

[54] **APPARATUS FOR SEPARATING MOISTURE FROM SOLIDS**

3,347,453 10/1967 Goergen 233/11

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[56] References Cited

UNITED STATES PATENTS

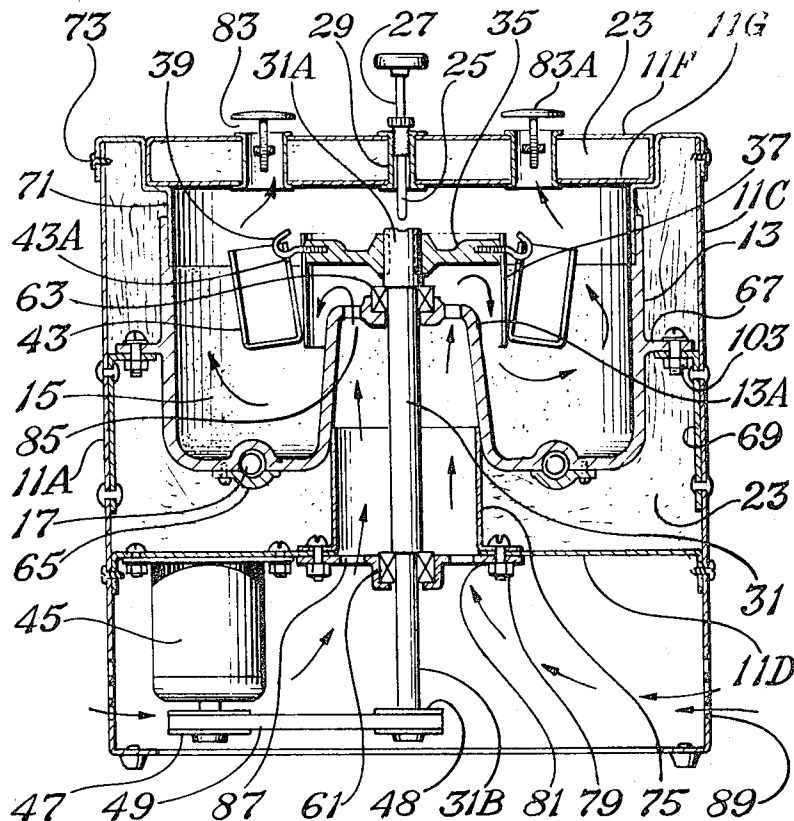
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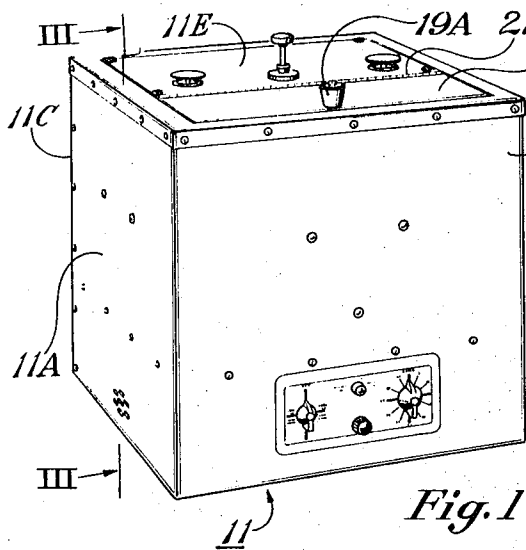
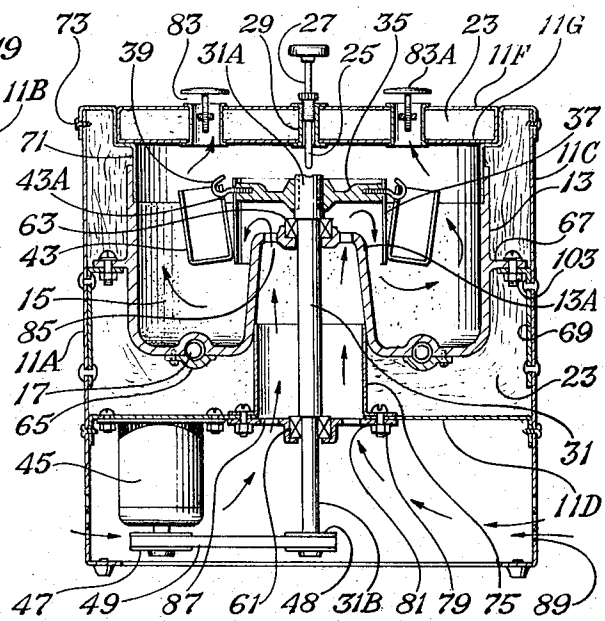
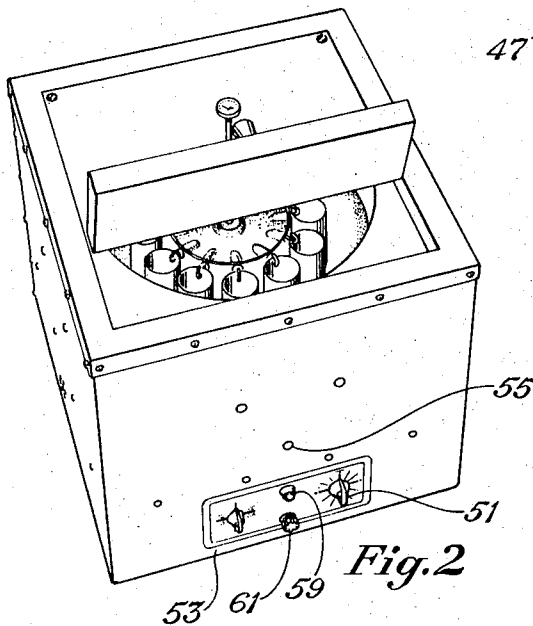
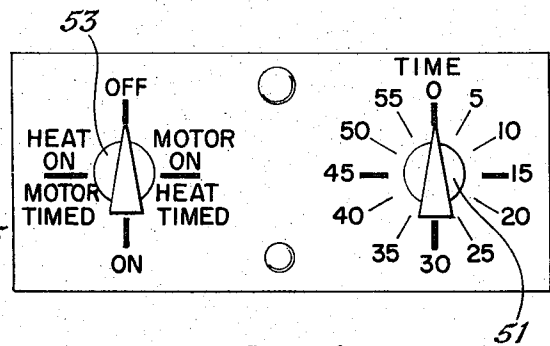
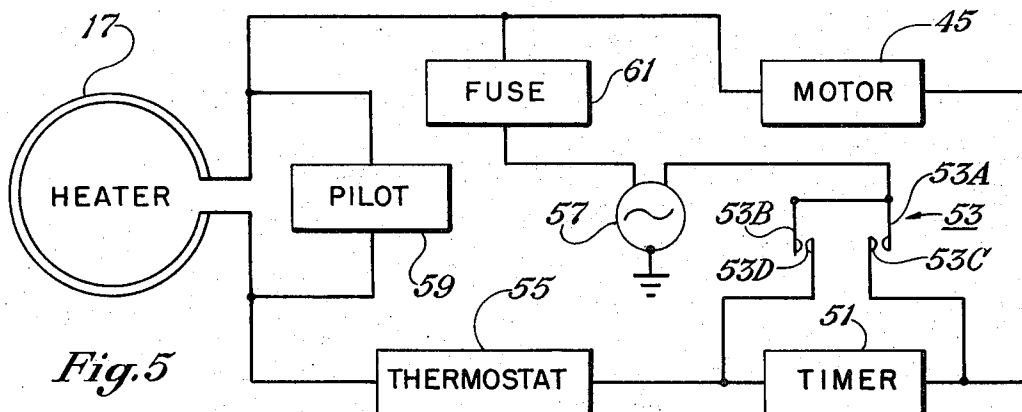
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ABSTRACT

The specification discloses a method of testing and an apparatus for use in determining the moisture content or nonvolatile residue of material by spinning the material in a heated zone or chamber. During this operation, the material is held in cup-like containers which are spun in the heated chamber. The nonvolatile material is retained in the sample cups by the centrifugal force, thus avoiding loss due to spattering.

