United States Patent [19]

Colclough

[11] **3,853,713**

[45] **Dec. 10, 1974**

[54] **METHOD AND APPARATUS FOR PROCESSING GRANULAR AND OTHER MATERIALS**

[75] Inventor: **Graham Richard Colclough,** Balwyn, Australia

[73] Assignee: **Phildon Engineering Co. Pty. Ltd.,** Fitzroy, Victoria, Australia

[22] Filed: **Oct. 2, 1972**

[21] Appl. No.: **293,798**

[30] **Foreign Application Priority Data**

Oct. 5, 1971 Australia 6571/71

[52] **U.S. Cl.** **195/131,** 195/71, 34/130

[51] **Int. Cl.** **C12c 1/14,** C12b 1/00

[58] **Field of Search** 195/128–131, 195/69–71; 34/130, 134, 138

[56] **References Cited**

UNITED STATES PATENTS

2,202,536 5/1940 Peterman 195/131

FOREIGN PATENTS OR APPLICATIONS

648,711 1/1951 Great Britain 195/131

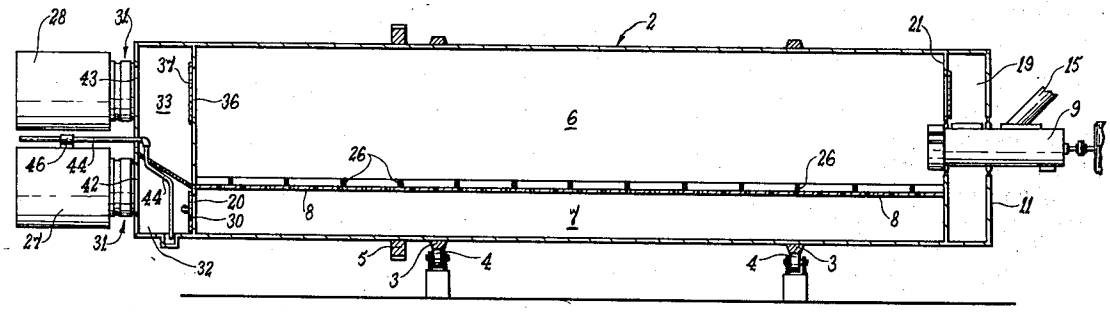
Primary Examiner—Lionel M. Shapiro

Attorney, Agent, or Firm—Lawrence I. Lerner

[57] **ABSTRACT**

A method of malting including the use of apparatus comprising a cylindrical drum mounted with its axis substantially horizontal and being rotatable about that axis, and which is divided longitudinally by a perforated floor member into a grain compartment and a fluid compartment. The process involves steeping, germination and drying of the grain, and each of those stages is performed with the grain contained within the drum. In the steeping stage the drum is rotated so that liquid can mix with grain in the grain compartment, and when the drum is held stationary with grain supported on the perforated floor, excess liquid drains into the fluid compartment. In the germinating and drying stages, the drum is held stationary at least part of the time with the grain supported on the perforated floor member, and a stream of air is caused to flow upwardly through the floor member and the bed of grain. Air entering the space above the bed of grain in both the germinating and drying stages is extracted from the drum, and in the germination stage at least some of that extracted air may be recirculated to the fluid compartment of the drum. The air stream may be humidified in the germinating stage before entering the drum, and is heated before entering the drum in the drying stage.

