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[54] **METHOD FOR DRYING MOISTURE FROM WET SPENT COFFEE GROUNDS**

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[51] **Int. Cl.** **F26b 7/04**

[58] **Field of Search** 432/13, 106, 118; 34/109, 34/31, 33, 17, 20

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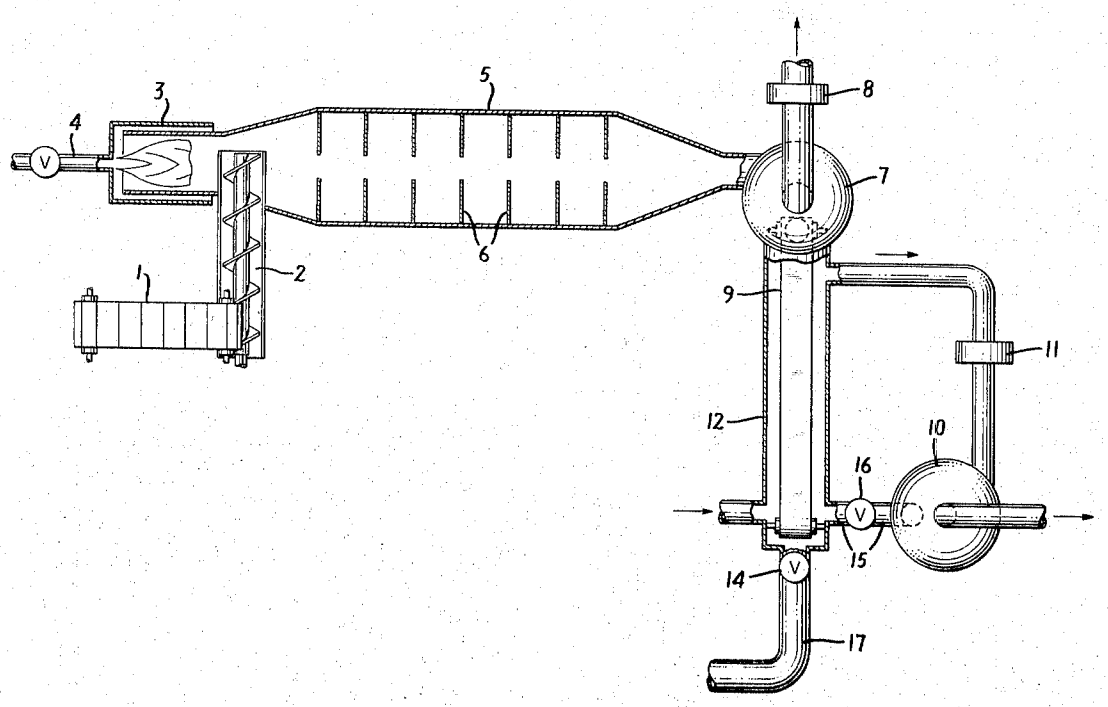
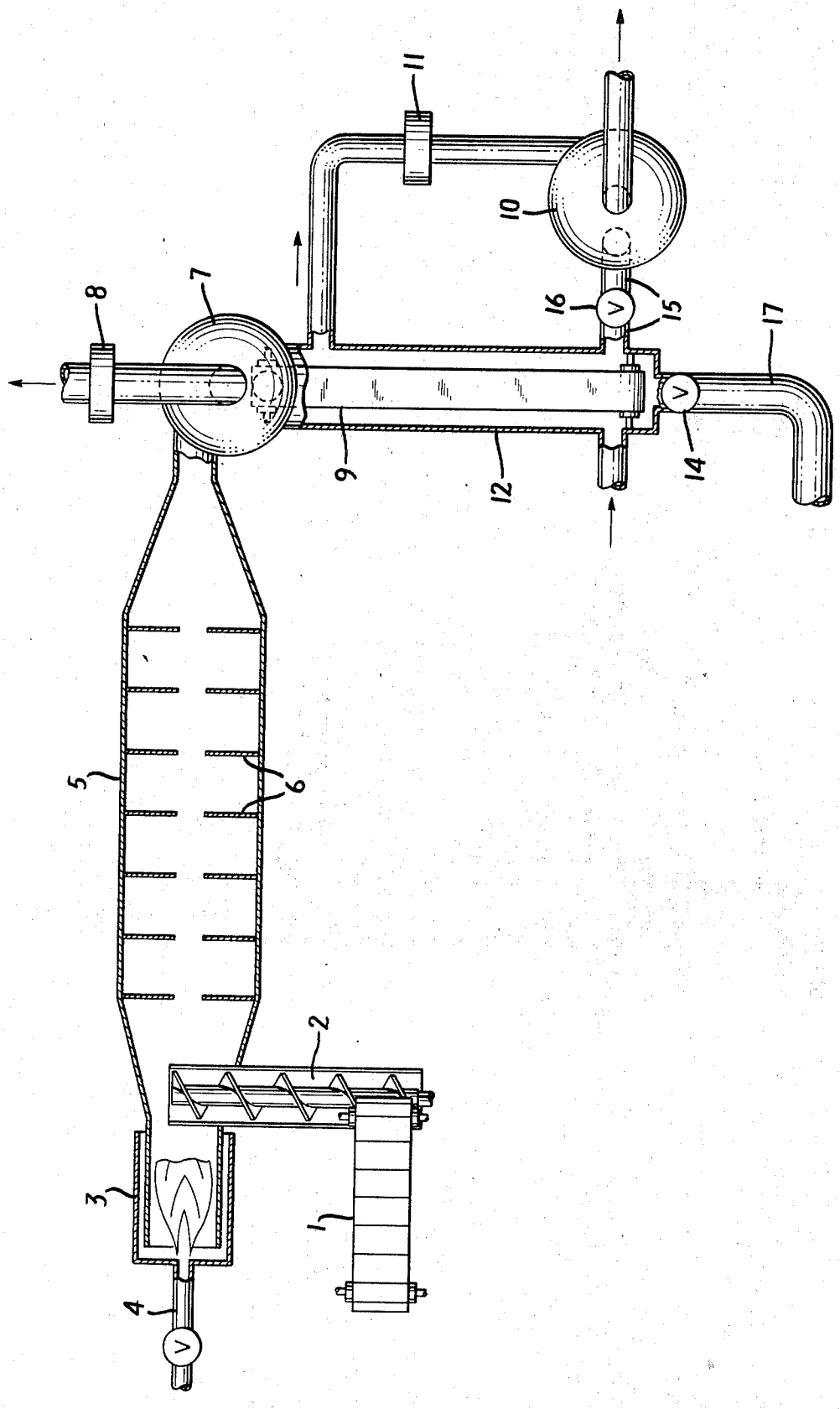
[57] **ABSTRACT**

