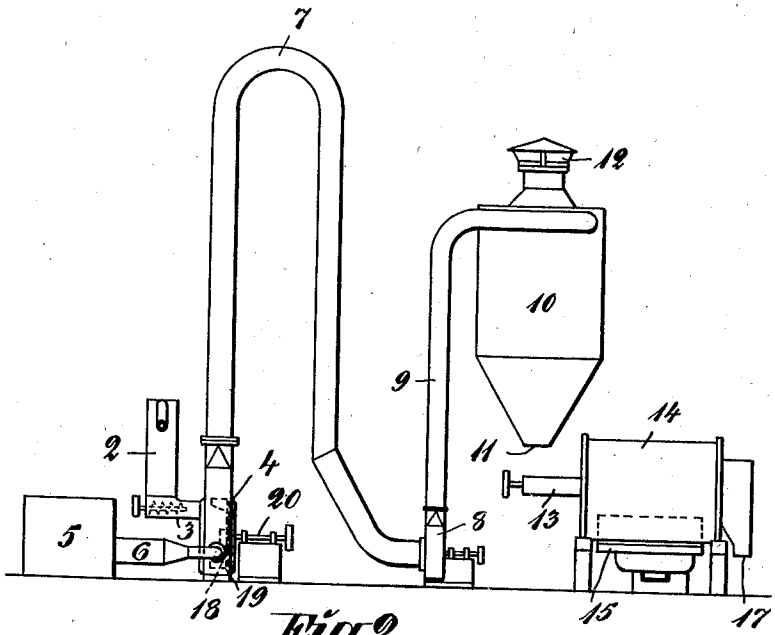
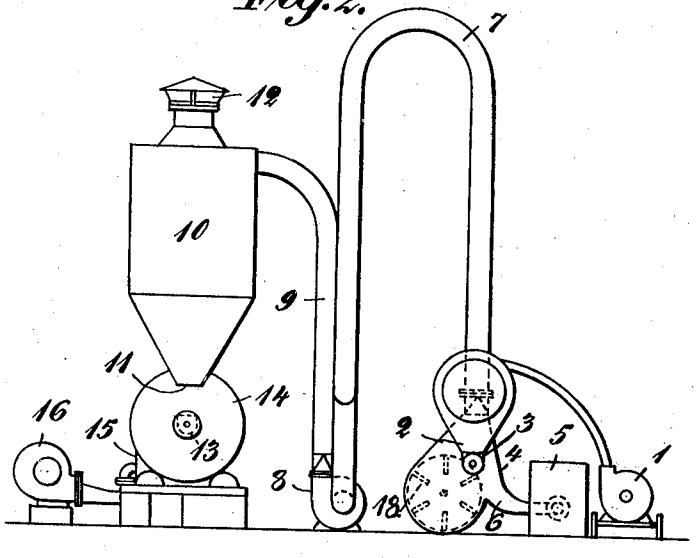



Fig. 2.




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## METHOD FOR DRYING MATERIAL SENSITIVE TO OVERHEATING

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1 Claim. (Cl. 34—24)

The present invention relates to a method of and means for drying material in a state of loose aggregation which is sensitive to overheating, particularly such material which in a very moist condition tends to be closely matted or packed together but is of a more porous or solid state when possessing a lower content of water. Such materials include for example most vegetable products, such as grass, clover, lucerne and vines of root crop and other vegetables, but also certain animal products useful as foodstuff or fodder.

Earlier methods of drying such products may be divided substantially in two groups, namely pneumatic drying and layer-drying, hot gases or air being in both cases used as drying medium. According to the first method the material is supported and transported by the drying medium, in a comparatively rapid current until the material has reached the required dryness, whereupon it is separated from the gases. According to the second method the material is fed into a suitable drying apparatus, being formed into a comparatively thick layer with which the drying medium is brought into contact. Many methods are adapted to work on this principle and of them have proved most efficient those in which the drying medium is led transversely through the charge or layer of material substantially from below upwards. Particularly good results have been obtained if the material has imparted to it simultaneously a mixing motion, as is the case for example in a rotating drying drum.

