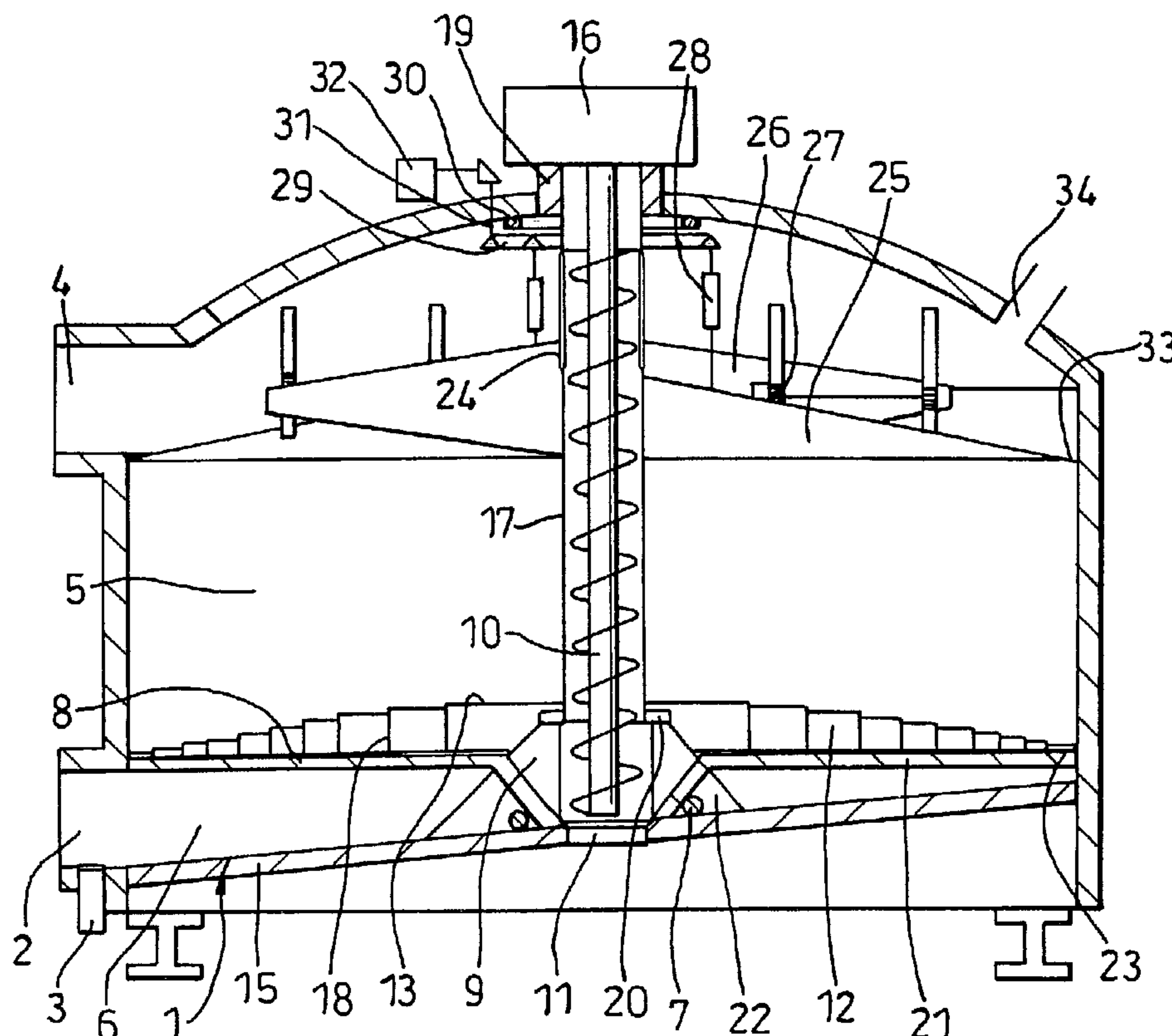




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(57) Abrégé/Abstract:

A method and apparatus for carrying out a malting process comprising means for efficiently turning over the grain mass in a bottom to top fashion by directing grain from adjacent to the bottom of the vessel to the centre of the bottom of the vessel from where it is elevated above the grain mass and redistributed back on top of the grain mass. The apparatus can be used for any stage of the malting process.