10 Claims, 9 Drawing Figures



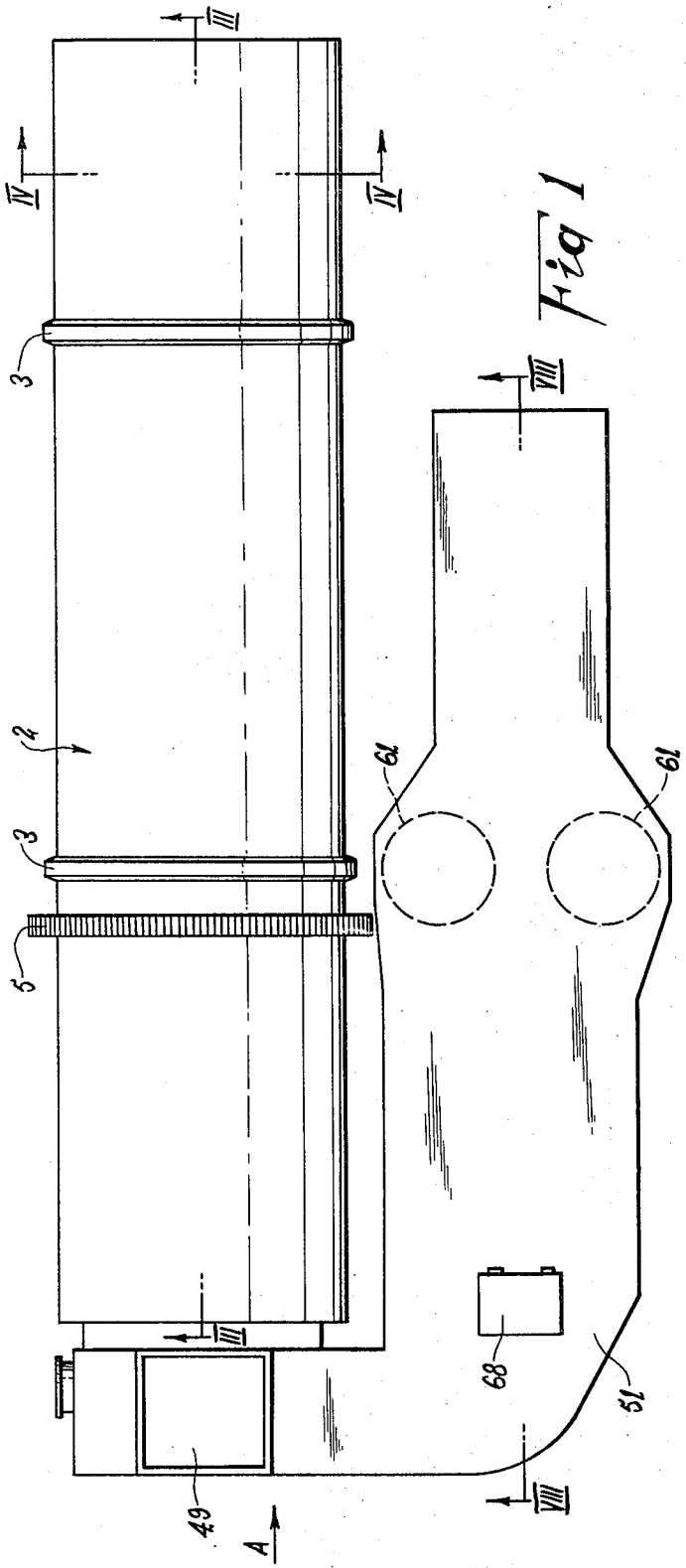


Fig 1

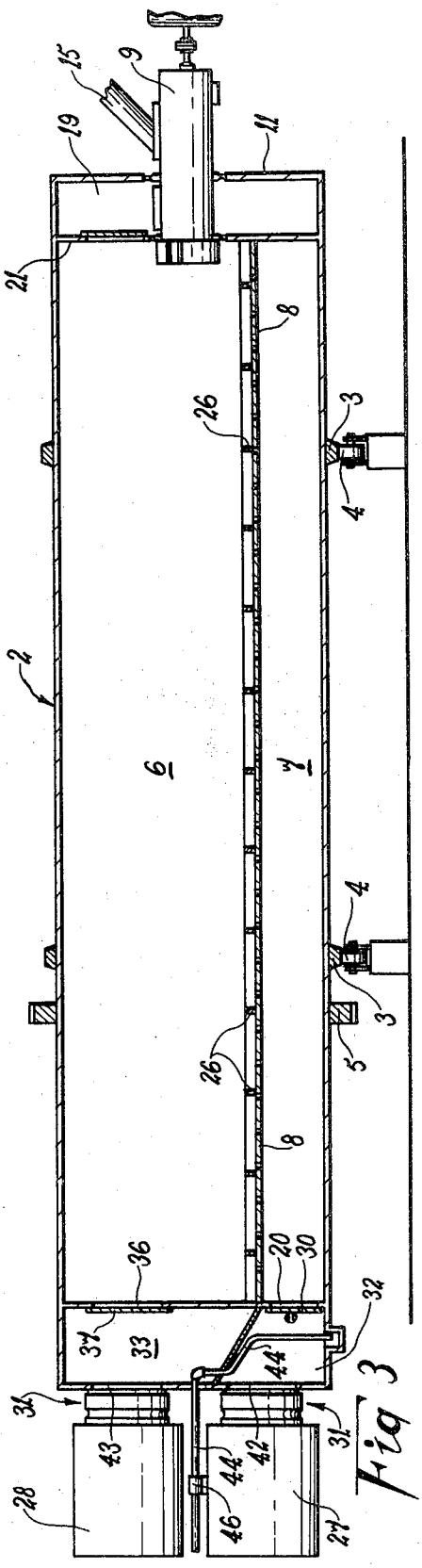


Fig 3

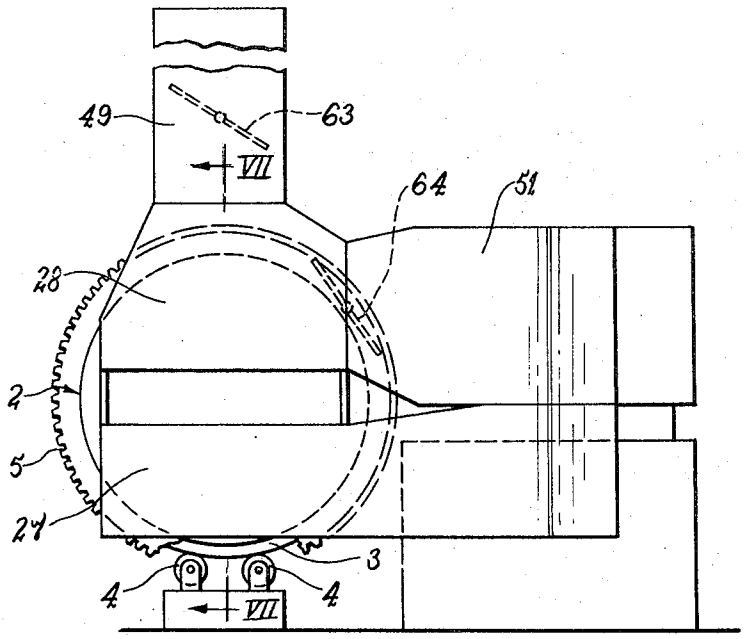


Fig 2

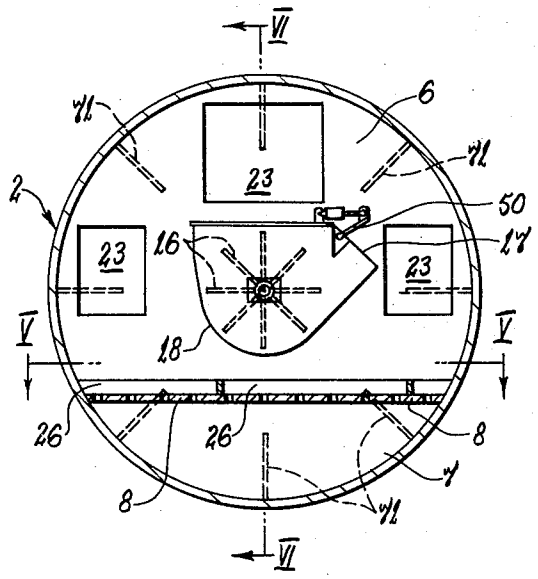


Fig 4

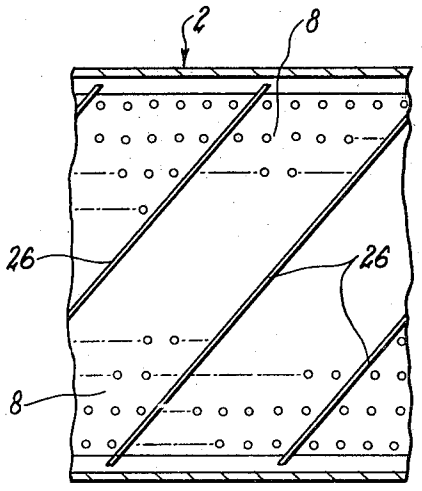