In the practical application of these drying methods certain rules for carrying out the drying have, of course, been established with a view to obtaining the best results.

Thus the pneumatic drying must work with comparatively high velocities of the drying medium in order that the material may be transported and, if necessary, supported by the dynamic pressure of the gases. Since the dimensions of the drying apparatus must be kept within reasonable limits, the period of treatment will consequently become very short. Consequently, the pneumatic drying is best suited for such materials, that readily give off their water content, this being the case with materials of high water content and highly disintegrated material.

Due to the fact that in the pneumatic drying the drying medium also must act as a transporting medium, the quantity of drying material treated per unit time must be in a certain relation to the quantity of drying medium used per unit time. For lower water contents of the material to be dried it is therefore very difficult to obtain a satisfactory thermal economy in the pneumatic drying, since the water given off by the drying material does not justify the comparatively large quantity of drying medium. For high water contents, however, it is apparent that considerable economy can be observed in the quantity of heat supplied.

Nevertheless, the treatment even of material of high water content according to the pneumatic method is very difficult in practice, if the water content is to be reduced to a comparatively low value. Thus, the drying effect of the drying medium has so decreased in the latter part of the process, when the final step of drying is to take place, due to the absorption of water in earlier stages of the process, that particularly sensitive or selective devices and a careful manual operation of the process are required in order that the desired degree of dryness may approximately be reached. When treating nonhomogeneous material it is further necessary to combine with the process a disintegrating operation involving extra costs, if an even drying is to be achieved.

When treating materials with high water content and when it is not required to carry the drying so far that the material approaches the hygroscopic state, the drying according to the pneumatic method may be carried out with very good thermal economy due to the high temperature of the drying medium and because the danger of overheating is small due to the short period of treatment.

In the layer-drying there is more liberty of selecting the temperature and the velocity of the drying medium as the latter has no transporting effect upon the material to be dried. In particular those methods according to this principle in which the drying medium is led in a current transversely through the material to be dried are characterized by the readiness with which the humidity, temperature and velocity of the drying medium may be adjusted in conformity with the state of the material to be dried. At the same time a good thermal economy may be obtained even when the material to be dried has a low water content, since the thickness of the layer of material may be so selected that the path of the drying medium through the material to be dried always will be sufficiently long to utilize the drying effect of the drying medium.

Methods working in the last mentioned manner have thus proved to be superior to all others with regard both to thermal economy and to the

possibility of superintending the process so that an even product of desired degree of dryness is obtained. This is particularly the case if a stirring motion is simultaneously given to the material. This will insure that all parts of the layer of material will be equally treated.

These latter methods have, however, the disadvantage that, if the material readily tends to be matted or packed together as is the case with most materials of high water content, a difficulty arises in forcing the drying medium through the layer of material. This difficulty is accentuated at high temperatures of the material, as the density of the gases then is so low that a given volume does not displace sufficient water from the material.

The present invention aims at developing a method of drying material of the aforementioned kind such that the material to be dried at all stages of the process will be treated effectively, the highest possible thermal economy being observed, the process being at the same time easily superintended and its course easily controlled.

The drying invention according to the present method is characterized therein that the whole drying process is carried out by direct contact between the material and hot gases in two separate steps in such a way that the material in the first step is introduced into and transported away by a hot current of gas, whereupon, after a substantial separation of the material from said current of gas, the material is subjected to final drying in a second step by leading hot gases of a lower temperature than the first gas current transversely through a layer of the spread out material.

Thus the drying method according to the invention is a combination of pneumatic drying and layer-drying according to the transverse current principle, so that the advantages of the two methods each known per se may be fully utilized without the combination suffering from any of the disadvantages of the separate methods. Thus the material may be treated by gases of very high temperature in its most humid state without difficulties and risks and in this way may in a short time be deprived of the main part of its water content while ensuring the highest possible thermal economy. The short period of treatment and the fact that it is not necessary to complete the drying, free water is still left in the material, have the consequence that the danger for overheating the material will be small in spite of the high temperature of the gases. Furthermore by using combustion gases of high temperature and an accordingly small supply of air, the danger of oxidizing those substances in the material sensitive to oxidation will be considerably lessened.