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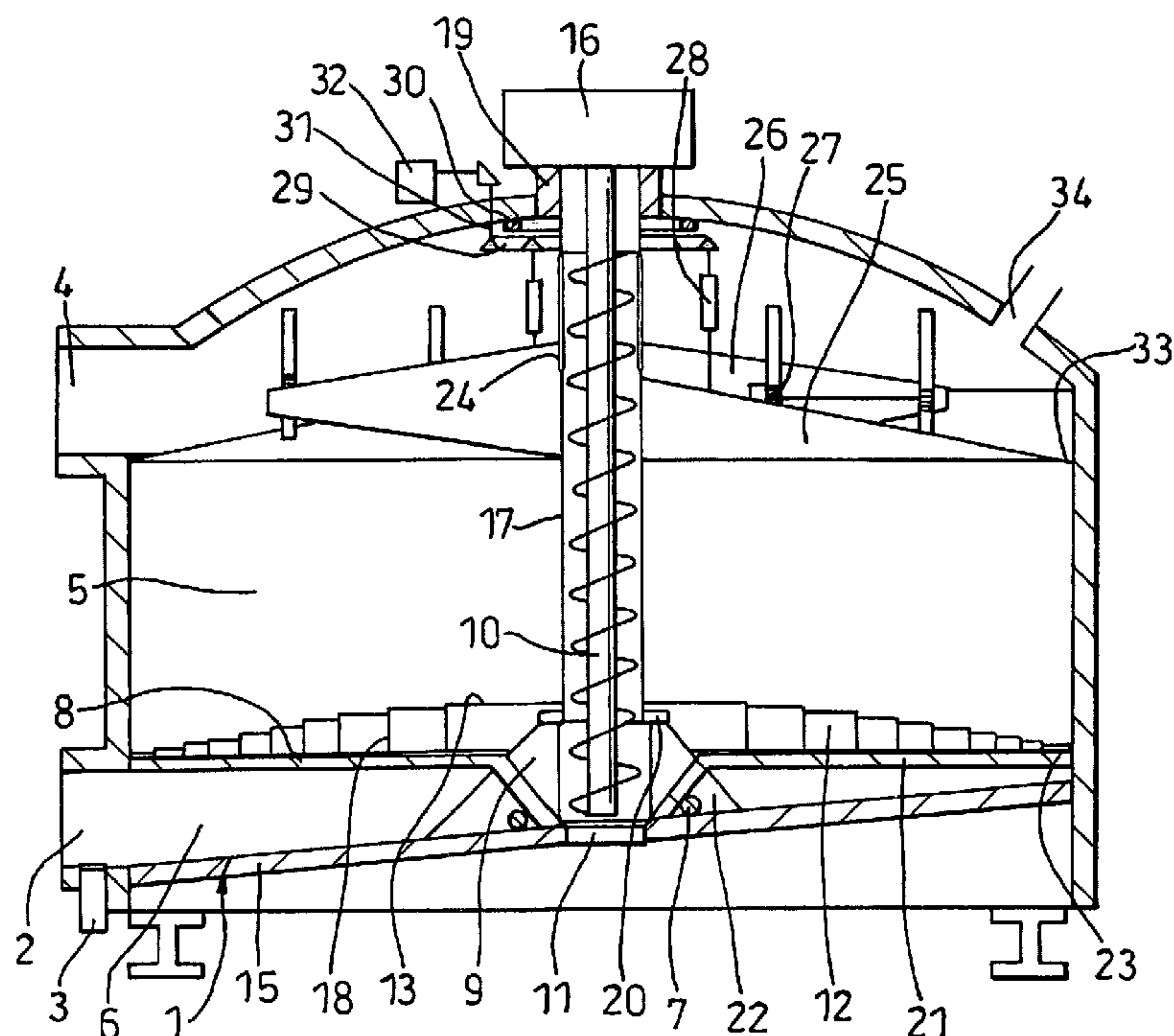
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(54) Title: METHOD AND APPPARATUS FOR MALTING



(57) Abstract: A method and apparatus for carrying out a malting process comprising means for efficiently turning over the grain mass in a bottom to top fashion by directing grain from adjacent to the bottom of the vessel to the centre of the bottom of the vessel from where it is elevated above the grain mass and redistributed back on top of the grain mass. The apparatus can be used for any stage of the malting process.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND APPPARATUS FOR MALTING

Field of the Invention

The present invention relates to the malting of grain, particularly barley, including all five phases of the
5 malting process, namely drying, steeping, germinating, kilning, and roasting, and provided means intended for use in that process.

Background to the Invention

The malting process consists of five identifiable phases,
10 which are drying, steeping, germinating, kilning and roasting.