Fig 5

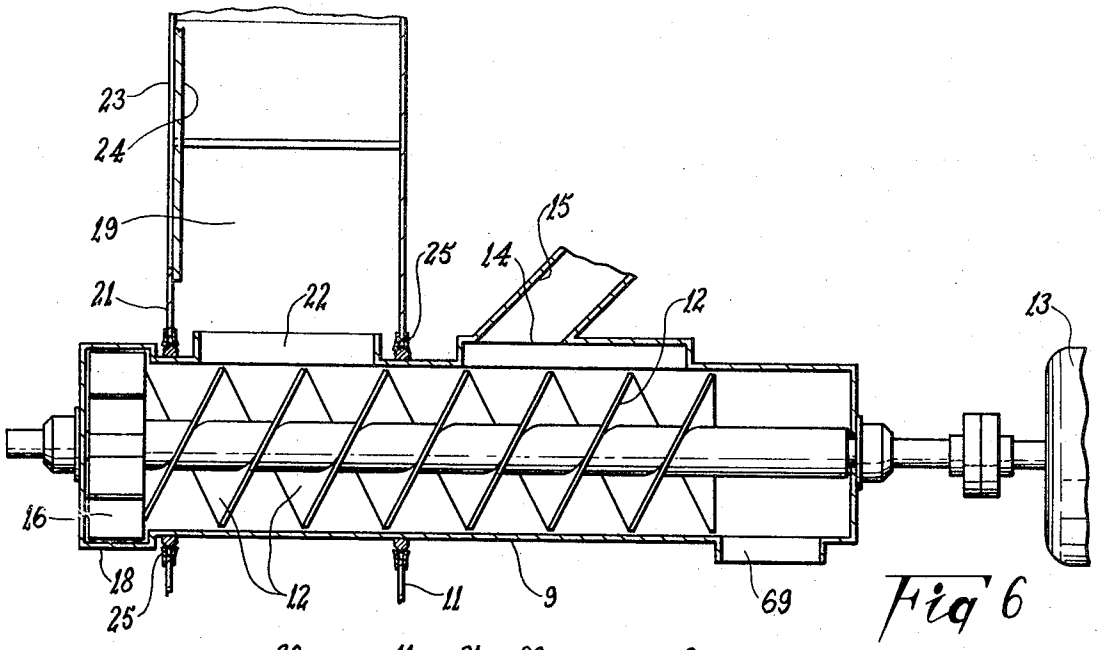

23
24
19
21
22
25
14
15
12
13
16
18
25
12
11
9
69

Fig 6

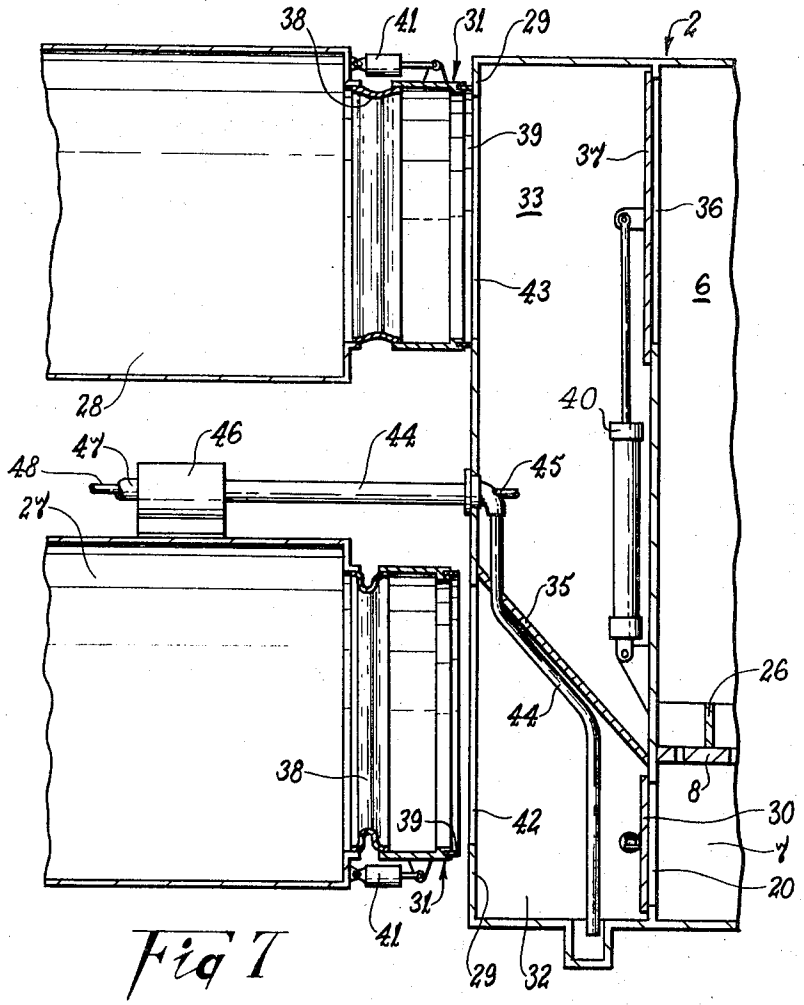

38
41
31
29
2
39
37
33
36
43
6
28
40
47
46
44
48
45
27
35
26
44
38
8
39
42
30
7
20
31
41
29
32