3 Claims, 5 Drawing Figures





APPARATUS FOR SEPARATING MOISTURE FROM SOLIDS

This is a division, of application Ser. No. 245,201, filed Apr. 18, 1972 now U.S. Pat. No. 3,813,928.

BACKGROUND OF THE INVENTION

This invention relates to a method of and apparatus for separating moisture from solids for conducting various tests on material of interest.

In the processing and packaging of foods such as meat products or starch products, for example sausage, or potatoes, it is generally necessary from a regulatory standpoint to know the moisture content of the foods. Heretofore, the moisture content has been determined by placing the food in a dish or container and then inserting the loaded container in a heated oven for drying purposes. In the oven, the food is heated for a certain period of time in an undisturbed condition to evaporate the moisture. By weighing the container when empty; the container with the food prior to drying; and the container with the food after drying, one can determine the original weight of the food, and its dry weight, the difference being the weight of the moisture. This difference divided by the original weight of the food and multiplied by 100 gives the percentage of moisture in the food.

In the conventional oven, the food must be heated for long periods of time to obtain adequate drying. Generally heating must be carried out for time periods which range between 3 to 18 hours. Although use of the conventional oven for drying purposes is an accepted practice, it has a large disadvantage due to the length of time required for drying.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a method of and apparatus for use in conducting moisture content tests of material and which tests may be carried out accurately in a very short period of time. The method and apparatus also may be employed to accurately and quickly test for nonvolatile residues of other types of materials or samples. In carrying out the present method, the material or sample to be tested is placed in a container having a closed end and the container with the sample located therein is weighed. The loaded container then is centrifugally spun in a heated environment to evaporate the moisture from the sample. Following this operation, the container with the remaining portion of the sample located therein is removed from the heated environment and then weighed to complete the test procedure.

By centrifugally spinning the sample in a heated environment, the rate of heat exchange is increased whereby the time required for drying is minimized. In this respect, certain samples, such as pure meat products can be satisfactorily dried in about 7 or 8 minutes. Moreover, loss of material through spattering is minimized due to the effect of the centrifugal force on the material while spun in the container.

The apparatus comprises outer wall structure forming side walls, a bottom, and a top. Interior wall structure is spaced from the outer wall structure and provides an interior chamber. A door is coupled to the top of the apparatus for providing access to the chamber. An electrical heater is located in the apparatus for heating the chamber. Insulation is provided between

the interior wall structure and the exterior wall structure for retaining the heat in the chamber and for minimizing the transfer of heat to the exterior wall structure. A shaft having one end extends through the interior wall structure and into the chamber. Means is connected to this end of the shaft for releasably holding in the chamber, in pivotal positions, a plurality of cup-shaped containers for holding the material or sample to be tested. In addition, an electrical motor is coupled to the opposite end of the shaft for imparting rotation thereto for rotating the containers in the chamber.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exterior view of the present apparatus employed for use in separating moisture from solids;

FIG. 2 illustrates part of the interior chamber of the apparatus as seen through its top door while in an open position;

FIG. 3 is a cross-section of the apparatus taken through lines 3—3 of FIG. 1;

FIG. 4 illustrates in more detail the controls of the apparatus for controlling its operation; and