The earliest historical records of the malting process go back to ancient Egypt. Through the ages this process has progressively become more mechanised at each phase, with
15 a multiplicity of different methods employed, including the Saladin and Wanderhaufen germinating systems in the early 1960's. These systems produce good quality malt using "Bottom to Top Turners" working in long rectangular "streets" or boxes, during the germinating phase. These
20 "turners" are machines which turn over or mix the mass of grain and are moved from box to box or end to end, as the process requires. The turners pick up the raw material at the bottom of the raw material mass ("piece") and drop it at the top, to fully aerate the piece and increase the
25 volume during the germination phase. This is achieved by driving scoops or enclosed Archimedean screws into the bottom of the germinating piece and depositing the turned, and now lightened (increased in bulk volume), piece behind the advancing turning machine. None of the
30 systems employed in mechanised malting processes achieve the preferred option of bottom to top turning during the other four phases of the malting process as well as during the germination phase.

It has been said that "Turners (during germination) must "lighten the piece," separate matted rootlets and allow the air to pass freely. Good turners can increase the volume of the piece by one quarter to one third."

5 (Malting and Brewing Science, Briggs, Hough, Stevens and Young).

The drive to improve efficiency, at the lowest unit cost, has reduced the first four phases of the malting process (drying, steeping, germinating and kilning) to large
10 batches produced in one or two circular vessels which use a multiplicity of prime movers within the vessel. (The last phase, roasting, is normally conducted separately from the first four phases). This condensing of the process has compromised malt quality with particular
15 regard to loss of the benefit of turning the raw material from bottom to top. If the grain is not treated homogeneously in the processing equipment then a homogeneous product does not ensue. These large circular vessels operate by either moving the raw material towards
20 a row of fixed stirring machines or driving a row of stirring machines through the static raw material. The stirring machines employed are open helical screws, which prevent the rootlets from matting during the germination phase, but do not turn the raw material from the bottom
25 to the top during any of the first four phases of the malting process. In particular they do not enhance aeration, or increase the volume of the piece by one quarter to one third during the germination phase. A further defect, entailing further cost, associated with
30 this type of equipment is that additional drives are also required to load, strip and discharge the vessels.

An object of the present invention is to provide improvements relating to the equipment used in the

malting process, wherein the aforesaid disadvantages of the current processing equipment are obviated or mitigated.

A further object of the invention is to provide a single
5 multi-purpose vessel equipped to carry out any or all of the five stages of the malting process, namely drying, steeping, germinating, kilning, and roasting. A yet further object of the invention is to provide equipment that permits the operation of the preferred practice of
10 turning the material from the bottom of the grain mass to the top of the grain mass at any or all of the five stages of the malting process. A still further object of the invention is to provide improvements to the quality of malt, especially with regard to homogeneity of the
15 grains, by carrying out the malting process utilising the equipment of the present invention.

Summary of the Invention

Accordingly the aforesaid objects are addressed in that the present invention provides a single multi-purpose
20 vessel, wherein all five stages of the malting process can be conducted to good effect whilst avoiding the compromised quality of the product such as is produced by the currently available equipment which uses large vessels with a multiplicity of prime movers to carry out
25 the various operations required.

According to one aspect of the present invention, a beneficial feature of the invention is the provision of a centrally located drive mechanism (or drive mechanisms) to be described hereinafter by reference to the
30 accompanying drawings. Such a drive as proposed herein powers the loading and levelling mechanism, the "turning arm and stripping plates" and the mechanism for lifting the grain collected by the stripping mechanism from the

bottom of the piece to the top for redistribution by the loading and levelling arms. Thus according to that aspect of the invention there is provided a drive mechanism comprising, drive means, a driven shaft
5 arranged to be upstanding in use in relation to the piece, a plurality of radially positioned upstanding plates arranged in a declining stages of height and mounted for rotation substantially in the plane of the piece about said shaft, and preferably each of said
10 plates is positioned by a radial off-set with respect to its radially inward neighbour such as to lag by a certain angular amount such that the overall effect is to provide a series of stripping plates constituting a sweeping arm extending from the shaft and having a curvature whereby
15 the distal end of the arm with respect to the mounted end of the arm trails during each rotation of the shaft.

The function of the sweeping arm is to carry the stripping plates repeatedly through the grain mass in such a way that a thin layer of grain, substantially that
20 which is adjacent to the bottom of the vessel (typically a foraminated floor), is collected by the stripping plates and propelled by the forces of their motion towards a centrally placed hopper set in the floor of the vessel.

25 According to a further aspect of the invention, there is provided a mass transfer device for lifting grain mass collected in the aforesaid hopper, to an elevated discharge level, and juxtaposed with respect to said device, for the purpose in use of collecting discharged
30 grain mass for loading back into the piece, there are provided a plurality of loading arms mounted upon a driven shaft for rotation substantially in a plane parallel with the piece. In a preferred embodiment each

loading arm having a curvature whereby the distal end of the arm with respect to the mounted end of the arm trails during each rotation of the shaft, the said curvature preferably corresponding to the curvature of the
5 aforementioned stripping plate arms. The mass transfer device is preferably an Archimedean screw conveyor device.