Fig 7

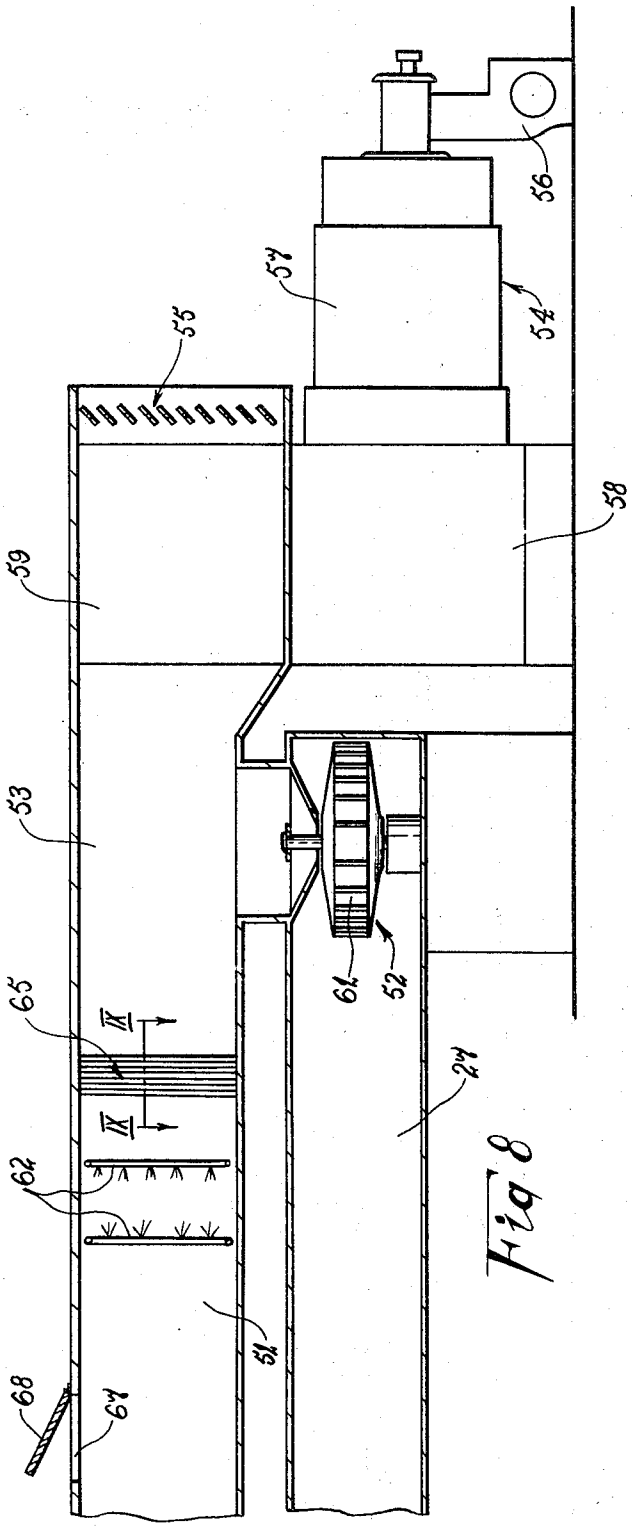


Fig 8

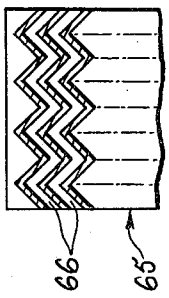


Fig 9

METHOD AND APPARATUS FOR PROCESSING GRANULAR AND OTHER MATERIALS

This invention relates to a method and apparatus for processing materials, and as that method and apparatus are ideally suited for processing granular materials such as barley, it will be convenient to hereinafter describe the invention in relation to a malting process. It is to be appreciated however, that the invention is not restricted to the example application and granular materials as hereinafter particularly described.

Malting involves three principal stages — steeping, during which the grain is soaked in a liquid (usually water) for a predetermined period of time; gemination, during which the grain is permitted to grow in a controlled environment; and drying whereby the germination process is terminated. It has been common practice to carry out each stage in different vessels or containers, thereby making the process somewhat complicated and time-consuming.

One conventional malting process involves the use of so-called "Saladin" boxes which can be adapted for use in both the steeping and germination stages. Drying however, is carried out in kilns separate from the Saladin boxes, and it is usual to connect several Saladin boxes to a single kiln. For economy reasons it is necessary to make continual use of the kiln in such a multiple connection plant, so that it should be connected to one box immediately after it is disconnected from another. Such a requirement imposes strict time limits on each stage of the malting process, thereby making it extremely difficult to obtain best results with all of the batches processed by that kiln. That is, the process is not so flexible as to allow adjustment of times as might be considered necessary by the malster having regard to variations in grain quality and form.

Because of the problems involved in the foregoing type of process, attempts have been made to devise apparatus which permits the three malting stages to be carried out in a single vessel. One such apparatus is disclosed in Australian patent specification No. 295,891 and involves a cylindrical vessel which is rotatable about a vertical axis, but that apparatus is relatively complex and does not permit adequate control of the various stages of the process. A further proposal has been to mount the cylindrical processing vessel for rotation about a horizontal axis, and such a construction is disclosed in U.S. Pat. No. 3,098,797 in the name of Graff. The Graff apparatus permits some flexibility in the processing, but the cylindrical vessel is of extremely complex construction.

It is a principal object of the present invention to provide an improved process, and particularly a malting process, which is flexible and does not require the provision of several separate vessels or containers for carrying out the principal steps of steeping, germination and drying. It is a further object of the invention to provide relatively simple apparatus for carrying out that improved process.

According to the present invention the grain is processed within a drum or like container mounted for rotation about a substantially horizontal axis, and the grain remains within that drum during each of the three principal stages previously mentioned. The drum is divided longitudinally by a perforated floor member so as to define a grain compartment and a fluid compartment on respective sides of that floor member. In a basic

form of the process, a batch of grain is fed into the grain compartment so as to be fairly evenly spread along its length, and a suitable quantity of steeping liquid is also fed into the drum either during or after feeding of the grain. Rotation of the drum then causes the liquid and the grain to mix so as to achieve the desired steeping effect.

After steeping, the grain within the drum is subjected to an environment which is such as to cause the grain to germinate, and that involves holding the drum stationary with the grain supported on the perforated floor member and inducing air to flow upwardly from the fluid compartment through the perforated floor member and the bed of grain supported thereon. It is generally necessary to humidify the air before passing it through the bed of grain, and it may be desirable to occasionally rotate the drum during the germination stage so as to achieve substantially uniform germination.