A method for drying wet spent coffee grounds to remove moisture therefrom is disclosed. The wet spent coffee grounds are entrained in a hot gas stream passing through a rotary drum drier to remove moisture therefrom and transport them through the drum. Grounds from which moisture has been removed to a desired level pass out of the drum drier with the hot gas stream while grounds containing moisture in excess of the desired level and falling from the stream during transport through the drum are collected in a compartment therein and conveyed in an unobstructed circular travel course about the hot gas stream for gravity return of such collected grounds to the stream for further moisture removal, the grounds being collected and returned to the stream as often as required to reduce the moisture therein to the desired level. Coffee grounds passing out of the drum with the moisture-laden gas stream are separated from the gas stream and cooled.

5 Claims, 1 Drawing Figure

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METHOD FOR DRYING MOISTURE FROM WET SPENT COFFEE GROUNDS

BACKGROUND OF THE INVENTION

It is known to dry certain agricultural products including the residue from product processing operations for the purpose of removing moisture, principally water therefrom. The reasons why moisture is removed from such agricultural products are many and include, inter alia, facilitating storage and/or disposal of the spent product as well as further processing of the spent product for useful purpose. Where the spent product is in particulate or granular form it is common to remove moisture by introducing the product into a highly heated gas stream flowing through a rotating drum, so that during the course of the passage through the drum the product being exposed to the highly heated gas stream has a substantial quantity of moisture removed therefrom. Representative of apparatus and method for the purposes aforesaid are U.S. Pat. Nos. 1,299,791; 2,236,006; 2,341,101 and 2,822,153. While such apparatus and processes as described in the noted patents are satisfactory for drying certain types of materials, they do not provide optimum methods for effecting the drying of certain types of materials wherein it is sought to control the final moisture content within relatively precise limits and yet operate the equipment in an efficient manner involving economical operation with attendant high throughput rates. One reason such methods as are known in the art are not satisfactory for drying certain types of material, as for example, spent coffee grounds, is the fact that the rotary drum wherein the moisture removal occurs is usually provided with longitudinally directed members at the drum inner wall which stir up or tumble the material to sustain it in the hot gas stream. Thus where the material being dried has varying particulate size as is the case generally with spent coffee grounds, the lighter or less dense grounds containing less moisture either are properly dried or overdried during passage through the drum while at the same time the larger denser grounds containing a greater quantity of moisture do not receive sufficient drying before they too are carried out of the drum by the hot gas stream. When dealing with spent coffee grounds, grounds which are dried to an excessive degree undesirably are explosive in character while on the other hand, insufficiently dried grounds are susceptible to mould formation when stored. It is desirable therefore, when drying wet spent coffee grounds, the coffee grounds be dried in a manner which permits properly dried grounds to immediately exit the drying space whereas the heavier, more moisture-laden grounds are collected as required within the drying space to insure a residence time therein which will provide sufficient exposure of the heavier grounds to drying thereof to the optimum intended moisture content level.

SUMMARY OF THE PRESENT INVENTION

The present invention is concerned with a method for drying wet spent coffee grounds to remove moisture therefrom so as to provide a final dried product having a moisture content within certain prescribed limits. As is well-known by those skilled in the art, in the manufacture of dry coffee extract, green coffee beans are roasted and ground, and the roasted grounds are then contacted with hot water so that soluble coffee material

is extracted from the grounds. The coffee extract is then dried, for example by spray drying, to produce instant coffee. This method of removing coffee extract from the grounds and subsequent drying of the extract may be carried out by any one of various known manners. Following recovery of the available coffee extract from the roasted grounds, the spent grounds are of little further use to the coffee manufacturer. Since the spent grounds have a high moisture content, i.e., in the region of about 65 percent up to about 85 percent by weight, further utilization of the grounds requires that as a first consideration, a major portion of this moisture be removed from spent grounds. But in the case of spent coffee grounds, economy and safety considerations require that the drying be effected under certain controlled conditions and that the dried product having a final moisture content of about 5 percent to about 15 percent by weight of water.

In accordance with the present invention, a fuel is combusted in a suitable combustion chamber and the products of combustion are drawn therefrom as a constricted hot gas stream passing longitudinally through and outwardly of an enclosed space. Most conveniently the latter can be provided in the form of an elongated rotary drum structure which has a series of longitudinally spaced, transversely directed baffle plates disposed therein, with each plate having a central opening, the openings of the respective plates being in alignment to define the gas stream flow course. The wet spent coffee grounds to be dried are entrained in the hot gas stream at the entry of the latter to the drum to expel moisture from the grounds for reducing the moisture content from an initial higher to a desired lower level, and also to transport the grounds through the central openings in the transverse plates and outwardly of the drum at the opposite end when said grounds have been dried to the desired level. Since wet spent coffee grounds usually are of nonuniform particle size, less dense grounds and which accordingly will contain less moisture, will be dried to the desired level and pass completely through the drum and outwardly therefrom without falling from the gas stream. On the other hand, more dense grounds of larger size and containing a greater quantity of moisture, may not be carried fully through the rotating drum by the gas stream without falling from the stream to the bottom of the drum. Such grounds as fall from the stream are collected within compartments in the drum defined by each transverse plate and an adjacent plate, the particular compartment into which the grounds fall being determined by the amount of moisture still in the grounds since for a given gas stream flow rate and velocity such stream will carry a given weight of moisture containing grounds only a certain predetermined distance through the drum. The grounds collected in each compartment are conveyed in an unobstructed circular travel course about the hot gas stream from the point at which they are collected, that is, the point below the stream at which they dropped therefrom, to a location above the stream whereby gravity returns the collected grounds to the stream for further removing of moisture from the same. The conveying of the collected grounds in the circular travel course about the hot gas stream is effected while inhibiting movement of the collected grounds in the direction of the stream exit from the drum thereby to enlarge the residence time of such collected grounds in the drum and lessen the likelihood of