According to a preferred aspect of the invention, the stripping plate arms and loading arms are mounted upon a
10 common drive shaft and spaced apart thereon by a distance corresponding in use to maximum height of the piece, in order to prevent the loading arms dragging through the piece during processing. In a most preferred aspect of the invention the loading arms are moveable in distance
15 from the stripping plate arms so that they can be adjusted to correspond closely to the top of the piece at each stage of the process, to facilitate even distribution of the grain.

According to yet another aspect of the invention there
20 is provided a process vessel incorporating a generally upstanding cylindrical walled section having a drive means located in an upper part thereof, and operationally connected to an upright centrally positioned drive shaft provided at an upper end thereof a plurality of curved
25 loading arms, and at a lower end thereof a plurality of correspondingly curved stripping arms formed from a series of upstanding plates arranged in a declining stages of height, the said vessel having a floor for receiving in use a piece, and a centrally positioned
30 piece mass collection hopper, the said shaft being positioned above said hopper and containing within its length a mass transfer device to elevate grain mass from the hopper to an upper discharge port of the shaft

adjacent to the loading arms. The vessel is suitably equipped as necessary with aeration and heating means as is understood in the art to be required for a malting process.

5 From the hopper in the vessel floor, the grain is lifted by a mass transfer means or mechanism, preferably a screw conveyor located in a sleeve (said sleeve serving as the shaft surface), towards the top of the vessel where it can be redistributed onto the grain mass with the
10 assistance of the loading arms. Thus bottom to top turning of the grain can be achieved by the combined action of the lower turning arms with height-staged stripping plates together with the centrally located lifting mechanism and upper loading arms.

15 The stripping plates can be carried on any number of turning arms, dependent on the desired size of the malting vessel or batch quantity. A preferred embodiment consisting of two opposing arms is shown in the Example and the accompanying drawings. The stripping plates are
20 pieces of metal or other suitable material that are fixed to the turning arm or arms in a generally upright manner and are sized and shaped in such a fashion that they act as deflectors or ploughs when the arm is rotated, directing a thin layer of the grain towards the centre of
25 the bottom of the vessel by the repeated passage of the plates through the grain mass.

The outermost stripping plate directs or deflects a portion of grain from the outermost part of the bottom of the vessel into the path of the next innermost plate.
30 When the next arm carrying stripping plates passes, the grain originally from the outside portion of the bottom of the vessel is again moved one further unit (the radial distance swept by a stripping plate) towards the centre

of the vessel. At the same time, because the plates increase in height towards the centre of the vessel, a portion of the grain that has dropped into place from the grain above the stripping plates following the previous
5 passage of stripping plates is also moved inwards. By this method, successive passages of the turning arm or arms move a thin layer of the grain from the entire base of the vessel into the central hopper. By repetition the entire batch of grain is taken from the base of the
10 vessel and transported to the top of the grain mass via the lifting mechanism. This procedure can be continued to turn over, loosen, aerate, or assist heating or cooling the grain mass, as often as desired at any stage of the malting process.

15 When employed in lifting the grain from the bottom of the vessel during turning procedures the lifting device can also serve to aerate or increase the bulk volume of the grain mass. When an Archimedean screw operating in a sleeve is employed as shown in the Example, the rate of
20 volume lift of the screw is set to exceed the rate at which the stripping plates deliver material to its feed hopper. This enhances the aeration and avoids damaging the grain during transport. The lifting device is also usefully employed at the end of the process or a chosen
25 process stage to discharge the grain via a discharge chute.

The loading arms are employed in distributing the grain both when the vessel is being loaded and also when the batch is being turned. In a preferred embodiment they
30 are located directly above the trailing edge of the turning arms and follow the same curve or profile. It is also preferred that they can be raised or lowered to

match the batch volume in the vessel so that they can be set to distribute and even out the material effectively.

The vessel of the invention is also equipped with a number of other features to enable all aspects of the
5 malting process to be carried out. These include insulation, air and water inlets and outlets, heat exchangers and means of humidifying the air. This allows appropriately conditioned air to be fed into the vessel depending on the stage of the malting process that is
10 being carried out. For instance, roasting of the malt, if it is required, is conveniently carried out in the vessel, immediately following the germinating phase, by supplying hot air through the foraminated floor of the vessel whilst turning the piece.