FIG. 5 is an electrical wiring diagram of the components of the apparatus.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS. 1-3, the apparatus of the present invention for use in separating moisture from solids is identified at 11. It comprises outer wall structure forming four side walls (only the three visible ones 11A-11C are designated), a bottom 11D, and a top 11E. An interior bowl 13 spaced from the outer wall structure forms an interior chamber 15 which is heated by an electrical heater illustrated at 17 (see also FIG. 5). A door 19, coupled to the top of the apparatus by way of hinges 21, is employed for providing access to the chamber 15. A handle 19A is provided for opening the door 19. Heat insulating material 23, such as fiberglass, is located between the bowl 13 and the exterior wall structure to provide insulation against loss of heat from the chamber 15. As illustrated, the top 11E of the apparatus is formed of spaced upper and lower metal walls 11F and 11G between which insulation 23 also is located. The door 19 is constructed in a similar manner. A removable thermometer 25 is provided for determining the temperature in the chamber 15. As illustrated, it is coupled to a rod 27 which may be inserted into an aperture 29 extending through the top 11E.

A rotatable shaft 31 has an upper end 31A extending through the bowl 13 into the chamber 15. A wheel or hub 35 is fixedly coupled to the shaft end 31A for rotation therewith. A cylindrical shield 37 is coupled to the periphery of the hub 35 and extends downward and around the upwardly extending central portion 13A of the bowl 13. A plurality of hooks 39 are threadedly coupled to the periphery of the hub 35 at equally spaced positions. As illustrated, these hooks are coupled to the periphery of the hub 35 through the cylindrical shield 37. In one embodiment twelve hooks 39 are provided. Also provided are a plurality of cup-shaped containers 43 which are releasably and pivotally coupled to hooks 39 by way of apertures 43A. These containers are provided for holding the material to be tested.

An electrical motor 45 is coupled to the opposite end 31B of the shaft 31 for imparting rotation thereto. As illustrated, the motor is coupled to the shaft by way of

pulleys 47 and 48 and a belt illustrated at 49. Rotation of the motor 45 causes the shaft 31 and hence the hub 35 and the containers 43 to rotate in the chamber. As the rotational speed builds up, the containers 43 will swing outward to a position nearly parallel to the plane of the hub 35.

Referring to FIGS. 4 and 5, the controls for operating the apparatus comprise a variable timer 51, a rotary switch 53, and an adjustable thermostat 55. These components are coupled electrically to an AC power supply 57 by electrical conductors in the manner illustrated. A pilot light 59 is provided across the heater 17 and in addition a fuse 61 is coupled to the AC source 57 and to the conductors leading to the heater 17 and to the motor 45. The switch 53 comprises terminals 53A and 53B coupled to the AC source 57 and terminals 53C and 53D. Terminal 53C is coupled between timer 51 and motor 45 while terminal 53D is coupled between timer 51 and heater 17. Although not shown, connectors will be provided for disconnecting the electrical system from the source 57.

The timer 51 as illustrated can be adjusted for various timing conditions and in the embodiment disclosed, it can time the operations for up to 60 minutes.

By rotating the switch 53 to the "Motor On-Heat Timed" position, terminals 53A and 53C will contact each other to operate the motor 45 and the heater 17. The heater will be timed in accordance with the position to which the timer 51 is moved. When the rotary switch 53 is moved to the "On" position, both the motor and heater are operated but neither are timed by the timer 51. In the "On" position of the switch 53 terminals 53A and 53C contact each other while terminals 53B and 53D contact each other. In this position, the timer 51 is shunted out of the circuit and does not control the operations. When switch 53 is moved to the "Heat On-Motor Timed" position, terminals 53B and 53D contact each other whereby the motor will be on for the timed period determined by the setting of the switch 51. In this position the heater will not be timed. The thermostat 55 always controls the operation of the heater.

In conducting moisture content tests for example on foods, the following procedure may be carried out. The chamber 15 is preheated and the cups or containers 43 dried. This may be accomplished by coupling the cups to their hooks in the chamber and moving the switch 53 to the "On" position for a desired time period. For testing operations, the desired temperature in the chamber 15 may be attained by adjustment of the thermostat 55 and use of the thermometer 23.