Drying of the germinated grain is then effected by circulating air at a suitable temperature through the drum. The heated air is induced to pass from the fluid compartment into and through the bed of grain supported on the floor member and is extracted from the space within the grain compartment above the bed of grain.

Other steps and features of the method will become apparent from a consideration of the following description of a preferred apparatus according to this invention. It is to be appreciated however, that each step or feature of the method as subsequently described is not restricted to the particular apparatus with which it may be related as the two aspects of the invention — method and apparatus — are hereinafter described sumultaneously purely as a matter of convenience and not because particular features of one aspect are strictly dependent upon particular features of the other aspect.

The particular apparatus hereinafter described is preferred only, and may be modified in numerous ways without departing from the spirit and scope of the invention. It will be therefore understood that the following description includes reference to both essential and non-essential features, and the former are identified by the appended claims.

In the drawings, which are diagrammatic only:

FIG. 1 shows a plan view of one form of apparatus in accordance with the invention;

FIG. 2 is an end view of the apparatus shown in FIG. 1, taken in the direction of arrow A;

FIG. 3 is a longitudinal cross-sectional view of the cylindrical drum taken along line III—III of FIG. 1;

FIG. 4 is a transverse cross-sectional view of the drum taken along line IV—IV of FIG. 1;

FIG. 5 is a fragmenary sectional view taken along line V—V of FIG. 4;

FIG. 6 is an enlarged longitudinal cross-sectional view of the grain feed end of the drum, and taken along line VI—VI of FIG. 4;

FIG. 7 is an enlarged longitudinal cross-sectional view of the air feed end of the drum, and that view is taken along line VII—VII of FIG. 2;

FIG. 8 is a longitudinal cross-sectional view taken along line VIII—VIII of FIG. 1; and

FIG. 9 is a fragmentary sectional view taken along line IX—IX of FIG. 8.

In the preferred form of the apparatus shown, the drum or treatment vessel 2 comprises an elongated cyl-

inder having a plurality of circumferential bearing rings or bands 3 located around its outside surface and engaging rollers 4 or other appropriate bearing supports such as to allow rotation of the drum 2 about its axis (see FIGS. 2 and 3). Any suitable drive means may be employed to effect rotation of the drum 2, such as a ring gear 5 secured about one end portion of the drum 2 and operatively connected to a drive motor (not shown), and either the drive motor or the drive connection is preferably reversible for a reason hereinafter made clear. The interior of the drum 2, or at least a principal part thereof, is divided longitudinally into a grain compartment 6 and a fluid compartment 7 as shown in FIG. 3, and the division between those compartments is formed by a perforated floor or plate-like member 8. The grain compartment 6 is generally considerably larger than the fluid compartment 7 so that the floor 8 is spaced radially from the axis of the drum 2 as shown.

Preferably, at least the cylindrical wall of the drum 2 is insulated to assist in maintaining a controlled environment within the drum 2 during the germination stage.

Grain inlet or feed means is provided through a wall of the drum 2, and in the preferred form shown most clearly in FIG. 6, that means includes a conveyor tube 9 protruding through an end wall 11 of the drum 2, and containing a helical screw conveyor device 12. The tube 9 is held against rotation with the drum 2, and the screw device 12 is arranged for rotation within the tube 9. The screw device 12 is drivably connected to a drive motor 13 in any appropriate fashion, and either the motor 13 or the drive connection is preferably reversible so that the screw device 12 can be used both for grain introduction and extraction. Grain is introduced in the tube 9 through a feed opening 14 and connected feed duct 15 which may extend from a grain hopper (not shown) or any other suitable supply source. Rotation of the screw device 12 in a forward direction will cause grain within the tube 9 to be urged towards the grain compartment 6.

Grain may be discharged from the tube 9 through a simple opening provided in a wall portion of the tube 9 located within the grain compartment 6, but in the particular arrangement shown in the drawings an impeller 16 is drivably connected to the inner end of the screw device 12, and that impeller is operative to propel grain laterally through an opening 17 provided in its surrounding casing 18 (see FIG. 4). Such an arrangement permits a relatively deep bed of grain to be laid on the perforated floor 8. A pneumatically operated closure flap 50 is associated with the opening 17 so as to enable that opening to be closed or opened as desired.

It is preferred to provide a grain transfer chamber 19 at the end of the drum 2 containing the conveyor tube 9, so that a controlled environment can be maintained within the drum 2, and particularly the grain compartment 6. In the arrangement shown, the chamber 19 is defined between the end wall 11 of the drum 2 and a substantially parallel and adjacent internal wall 21 which in effect forms one end of the grain and fluid compartments 6 and 7. Grain can be transferred between the tube 9 and the chamber 19 through an opening 22 in the cylindrical wall of the tube 9 and disposed intermediate the walls 11 and 21. At least one door controlled opening 23 is provided through the internal wall 21 to provide a connection between the chamber 19 and the grain compartment 6, and the door 24 (see FIG. 6) of opening(s) 23 is pneumatically or otherwise controlled for movement between open and closed positions. Preferably, the door control means is interlocked with the drum drive means so that there is little or no danger of door(s) 24 being left open at inappropriate times, and particularly during the germination and drying stages. Any suitable rotary seal 25 is provided between each wall 11 and 21 and the conveyor tube 9.

Grain spreading or distributing means is preferably provided within the drum 2, and may include angularly disposed vanes or flights secured to the drum wall and/or the perforated floor. It is usually found satisfactory to simply provide flights 26 on that surface of the perforated floor 8 forming the base of the grain compartment 6, as is shown in FIGS. 3, 4 and 5 of the drawings. The flights 26 are angularly arranged as best shown in FIG. 5, to cause grain within the grain compartment 6 to move axially of the drum 2 away from the wall 21, when the drum is rotated in a forward direction. In practice, the flights 26 generally lose their effect as grain distributing means after they have been covered by grain, but they are nevertheless useful for spreading grain at the beginning of the feed operation and assisting in removing material at the end of the discharge operation.