15 Thus it will be understood that according to this invention there is provided a method of turning a piece that comprises introducing a mass of grain to a vessel to form a piece, arranging therein an upstanding driven shaft about which there are arranged curved turning arms
20 comprising height-staged plates of radially declining height, at a lower end of the shaft, and collector loading arms of corresponding curvature at an upper end of the shaft, said shaft incorporating within its length a mass transfer device, and having a collection hopper at
25 the lower end for introducing grain mass to the transfer device, and discharge ports at its upper end for discharging elevated grain mass, operating the driven shaft to turn the respective upper and lower arms, whereby grain mass at the lower end of the shaft migrates
30 radially inwards to the collection hopper, elevating the grain mass to the discharge ports, collecting the grain mass and distributing same over the piece, said steps

being operable in a continuous cycle for a period of time adequate for the purpose of a malting process.

The aforesaid mechanisms, vessel and method are ideally used to conduct the whole malting process within a single
5 vessel, the manner of such use being more fully described hereinafter by way of illustrative example with reference to the accompanying drawings in which:

Figure 1 shows a cross section of the vessel equipped for carrying out all the stages of the
10 malting process; and

Figure 2 shows a plan view of an embodiment of the turning arms and height-staged stripping plates of the invention.

A vessel adapted for the performance of a malting process
15 is represented by the cross sectional view of the vessel as shown in Figure 1. The main vessel 1 is built out of stainless steel. At the base of the vessel there is an air inlet duct 2. This duct is fixed to the side of the vessel with a fall to drain 3 to aid drainage of the
20 steep liquor. This also enables self-cleaning of debris and culms disposal after drying, kilning and roasting. The air inlet duct serves to introduce air to the vessel via a plenum chamber 6 and thence the perforated floor. The air is warmed and or humidified as required by the
25 stage of the process using proprietary equipment. A similar air outlet duct 4 is also fixed to the top of the vessel. (The air inlet and outlet ducts house the following proprietary equipment, which is not shown:- Air heat exchanger, multi-louver dampers, butterfly valve,
30 spray chamber and a centrifugal multi-speed fan).

The vessel houses a mass transfer mechanism including arms 12, 25 that sweep around the vessel at upper and

lower levels, said arms being mounted on a centrally positioned drive shaft 17 that also incorporates a mass elevation device such as a screw conveyor 10. This mechanism is put to the following purpose.

5 During the germination stage of the malting process high concentrations of carbon dioxide suppress respiration and cause "hot spots" in the piece 5. Turning the piece from bottom to top, and lightening it to aid aeration, addresses this problem and improves evenness of
10 modification during both steeping and germination. The airflow arrangements in the vessel permit periodic reversal of flow through the piece to remove the carbon dioxide gradient during germination. These procedures will also enhance the evenness of drying and colour
15 formation during the subsequent stages of kilning and roasting. This significantly improves the finished malt quality and homogeneity.

The plenum chamber 6 has a fall to the inlet duct to assist drainage and debris removal. There is a circular
20 manifold 7 for high-pressure water injection during vessel cleaning and can also be used for air injection to rouse the piece and aerate during steeping. It can further be used for dousing during roasting. The static, stainless steel, foraminated floor 8 has a foraminated
25 conical feed hopper 9. The raw material is fed via this hopper to the mass elevation device in the form here of an Archimedean screw 10, during turning, or to the discharge point 11 at the end of each or any of the five process stages that can be carried out in the vessel.
30 The rate of volume lift of the screw conveyor is chosen to exceed the rate of vessel stripping (removal of grain from the vessel) to enhance aeration of the piece being turned during germination, and to avoid damaging the raw

material or over loading the turning arm 12. The central section 13 of the perforated floor is part of the turning arm, which rotates above the conical hopper. This central section has two curved stripping slots 14 (See Figure 2). These slots receive the grain collected by the action of the stripping plates and deliver it into the hopper 9. The slots are protected by suitable skirting (not shown) from grain in the body of the vessel falling in under gravity. This means that substantially only grain that has been collected by action of turning arm and stripping plates is fed to the screw conveyor.

The exterior of the vessel is coated with insulation 15. This is valuable for all five phases of the process where appropriate temperature control is needed to attain a quality product.

The central drive 16 is located at the top of the vessel and provides the motive force for the turning and loading arms and the Archimedean screw. Both the Archimedean lifting screw and the outer sleeve 17 rotate on the same centre of rotation. The outer sleeve acts as the drive shaft for both the turning and loading arms. The turning arms also carry the stripping plates 18, which move the raw material towards the centre of the vessel as discussed above in the Summary of the Invention. The stripping plates in this embodiment are rectangular plates fixed vertically to the turning arms, angled to direct the grain across towards the centre of the vessel floor. The height of the stripping plates increases towards the centre of the vessel to provide the required action as discussed previously. The height of the stripping plates nearest the centre of the vessel corresponds to the height used for the stripping slot 14

with an incremental decrease from plate to plate towards the circumference of the vessel.