After the chamber has been heated and the cups dried, the switch 53 is turned to the "Off" position and the cups may be removed from the chamber and from the apparatus. They then will be cooled and weighed empty. The material to be tested then is placed into the cup or containers and the loaded containers with the material in them are weighed, tagged, and then placed in the chamber 15 and attached to the hooks. The switch 51 then is moved to the desired timing position depending upon the material desired to be tested and the temperature to be attained in the chamber 15. In testing the moisture content of meat products, it has been found that at a chamber temperature of 155°C., and at 600 R.P.M., satisfactory drying may be obtained on a 4 to 5 gram sample in a maximum time period of about 12 minutes and as indicated previously in a lesser

time period for pure meat products. Products containing high content of starch or sugar can be satisfactorily dried, using a 4 to 5 gram sample, at about 120°C. in a maximum time of 18 minutes. The drying operations may be carried out by moving the switch 53 either to the "Motor On-Heat Timed" position or the "Heat On-Motor Timed" position. As indicated previously, drying is obtained in a minimum of time since by spinning the loaded containers 43 in the heated chamber, a very rapid rate of heat exchange is obtained. In addition the centrifugal force drives the samples into the bottom of the cups as they are spun thus preventing loss of material through spattering but allowing evaporation to take place. Stated in another manner, the centrifugal force presses the sample in a cup, to the bottom and sides of the cup, squeezing out intracellular moisture and thus freeing the moisture for rapid evaporation. The pressure of the centrifugal force spreads the material across the bottom of the cup creating maximum contact for heat transfer. Thus for certain food products the present process and apparatus produces drying results comparable to regulatory methods in no more than 18 minutes, resulting in a substantial saving of laboratory time compared with conventional techniques.

During the time that the heater 17 is on, the pilot light 59 also will be on. The timer 51 is an automatic timer and will move from the position set to the zero position at which time either the motor or heater will be turned off depending upon which is being timed during the drying operations. In the embodiment disclosed, a bell will ring when the timer reaches the zero position to notify the operator.

After drying has occurred the switch 53 is moved to the "Off" position and the containers 43 with the dried material therein are removed from the chamber 15 and allowed to cool. When cooled, the containers 43 with the dried material therein are weighed to obtain the loaded dry weight of the material. As indicated previously, the empty weight of the containers; the loaded weight prior to drying; and the loaded weight after drying are employed to determine the original weight of the material and its dry weight. The difference is the weight of the moisture. This difference divided by the original weight of the material and multiplied by 100 gives the percentage of moisture or volatile matter in the material.

In other details of the apparatus, bearings 61 and 63 are provided for supporting the shaft 31 for rotation. The heater 17 is held in place within an annular slot formed around the bottom of the bowl 13 by way of an annular member 65 bolted to the bottom of the bowl 13. The bowl 13 is held in place by way of tabs 67 bolted to L-shaped members 69 which are bolted to the side walls of the apparatus. The top of the chamber 13 has a cylindrical extension 71 fitted therein and which is coupled to the outer side walls by way of metal screws illustrated at 73. A protective cylindrical shield 75 is bolted to the bottom 11D and extends into the upward extending portion 13A of the bowl 13 for providing space for extension of the shaft 31 and a passage for air by way of the vents formed in the apparatus. The cylinder 75 is coupled to the bottom 11D by way of bolts 79. These bolts also hold the annular member 81 which supports the bearings 61.

As illustrated, the chamber 15 is vented by way of vents 83 formed in the top 11E, apertures 85 formed in the upward extending portion 13A of the bowl 13

and apertures 87 formed in the annular member 81 and in addition by way of apertures 89 formed in the lower extending portions of the side walls 11A and 11B. Air flows through the chamber in the direction indicated by the arrows. Control knobs 83A are employed to adjust the top vents 83.