In the particular form of the apparauts shown in the drawings, inlet and outlet air ducts, 27 and 28 respectively, are connectable to the end of the drum 2 remote from the feed conveyor, so that air may be fed into and removed from that end during the germination stage and/or the drying stage. As shown in FIG. 7, the inlet and outlet ducts 27 and 28 are connectable to the end wall 29 of the drum 2 through respective tubular sealing members 31 which will be hereinafter described in detail, and a pair of air transfer chambers 32 and 33 are provided within the adjacent end of the drum 2 for connection to the inlet and outlet ducts respectively. The outlet air transfer chamber 33 is defined between the end wall 29 of the drum 2 and a substantially parallel adjacent internal wall 34 which forms the adjacent end of the grain compartment 6, and a further wall 35 extending between the walls 29 and 34 separates the two air transfer chambers 32 and 33. The fluid compartment 7 communicates with the chamber 32 through at least one opening 20 which can be closed by a pneumatically or otherwise operated door 30, as shown in FIG. 7.

The air outlet chamber 33 communicates with the grain compartment 6 through at least one door controlled opening 36 in the end wall 34 of that compartment. Opening and closing movement of door(s) 37 is pneumatically controlled through a piston-cylinder assembly 40, although other control means could be used, and that assembly is preferably interlocked with the drum drive means so as to ensure that door(s) 37 is not left open at inappropriate times. The control means for door 30 can be interlocked in the same way.

The connection between the ducts 27 and 28 and the drum 2 could be effected in any suitable manner such as through an appropriate rotary and substantially fluid-tight gland, but it is preferred that the connection is effected through a releasable seal assembly as particularly shown in FIG. 7, which can be disconnected

from the drum 2 when the drum is to be rotated. Each tubular member 31 of that assembly is connected to the adjacent end of its respective duct 27 or 28 through a flexible coupling 38 and has a resilient sealing lip 39 attached to its end adjacent the drum wall 29. A pneumatically operated piston-cylinder assembly 41 is connected between each member 31 and its respective duct 27 or 28 (or support for same) so as to move that member 31 into and out of sealing engagement with the drum wall 29. The two members 31 are arranged to respectively seal around inlet and outlet openings 42 and 43 formed through the wall 29, and those openings may be of any suitable shape.

If necessary, suitable guide means (not shown) may be associated with each sealing member 31 so as to guide those members along an appropriate path of movement. Also, the members 31 may be interconnected for simultaneous movement, in which case a single piston-cylinder assembly 41 may be suitable for operating both members. It is generally preferred to have the two members 31 moving together between their sealing and non-sealing positions, but for convenience of illustration FIG. 7 shows the member 31 associated with the inlet duct 27 in the non-sealing position, and with the other member 31 in its sealing position around the outlet opening 43.

Water and air conduits 44 and 45 respectively enter the drum 2 through the center of the end wall 29, and those conduits are coupled to a rotary gland 46 of any suitable known construction to permit them to rotate with the drum 2 relative to associated fixed water and air conduit sections 47 and 48. The conduit 45 is connected to the piston-cylinder assembly 40, and possible other pneumatically operated assemblies within the drum 2. An extractor pump (not shown) is connectable to the conduit 47 so as to permit rapid removal of liquid from the tank 2.

It is preferred that the main sections of the air ducts are located alongside the drum 2 as shown in FIG 1, because that arrangement conserves space, but the ducts can be in line with the drum 2 or arranged in any other way as desired. According to the particular embodiment shown in the drawings (see FIGS. 1, 2 and 8) the inlet duct 27 extends alongside the drum 2, the outlet duct 28 communicates with an exhaust stack 49, and a recirculating duct 51 extends between the inlet and outlet ducts 27 and 28.

Air may be force-fed through the drum 2 by a blower unit connected to the inlet duct 27, and/or an exhaust fan connected to the outlet duct 28, but the former is preferred and is shown in the drawings (see FIG. 8). The blower unit 52 is conveniently located within the inlet duct 27, and is of the centrifugal type, although an axial type fan can be used if desired. An intake duct section 53 is connected to the intake side of the blower unit 52 as shown in FIG. 8, and that section is connectable with a furnace or other heating unit 54 so that the air passing therethrough may be heated during the drying stage. Means (not shown) is preferably provided to close communication between the duct section 53 and the heating unit 54 when desired, although the heating unit 54 is not usually fired during the germination stage. Adjustable louvres 55 or other valve means is provided over the entrance to the duct section 53, and that valve means can be operated manually or through remote control means as desired.

The louvre valve 55 enables the air flow through duct section 53 to be regulated according to requirements. For example, the valve 55 may be partially or fully closed during the germination stage, and fully opened to give maximum flow during the kilning stage.

The heating unit 54 may be of any suitable form, but in the embodiment shown in FIG. 8 includes an oil burner 56, combustion chamber 57, and fire box 58. An appropriate heat exchanger 59 is provided in the duct section 53.

In the preferred construction shown, the blower unit 52 includes two centrifugal fans 61 located side by side (see FIG. 1) and both connected into the inlet duct 27. This allows greater flexibility of the apparatus so that, if desired, one fan 61 may be used during the germination stage and both may be used during the kilning stage. Generation of high pressure during the kilning stage has the advantage of facilitating percolation of the heated air through the thick bed of material in the drum 2.

Valve means (not shown) such as adjustable louvres may be provided over the outlet of the fan 61 not normally used during the germination stage, so enabling that outlet to be closed or partially opened when and if desired.

Moisture introduction means, such as sprays or an air washer, may be provided in the inlet duct 27 for use during the germination stage so as to enable a desired humidified environment to be maintained within the drum 2. It is preferred however, to recirculate air from the outlet duct 28 back to the inlet duct 27 during the germination stage, and in that case the moisture introduction means is located within the recirculation duct 51 as shown in the drawings. Location of the moisture introduction means, which is shown as sprays 62, within the duct 51 has the advantage of minimising resistance to air flow through the inlet duct 27 particularly during the kilning stage when it is generally desired to obtain maximum air flow at high pressure. The outlet duct 28 is connectable to atmosphere through a louvre or other control valve 63 (see FIG. 2) which is closed during recirculation as aforementioned, and a further control valve 64 (louvre or otherwise) is located between the outlet duct 28 and recirculation duct 51. The valve 64 is of course closed when it is desired to connect the outlet duct 28 to atmosphere, and is opened during recirculation.