The power required to turn the arm is a function of the need for it to be turned. For example during the
5 germination phase a well turned and lightened piece will permit easier movement of the turning arm than a dense compacted mass. This relationship can be applied to automatically increase or decrease the rate of rotation of the turning arms during any phase of the process by
10 the appropriate use of an automatic system controller e.g. including a microprocessor. The airflow and air temperature controls can also be similarly moderated by the state of the grain mass as may be detected by the force required to move the turning arm. Thus increased
15 resistance to turning of the arms indicates a compact state in the piece, thus requiring further work to lighten the piece which will be detectable when resistance eases.

The Archimedean sleeve is located in top 19 and bottom 20
20 bearings. The bottom bearing is secured by means of horizontal supports from the circumference 21 and the base 22 of the vessel. These supports also act as supports for the perforated floor. A load bearing safety plate/distance piece 23 is fixed circumferentially to
25 prevent the stripping plates from coming into contact with the perforated floor. The Archimedean sleeve has two slots cut into the top section 24. These act as discharge points for the raw material being lifted from the bottom of the vessel to the top. A distribution
30 chute allows the raw material to drop in front of the loading arms 25, which then spreads it evenly over the top of the piece. These loading arms are located directly above the trailing edge of the turning arms and

follow the same curve profile. This arrangement maintains an even raw material depth to avoid air channelling. These loading arms are attached to support brackets 26 via racks and pinions 27. These raise and
5 lower the loading arms as needed to permit proper control of the distribution of the grain batch. The level of the batch fluctuates due to the change in moisture content and bulk density of the raw material during the five different phases of the process. Further the high
10 quality bottom to top turning that the equipment permits leads to substantial volume increases during lightening procedures carried out during any one of the process stages, especially during the germination phase.

The drive for these racks and pinions is transmitted via
15 drive shafts, which have splined couplings 28 to allow for the rise and fall of the loading arms. The drive end of these drive shafts mesh into a double sided cog 29 which is mounted in a free running bearing 30 at the top of the vessel. The double-sided cog is rotated
20 externally when the loading arms are required to be raised or lowered through the drive shaft 31 this can be achieved either manually or via the indexing motor 32. Sensors located at the loading arm tips 33 supply the signal for this motor to either raise or lower the
25 loading arms. In the absence of a signal to the indexing motor the drive shafts and double-sided cog free-wheel, so maintaining the set height of the loading arms.

Raw material is supplied via the inlet pipe 34 at the beginning of each batch to be processed.

30 All five phases of the malting process can be carried out in one vessel as described in this example. However, depending on the scale of malting operation required a multiplicity of vessels can be utilised for efficiency of

throughput. Whilst it is conceivable to house a plurality of mutually laterally spaced lifting and turning mechanisms in a single housing to process a piece of substantially large surface area, this arrangement may
5 be liable to leave "dead spots" in the piece where elevation and turning is ineffective or inefficient. Therefore, the confinement by use of a cylindrical wall section around the lifting and turning mechanism is considered to be the best mode of operation.

10 Normally the drying phase is kept separate from the following four phases with the exception of some specialist roasted products. Steeping, germination and kilning phases can all be run consecutively within one vessel or by transfer to other vessels to maximise
15 process flexibility and energy conservation. If a multiplicity of vessels is used two or more phases can be operated concurrently if desired to maximise throughput. With the exception of roasting raw material after the drying phase for specialist products, as mentioned above,
20 the roasting phase normally commences after the germination phase and replaces the kilning phase by simply applying much higher air on temperatures to the malted material.

Claims

1. A method for carrying out a malting process wherein a mass of grain is introduced into a vessel, the
5 portion of the grain that is substantially adjacent to the base of the vessel is moved, in an incremental fashion, to a collection hopper in the centre of the base of the vessel by the action of height-staged plates of radially declining height
10 mounted on turning arms, said turning arms rotating in a substantially horizontal plane and being located at the lower end of an upstanding driven shaft, the grain collecting in said collection hopper is then elevated to the top of the mass of
15 grain by a mass transfer device and distributed over said mass of grain by the action of loading arms located at the upper end of the upstanding driven shaft such that the overall effect is to turn over the grain mass introduced to the vessel in a bottom
20 to top fashion, said turning over being operable in a continuous cycle for a period of time adequate for the purpose of a malting process.
2. A method for carrying out a malting process according to claim 1 wherein the process is a drying
25 process and the vessel is supplied with conditioned air.
3. A method for carrying out a malting process according to claim 1 wherein the process is a
steeping process and the vessel is supplied with
30 means for the supply and removal of water and conditioned air.
4. A method for carrying out a malting process according to claim 1 wherein the process is a