premature discharge of them from the drum. It will be understood that inhibiting the movement of the grounds is intended to means restricting or reducing movement of the grounds within the drum due to the action of the hot gas stream. The collection of the heavier more moist grounds in a particular compartment or succeeding compartment is repeated as often as the same falls from the stream so as to return the excess moisture containing grounds to the stream for further drying until the moisture content is reduced to the desired lower level, at which time these grounds are carried through the drum by the hot gas stream. Following the exit of the moisture-laden hot gas stream and dried grounds therein from the drum, the moisture-laden products of combustion are separated from the grounds. If desired, the recovered grounds may then be transported through a cooling tunnel wherein they are contacted with a cooling stream of ambient air to bring their temperature down to a desired level, as for example, a temperature of 20° C. or below or the grounds may be subjected to such other processing as is required for the ultimate end use of the dried grounds.

In accordance with the invention, the processing of the spent coffee grounds can be carried out by entraining them in the heated gas stream at a location in the latter where the temperature is in a range of about 500° C. to about 600° C. If the gas stream temperature is above 600° C. there is a danger that the oil constituents of the coffee grounds could volatilize and produce an explosive mixture in the drum. If the gas stream temperature is below 500° C. insufficient drying is effected and the dried grounds will contain an excessive amount of moisture.

The invention, accordingly, comprises the several steps and the relation of one or more of such steps with respect to each of the others, all as exemplified in the following detailed disclosure and the scope of the invention will be indicated in the claims.

BRIEF DESCRIPTION OF THE DRAWING

The invention and a fuller understanding of its nature and objects will appear more clearly from the following detailed description taken in conjunction with the accompanying drawing which is a diagrammatic illustration of apparatus with which wet spent coffee grounds can be dried.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the drawing, there is depicted a slatted conveyor feeder 1 for supplying spent wet coffee grounds obtained from a suitable source thereof to a screw conveyor 2. Such grounds generally will have a moisture content in a range of about 65 to 85 percent and optionally may have been dewatered to a certain extent in a press unit in known manner. The screw conveyor 2 feeds the grounds into the top of flash drier unit 3 so that as the wet grounds fall into the flash drier 3, they encounter a propane flame or the flame of any other suitable fuel fed through supply-line 4 and combusted in the combustion chamber of the flash drier.

The flash drier 3 opens into and is in communicative connection with one end of a rotary drum drier 5 which in turn is provided with a plurality of longitudinally spaced transverse plates or baffles 6 each of which has a central opening, the respective baffle openings being aligned to define a constricted flowthrough course in the drum through which can be drawn the products of combustion of flame 3 as a high speed hot gas stream. To the other end of the drum drier 5 there is connected a cyclone separator unit 7 of known construction which functions as will appear from further description herein to separate the moisture-laden products of combustion from dried coffee grounds outflowing therewith from the drum. The separator 7 as is conventional is provided with a suction pump 8 for drawing gas from the driers 3 and 5 and the separator 7 and creating the high-speed gas stream through the drum.

A conveyor 9 which optionally can be enclosed in a tunnel 12 leads from the cyclone separator 7 via a rotary valve 14 to connection with feed pipe 17. A second cyclone separator 10 can be provided with a pump 11 for drawing air through the tunnel 12 to cool the separated grounds with ambient air to a desired temperature, e.g., 20° C. Other means for contacting the separated material with a cooling air flow also could be employed. A feed pipe 15 leads from separator 10 through a rotary valve 16 into tunnel 12.