An extractor unit 65 is located between the sprays 62 and the entrance to the fans 61, so as to remove large droplets of moisture from the air stream drawn towards the fans 61. The unit 65 may be of any known construction, and may define a series of tortuous passages 66, as shown in FIG. 9. At least one door or valve controlled inlet opening 67 is provided in the recirculation duct 53, as shown in FIGS. 1 and 8, and the door 68 of that opening can be controlled through pneumatic or other means.

A reservoir (not shown) for water or other steeping liquid may be provided in any convenient manner and connected to the drum 2 as desired. An extraction pump (previously mentioned) is arranged to enable relatively rapid withdrawal of the liquid from the drum 2 after completion of the germination stage, and appropriate level control means can be provided to ensure that a predetermined level of liquid is maintained during the germination stage and/or the steeping stage. A storage tank (not shown) for gibberalic acid, bromate,

or any other additive may be also connected to the drum 2.

Having now described the principal component parts of a preferred practical embodiment of the apparatus, the operation thereof is as follows.

Grain is fed into the drum 2 through the inlet tube 9 in response to rotation of the screw device 12 and associated impeller 16, and the drum 2 is also rotated in the forward direction during at least part of that feeding operation. At this time the air sealing members 31 at the other end of the drum 2 are disconnected from the drum 2 as shown in the lower part of FIG. 7. As the grain enters the grain compartment 6, it is caused to spread therealong by the action of the vanes or flights 26 during forward rotation of the drum 2. Steeping liquid may be pumped into the drum 2 during or after completion of the grain feeding operation, and that liquid is preferably maintained at a predetermined level throughout the steeping process. The drum 2 is rotated during the steeping process so that liquid passes through the perforated floor 8 of the grain compartment 6 and is mixed with and absorbed by the grain. The doors 24 and 37 at each end of the grain compartment 6 are closed during this stage of the process, and the or each door 30 is also closed to prevent liquid passing out through the inlet opening 42.

Rotation of the drum 2 may be stopped occasionally during the steeping stage so as to allow the grain an opportunity to obsorb steeping liquid. It may be also desirable to periodically reverse the direction of the drum rotation so as to obtain uniform mixing of the grain and liquid. Additives such as gibberalic acid and bromate can be introduced into the drum 2 at any convenient time during the germination operation.

At completion of the steeping stage, rotation of the drum 2 is stopped and the drum 2 is located with the grain compartment floor 8 substantially horizontal with the grain compartment 6 above the fluid compartment 7 as shown in FIGS. 3, 4 and 7. All excess liquid is withdrawn from the drum 2, and under some circumstances it may be desired to introduce a fresh body of liquid into the drum 2 for use during the germination stage, but that is not absolutely necessary. If fresh liquid is added, the level of liquid within the fluid compartment 7 during the germination stage may or may not be the same as that existing during the steeping stage, but in any event the level is such that an air space remains between the liquid and the perforated floor 8 of the grain compartment 6.

The seal members 31 are moved into their sealing positions around their respective openings 42 and 43 as is shown in the top portion of FIG. 7, and the doors 30 and 37 are opened to provide communication between the compartments 6 and 7 and their respective associated air ducts 28 and 27. Assuming that the air to be used during the germination stage requires to be humidified before entering the drum 2, the louvre member 55 is closed and the air access door 68 is opened. Also, if recirculation of air is required, the stack valve 63 is closed and the recirculation valve 64 is at least partially opened. The degree of opening of valve 64 would be determined by the desired relative proportions of fresh and recirculated air, and the degree of opening of door 68 would also have some affect on that aspect.

One or both of the fans 61 may be operated during the germination stage, and the sprays 62 are operated to add moisture to the air stream if required. Initially, air is drawn through the access opening 67 towards the inlet of the fans 61, and that air stream passes through the sprays 62 and the extractor 65, which removes excessively large droplets of water from the air stream. The air drawn through the fans 61 is then pushed through the duct 27 into the chamber 32 of the drum 2, and from there it passes through the opening 20 into the fluid compartment 7. The air within compartment 7 is subjected to such pressure that it passes upwardly through the floor 8 and the bed of grain supported on that floor and is then subsequently withdrawn from the space above the bed of grain through the openings 36 and 43. If the recirculation valve 64 is open, air withdrawn into the duct 28 is returned to the sprays 62 and fans 61 through the duct 51.

It is preferred that the air rising off the grain during the germination stage has a temperature within the range 68° to 70°F. inclusive, and if the air entering the duct 27 is not at a sufficiently low ambient temperature to achieve that "off-grain" temperature, means may be provided to cool that air before it enters the drum 2. For example, a single or multiple state refrigeration system may be connected to the inlet duct 27, or the recirculation duct 51, and could be incorporated with the moisture introduction means 62.

If desired, the outlet duct 28 may communicate with atmosphere during recirculation, if recirculation is employed during the germination stage. That is, the atmosphere control valve 63 may be opened approximately 10 percent of its range from fully closed to fully opened.

It may be desirable to periodically rotate the drum 2 during the germination stage, and in that case the rotation is preferably alternately forward and reverse. Such rotation can have the advantage of ensuring substantially even germination throughout the bed of grain. Normally, a single revolution is all that is required each time the drum 2 is rotated, and the time between rotations will depend on the type of grain being treated and other circumstances of the processing. It is of course necessary to move the sealing members 31 into their non-sealing positions each time it is required to rotate the drum 2. The doors 24 and flap 50 are closed during the germination stage to ensure adequate control of the environment within the grain compartment 6.

After germination, all liquid is extracted from the drum 2 and the inlet duct 27 is connected to the heating unit 54, which in the embodiment described, is an oil fired furnace. Preferably, the moisture content of the grain at the end of the germination stage is approximately 41 to 43 percent, depending upon the type of grain and the end product to be achieved, and after drying the moisture content is preferably 2.6 to 4 percent.