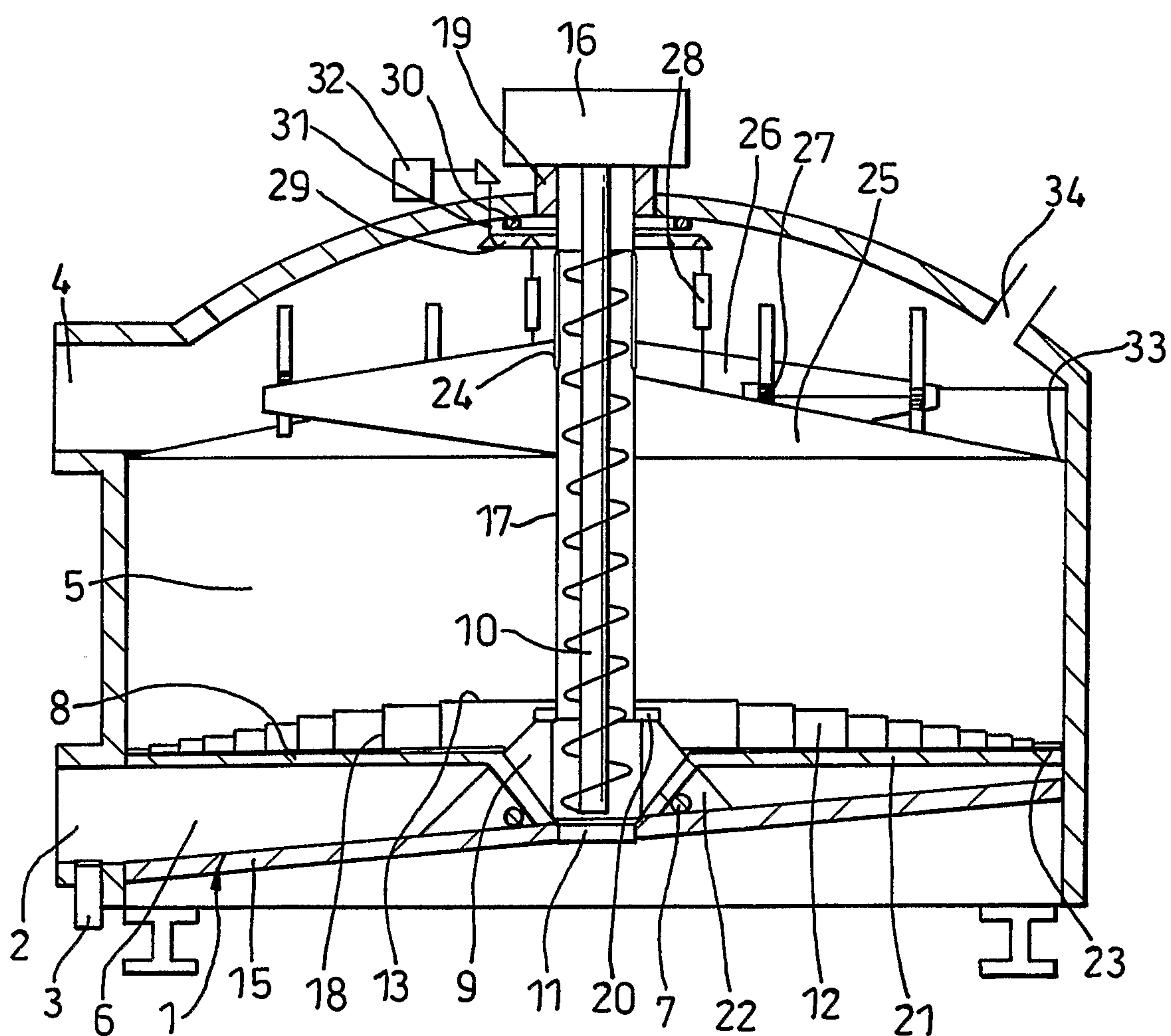
germinating process and the vessel is supplied with conditioned air and water.

5. A method for carrying out a malting process according to claim 1 wherein the process is a kilning process and the vessel is supplied with conditioned air.
6. A method for carrying out a malting process according to claim 1 wherein the process is a roasting process and the vessel is supplied with conditioned air and water.
7. A method for carrying out a malting process according to claim 1 wherein the process consists of any combination of drying, steeping, germinating, kilning and roasting.
8. An apparatus for carrying out malting processes comprising a vessel provided with a drive means, a driven shaft arranged to be upstanding in use in relation to the grain mass, a plurality of turning arms mounted for rotation substantially in the plane of the piece about said shaft, said turning arms comprising a plurality of radially positioned upstanding plates arranged in declining stages of height, such that the overall effect is to provide a series of stripping plates for moving grain incrementally from the base of the vessel, a collection hopper located at the centre of the base of the vessel, and a mass transfer device for lifting the grain mass from the collection hopper to an elevated discharge level, a plurality of loading arms rotating substantially in the plane of the piece mounted upon a driven shaft, for