In operation, spent wet coffee grounds are fed, at a controlled rate, by the slatted feeder 1 into screw conveyor 2 which feeds the coffee grounds into the products of combustion gas stream issuing from the flash drier 3. The wet grounds, on meeting the stream of hot gases are heated very rapidly and much of the water in the grounds is transferred to the hot gases. The grounds become totally dispersed and entrained in the high-speed gas flow and are thus conveyed or transported by the gas stream from the flash drier 3 into and through the rotary drum drier 5. The drum drier 5 which as mentioned above is provided with baffles 6, serves further to dry the spent coffee grounds from an initial higher to a desired lower level. Those of the grounds which have lost sufficient water at introduction to the gas stream and at the upstream end of the drier as to be at approximately the desired moisture content, are less dense than those of the particles which have a higher moisture content and will in the main be transported through the drum and outwardly therefrom without falling from the gas stream. On the other hand, as the grounds are conveyed along in the gas stream in the rotary drum drier 5, the denser of the grounds, i.e., those having a higher moisture content than desired, will drop lower in the gas stream and finally fall therefrom into one of the collection compartments defined by adjacent ones of the baffles 6. In this way the dense grounds as they remove from the gas stream are collected, but as the drum slowly rotates these dense particles are carried in an unobstructed circular travel course about the gas stream from point of collection towards the top of the drum while inhibiting collected material displacement in the direction of the discharge end of the drum and will then fall by gravity through the hot gas stream losing more of their moisture. If these grounds still have not lost sufficient moisture, then they will still be too dense to be carried out of the drum drier by the gas stream, and will remain in the collection compartment or if transported by the stream a further distance, will fall into a downstream collection compartment. Thus, the process of being carried to the top of the drum and falling through the gas stream and losing more moisture will be repeated until the grounds are sufficiently dry. The rotary drum drier 5 is provided in a predetermined length such that all of

the grounds will have a desired low moisture content on having passed through the drier **5**.

On passing out of the drum **5**, the grounds enter cyclone separator **7** where they are separated from the hot gas stream which now contains the moisture removed from the grounds. This moist gas stream is removed from the top of the separator by the pump **8** and is exhausted to atmosphere. The coffee grounds removed from the bottom of the separator **7** are deposited on a conveyor **9** where they then can be cooled by contact with a counter flow airstream of ambient air to a temperature of 20° C. or below. This cooling in one advantageous manner can be effected by enclosing the conveyor **9** in tunnel **12** and drawing cold air through this tunnel by means of pump **11**. In this cooling step some further quantity of moisture, e.g. up to 5 percent is removed from the grounds, such additional moisture removal being considered in respect of the final desired moisture content to be achieved. Thus the moisture removal effected in the drum will be to a desired lower level of up to 5 percent higher than that sought in the fully processed product. Air that has passed through pump **11**, together with any entrained grounds, passes into the second cyclone separator **10** where the cooling air is removed from the top of the separator and is exhausted to atmosphere. The dried spent coffee grounds which were in the air are extracted from the bottom of the separator through the pipe **15** and valve **16**, where they join the grounds conveyor **9**. The grounds pass through rotary valve **14** and pipe **17**, and may be loaded in bags or in bulk or further processed for use as desired.

After the dried grounds have been cooled, various additives may be added. For example, butylated hydroxytoluent (BHT) may be added to the grounds as a fat or oil stabilizer.

In the above-described embodiment of the invention a slatted feeder and screw conveyor are used to feed wet coffee grounds into the flash drier. However, any means may be used for feeding the grounds into the drier provided that it gives the requisite evenness of flow.

In operating the apparatus, it has been found that the best results are obtained when the temperature of the gas stream at the point where the wet coffee grounds are introduced thereto is in the range of about 500° C. to about 600° C. If the temperature is raised above 600° C., the process becomes dangerous since the oil in the coffee grounds is like to volatize so producing an explosive gaseous mixture in the drum drier. Below about 500° C. insufficient drying of the coffee grounds takes place and the process becomes less economic.

The temperature of the gas stream in the flash drier may be controlled in known manner, e.g., by altering the quantity of fuel fed into the combustion chamber. Preferably, the temperature of the gas stream as it leaves the rotary drum drier **5** is from 78°–80° C. when drying spent wet coffee grounds to a final moisture content of about 5 percent to about 15 percent. This temperature when selected is kept constant by varying heat input or wet grounds input rates. A further control of the rate of feeding the wet grounds into the flash drier **3** may be provided by using a flail type level controller to control the level of the wet coffee grounds on the slatted feeder **1**.