The heating unit 54 may be operated so that the temperature of the air within the drum 2 is within the range 160° to 170°F. inclusive. During drying, the sealing members are connected to the drum 2 and the various doors within the drum 2 are arranged as in the germination stage. The duct valves however, are rearranged, and in particular the louvres 55 are open, the door 68 is closed, and the valves 63 and 64 are open and closed respectively. Nevertheless, the door 68 may be opened if the air entering the fans 61 direct from the heating unit 54 is at an excessively high temperature. Also, the valves 63 and 64 may be adjusted to permit some recir-

culation through duct **51** if desired. The drum **2** may be rotated peroidically to assist in even drying, but such rotation is generally required less frequent than in the germination stage.

In order to assist in obtaining substantially even drying along the length of the bed of grain, baffles (not shown) may be provided so as to extend downwards from the underside of the perforated floor **8.** Preferably, each baffle or group of baffles projects a different distance into the fluid compartment **7** according to its axial displacement from the air inlet chamber **32,** so that an appropriate volume of air is directed into those regions which might otherwise experience relatively slow drying.

When drying has been effected, the sealing members **31** are moved into their non-sealing positions, and the doors **30** and **37** are closed. Doors **24** are opened to place the grain transfer chamber **19** in communication with the grain compartment **6,** and the drum **2** is then rotated in the reverse direction. The flights **26** within the grain compartment **6** then function to push the grain towards the grain transfer chamber **19,** which receives the grain through openings **23,** and from there it passes into the feed tube **9** to an outlet opening **69** of that tube. Lifter plates **71** provided around the inside surface of the chamber **19** serve to direct grain into the opening **22** of the feed tube **9,** and the screw device **12** is rotated in the reverse direction to function as a discharge conveyor rather than as a feed conveyor so that grain is discharged through opening **69.**

From the foregoing description, it will be understood that the present invention provides a relatively simple method and apparatus for treating grain, and particularly for carrying out a malting process. As all stages of the malting process are carried out in a single container, the invention allows for greater flexibility and economy. The apparatus may be used in other processes however, such as in the manufacture of gin and whiskey.

One particular advantage of the apparatus described is that the drum is above ambient temperature at the completion of a malting process, because of the passage of heated air in the grain drying stage which is the final stage of the actual processing. Consequently, the next batch of grain to be introduced into the drum will enter an environment adapted to accelerate germination, provided of course that the apparatus is not left idle for an excessive period of time.

Finally, it is to be understood that various alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the spirit or ambit of the invention as defined by the appended claims.

Having now described my invention, what I claim as new and desire to secure by Letters Patent is:

1. Grain treating apparatus including: a cylindrical drum located with its axis substantially horizontal and being mounted for rotation about that axis, said drum having a first end and a second end; a perforated floor member extending the length of at least a portion of said drum and dividing said portion into a grain compartment and a fluid compartment; an end wall at said first end of said drum; an intransverse wall adjacent said first end of said drum defining a grain transfer chamber between said end wall and said internal transverse wall; conveyor means extending through said end wall and said internal transverse wall; drive means connected to said conveyor means and operable to move said conveyor means in either a grain feeding or a grain discharging direction; a feed opening associated with said grain compartment whereby grain is fed to said grain compartment from said conveyor means during movement thereof in said grain feeding direction; a controllable opening in said transverse wall section whereby grain is passed to said conveyor means through said grain transfer compartment during movement of said conveyor means and said grain discharge direction; separate air inlet and outlet openings associated with said second end of said drum, located remote from said grain transfer member; inlet duct means and outlet duct means connectable to said inlet and outlet openings respectively; and means for connecting said inlet and outlet openings with said fluid and grain compartments respectively.

2. Apparatus according to claim **1,** wherein second internal transverse wall means is provided in said drum adjacent said second end to prevent direct communication between said air inlet opening and said grain compartment and to define an air transfer chamber between said outlet opening and said grain compartment, and including valve means in said wall means to permit selective communication between said air transfer chamber and said grain compartment.

3. Apparatus according to claim **2,** wherein said inlet and outlet duct means are connectable so that air withdrawn from said grain compartment can be recirculated into said fluid compartment.

4. Apparatus according to claim **1** wherein said conveyor means includes a conveyor tube extending through said first end wall of the drum and held against rotation with said drum, a helical screw conveyor element rotatably mounted within said tube and connectable to said drive means, an external feed opening in said tube through which grain can be introduced into said tube for influence by said screw conveyor element, and a further opening in said tube within said grain compartment through which grain is fed to said grain compartment.

5. Apparatus according to claim **4,** wherein said further opening is a lateral opening in an end portion of said tube which defines an impeller casing, and an impeller is rotatably mounted within said casing and is drivably connected to said screw element for rotation therewith, the arrangement being such that said screw element is operative to urge grain into said casing and said impeller is operative to throw that grain outwardly through said lateral opening.

6. Apparatus according to claim **1,** wherein fan means are provided within the said inlet duct means and are operative to cause air to flow through said duct means toward said air inlet opening; an air intake duct section connected to the intake side of said fan means and including a control valve which is operative to open and close said duct section; a recirculating duct section extending between said intake side of said fan means and said outlet duct means; and a recirculating valve provided for opening and closing communication between said outlet duct means and said recirculating duct section.

7. Apparatus according to claim **6,** wherein humidifying means is provided in said recirculating duct section between said recirculating valve and said intake side of the fan means, and a controllable opening is provided

in said recirculating duct section intermediate said recirculating valve and said humidifying means.

8. Apparatus according to claim **6,** wherein air heating means is connected to said intake duct section.

9. Apparatus according to claim **6,** wherein each said duct means is connectable with said end wall through a respective tubular sealing member which is movable towards and away from said end wall and is arranged to engage said end wall to form a substantially fluid-tight seal around the respective said opening.

10. Apparatus according to claim **1,** wherein vane means are provided within said grain compartment and are arranged to urge grain lengthwise in respect to said drum in response to rotation of said drum.

* * * * *

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,853,713 Dated December 10, 1974

Inventor(s) Graham Richard Colclough

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 8, line 23, "state" should read -- stage --.

Signed and sealed this 4th day of February 1975.

(SEAL)
Attest:

McCOY M. GIBSON JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents

FORM PO-1050 (10-69)

USCOMM-DC 60376-P69
U.S. GOVERNMENT PRINTING OFFICE : 869-930