Further, the material may be subjected to final drying to any desired degree of dryness with the greatest possible economy of heat while the drying process is adapted to be fully controlled as the inlet temperature of the drying medium at any moment in the latter part of the process may be adjusted to suit the state of the material, and the quantity of the drying medium may be so adjusted as to utilize it with the greatest efficiency. Finally even materials which only slowly give off the last part of their water content may be readily treated without the necessity of subjecting the material to disintegration.

To obtain a uniform product it is of course of the highest importance that the material should be given a stirring motion during the final treatment in the second step. This is effected in a simple manner by carrying out the treatment in a rotating drum, in which according to the invention the hot gases are led transversely through the charge.

The invention further relates to a plant for carrying out the method according to the invention, and this plant consists substantially of a combination of two drying devices, namely a drying device provided with a feeding device of the known type for loose, moist material, in which the material is introduced into and transported by a hot gas current, and a drying device of a known kind consisting of a rotating drum, in which hot gases are led transversely through material fed from the first drying device and spread out in a layer, and in addition a device, for example a cyclone separator or the like, for separating the material coming from the first drying device from the accompanying gas current being arranged between the first drying device and a feeding device for the second drying device.

Such a plant for carrying out the mehod is illustrated diagrammatically on the accompanying drawing.

Figs. 1 and 2 show two elevations of the plant taken at right angles to each other.

By means of the fan 1 the material to be dried is brought into the hopper 2 from where it is introduced into the container 4 by means of a transport screw arranged in the channel 3. Hot gases from the furnace 5 enter the said container through the pipe 6.

The gases transport the material to be dried from the container 4 and are driven through the drying channel 7 by the fan 8 and then through the pipe 9 into the cyclone separator 10, in which the material and the gases are separated so that the material is discharged through the opening 11 and the gases leave at 12. The fan 8 may be arranged either ahead of the cyclone separator, as shown, or after the same. In this drying device the first stage of the drying is carried out.

From the opening 11 the drying material drops onto the transport screw 13 which feeds it into the transverse current drying apparatus 14 in which the second stage of the drying takes place. This drying apparatus consists of a rotating drying drum in which the material to be dried being spread out in a layer, is automatically fed longitudinally towards the discharge end of the drum. The drying drum is provided with openings in its circumference, hot gases of a lower temperature than the gas current used in the first stage, for instance cooled combustion gases from the furnace 5, being introduced through the connecting box 15 to said drum by the fan 16. From the connecting box 15 the combustion gases flow into the drying drum through holes in its circumference covered by the material with which the drum has been charged, the gas current flowing transversely through the material which due to the rotation is subjected to a mixing motion.

Those parts of the material to be dried, which at their admission into the container 4 due to their weight cannot immediately be supported and transported by the gas current but fall downwards towards the lower part of the container 4, are caught by wings 18 of a rotor 19 (indicated by dashed lines in Fig. 1) carried on the shaft 20. On the rotation of the rotor the wings catch the falling material and throw it back upwards into the gas current. This is repeated until the different parts of the material have lost so much

in weight due to drying that they are carried away by the gas current. The finally dried material is discharged at the outlet 17.

In both of the drying devices the material to be dried is supplied by a transport screw arranged in a feed channel 3 or 13 respectively. The screw and the feed channel are so dimensioned that the material being fed in forms a plug between the walls of the channel in order to prevent as far as possible the entrance of air through the feed channel.

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

A method of drying piece formed material sensitive to overheating, comprising subjecting said material to two separate heating steps, subjecting the material during the first step to hot gases of combustion for a time sufficient only to partially dry said material, utilizing said hot gases for transporting said material to the second heating step, separating the gases used in the first heating step from the partially dried material, and subjecting said partially dried material to further heating by leading hot gases of a considerably lower temperature than the gases of the first heating step transversely through the material for a period of time sufficient to complete the drying of the material.

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