After the dried spent coffee grounds have been removed from the cyclone separator **10**, they have approximately the following dry composition:

ether extract (oil)	27%
crude protein	11%
crude fibre	40%
ash	1%
nitrogen-free extract	21%

As indicated above, the dried coffee grounds desirably should have following cooling of the same, a moisture content of about 10 percent although the content can vary from 5 percent to about 15 percent. Below 5% moisture content, the grounds are likely to be very explosive in view of their high oil content, and above 15 percent moisture content, mold is likely to grow in the grounds.

The dried spent coffee grounds have numerous applications, and may be used, for example as fertilizers, soil conditioners, fuel, a constituent of animal feeding stuffs, spacings in abrasives, and a source of oil.

For use as a fuel, the dried grounds are preferably formed into nuts, usually with the addition of a binder such as molasses.

A particularly important use for the dried grounds is as a constituent of animal feeding stuffs. In such use the feeding stuff desirably includes from about 5 to 10 percent by weight of the dried grounds. The dried grounds are rich in oil and have a strach equivalent of about **75** which is somewhat higher than barley which has a starch equivalent of **71**.

From the foregoing description it will be seen that the present invention provides a method for drying wet spent coffee grounds efficiently with the capacity for high throughput processing rates particularly since it involves sustaining the residence time of the grounds in the rotary drum to the extent required to insure complete drying to the intended moisture level.

In respect of drying coffee grounds, a substantial quantity of water is removed therefrom on first contact with the hot gas stream to the extent that such initial impact of moisture removal can result in evaporation of moisture down to a level of about 30 percent, with the remaining moisture being removed during transport of the coffee grounds through the drum and subsequent cooling.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are efficiently attained. Since various changes in carrying out the process of the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A method for drying moisture from wet spent coffee grounds and the like to reduce same from an initial higher to a desired lower level which comprises

combusting a fuel and drawing the products of combustion therefrom as a constricted hot gas stream passing longitudinally unobstructedly centrally through and outwardly of an enclosed space,

entraining said wet spent coffee grounds in said hot gas stream at the entry of the latter to said space to expel moisture from said coffee grounds for reducing the moisture content from said initial higher to

said desired lower level and to transport said coffee grounds through said space,

collecting any coffee grounds containing moisture in excess of said desired lower level which fall from said stream within said enclosed space during transport therethrough and conveying such collected coffee grounds in an unobstructed circular travel course about said stream from the point of collection to a location above said stream while inhibiting axial displacement of said collected coffee grounds within said space by the action of said hot gas stream in the direction of the stream exit from said space during such circular travel course whereby gravity returns said collected coffee grounds to said stream at substantially the same location at which they were collected for further removing moisture from said collected material,

further collecting as required any of said coffee grounds still containing moisture in excess of said desired lower level which fall from said stream and conveying same in said circular travel course for gravity return to said stream for further removing moisture therefrom until the moisture content thereof is reduced to said desired lower level,

separating moisture-laden products of combustion from the coffee grounds outflowing therewith from said enclosed space, cooling and drying the coffee grounds by conveying said grounds through a closed chamber and passing a counter flow stream of ambiant air through said chamber to reduce the temperature of the coffee grounds to at least 20° C or below whereby an additional 5 percent reduction in moisture is effected, thereafter subjecting said stream of ambiant air to a separation operation to recover any coffee grounds which become entained in said ambiant air stream during said cooling and drying operation, and delivering any recovered grounds to cooled grounds at the extraction end of said closed chamber.

2. The method of claim **1** wherein the coffee grounds have an initial moisture content of between about 65 percent to about 85 percent by weight in the material and are subjected to contact with said hot gas stream and said stream of ambient air for a time sufficient to reduce the moisture content thereof to about 5 percent to about 15 percent by weight in the material.

3. The method of claim **2** wherein the coffee grounds are subjected to contact with said hot gas stream and said stream of ambient air for a time sufficient to reduce the moisture content thereof to about 10 percent.

4. The process of claim **1** wherein the temperature of the gas stream at the location of entrainment of said coffee grounds therein is about 500° C. to about 600° C.

5. The method according to claim **1** comprising controlling the temperature of the moisture-laden gas stream outflowing from said enclosed space to maintain it at substantially 78° C. to 80° C.

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