In one embodiment, the electric motor 45 attains a speed of 600 RPM. The heater 17 is rated at 115 volts, 10 amps, and 1,100 watts. For most food products, the heater will be adjusted to obtain chamber temperatures from 115°C. to 190°C. The insulation 23 is of fiberglass and the bowl 13 as well as the cups 43 are constructed of aluminum. The cups 43 have a diameter of 1½ inch and a height of 2 inches. The radius from the shaft axis 31 to the bottom of the cups when swung out is about 6 or 7 inches. The structure forming the outer walls of the apparatus is formed of stainless steel. The exterior dimensions of the apparatus are 17 inches by 17 inches by 16 inches and its weight is 60 pounds. It may conduct 12 tests at a time although more tests may be conducted by providing more cups 43.

In the previous discussion, the present method and apparatus was described as being employed primarily to determine the moisture content of material such as foods. It is to be understood, however that the process and apparatus may be used in other tests, for example in determining the nonvolatile residue of liquids obtained from production wells in oil field operations. In this respect, production liquids may be tested to determine subsurface formations from which salt water is flowing into the well by way of casing leaks. In conducting these tests, the water sample is inserted into the containers and centrifugally spun in the heated chamber to evaporate the water to obtain only the nonvolatile residue which is the dissolved solids or salts in the production liquid. At 100°C., a 25 ml. sample of an oil field brine can be dried in about one hour; at 200°C. it can be dried in about 25 minutes. The drying time employing the present invention is a fraction of that required using conventional methods. In conducting these tests using the present invention, a container is weighed when empty; when loaded with a sample prior to drying; and after drying with the remaining residue therein to determine the original weight of the sample and the weight of the remaining residue after drying. By dividing the weight of the remaining residue by the original weight of the sample tested, one can determine the percent of dissolved solids or residue in the original sample. These results can be compared with previously determined results obtained in the various formations while drilling operations were carried out to determine or locate the formation from which the unwanted fluids are flowing into the well.

I claim:

1. An apparatus for use in separating moisture from solids forming a material to be tested comprising: outer wall structure forming side walls, a bottom, and a top,

interior wall structure spaced from said outer wall structure and providing an interior chamber, a door coupled to the top of said apparatus for providing access to said chamber,

said interior chamber having an inverted bowl shaped central portion extending upwardly from the bottom of said interior chamber to a position below the level of the top of said apparatus forming an annular chamber portion at the lower end of said interior chamber,

a heater located in said apparatus at the bottom of said annular chamber portion for heating said interior chamber,

insulation located between said interior wall structure and said exterior wall structure,

a shaft having one end extending upwardly through the top of said central portion and into said interior chamber,

rotatable means connected to the top of said shaft for rotation therewith,

said rotatable means comprising a top wall connected to the top of said shaft at a position spaced above the top of said central portion and having side walls extending downward therefrom to a level below the level of the top of said central portion and which surround the top portion of said central portion and are spaced radially outward therefrom,

means for pivotally coupling to said rotatable means on the outside of its side walls, a plurality of cup-shaped containers for holding the material to be tested,

said cup-shaped containers being adapted to have their bottom ends moved by centrifugal force in a direction away from said shaft upon rotation of said shaft and said rotatable means,

drive means coupled to the opposite end of said shaft for imparting rotation thereto for rotating said rotatable means and said containers in said chamber, and

air inlet means formed through the top of said central portion and air outlet means formed through the top of said apparatus to allow air flow into said interior chamber by way of said air inlet means and out of said interior chamber by way of said air outlet means,

said top and side walls of said rotatable means acting to direct the air entering through said air inlet means to flow downward over said heater for the passage of heated air upward and around said cup-shaped containers and out of said interior chamber through said air outlet means.

2. The apparatus of claim 1 wherein:

said air inlet means is located closer to the axis of said shaft than said air outlet means.

3. The apparatus of claim 2 wherein: said heater comprises an electric heater, said drive means comprises an electric motor.

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