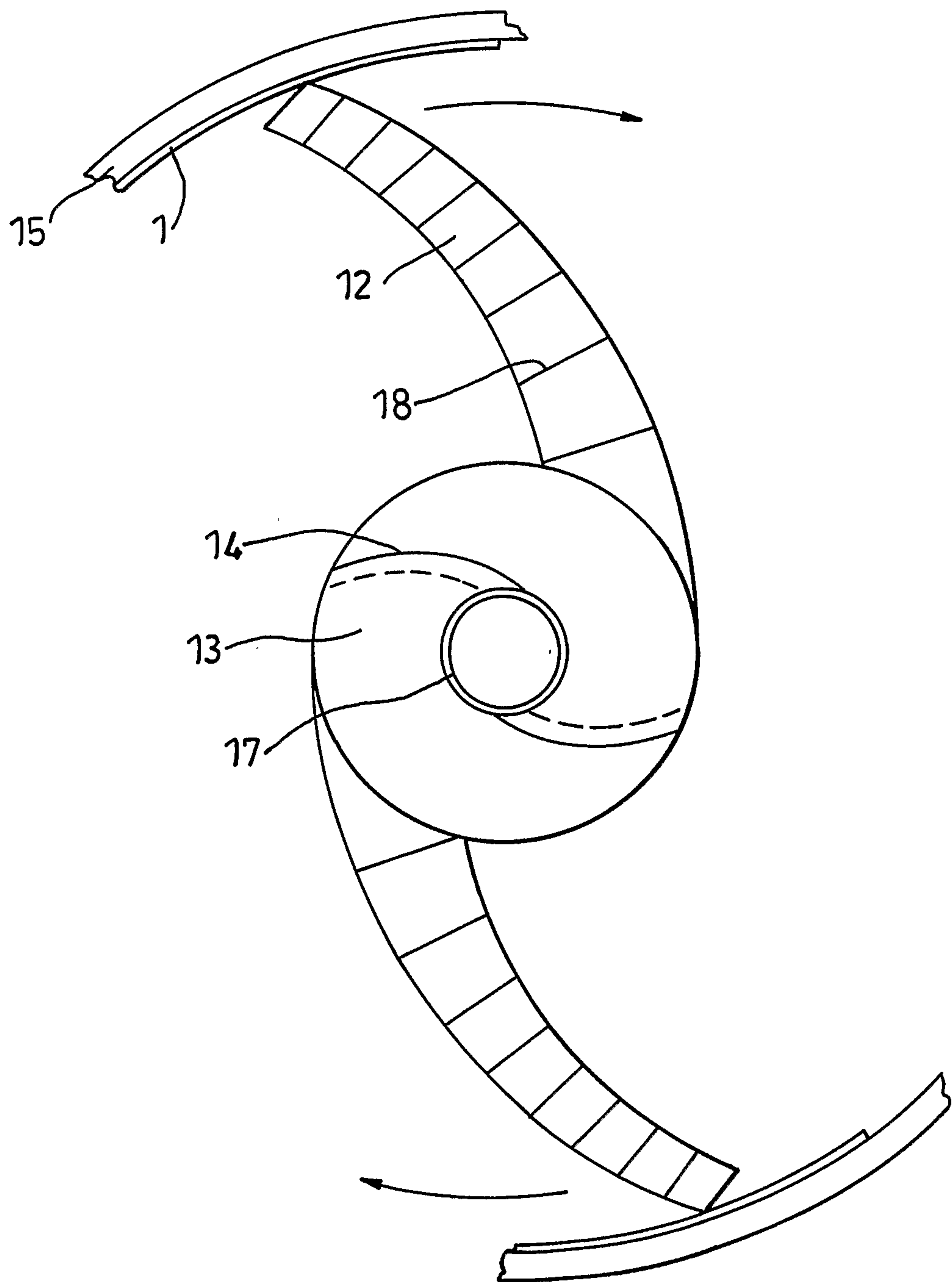
redistributing the elevated grain onto the grain mass.

- 5 9. An apparatus for carrying out a malting process according to claim 8 wherein the plurality of radially positioned upstanding plates are each offset radially by a certain angular amount, constituting a sweeping arm extending from the shaft and having a curvature whereby the distal end of the arm with respect to the mounted end of the arm trails during each rotation of the shaft.
- 10 10. An apparatus for carrying out a malting process according to claim 8 or 9 wherein the mass transfer device is located within the driven shaft which drives the loading arms and the stripping plates.
- 15 11. An apparatus for carrying out a malting process according to claim 10 wherein the mass transfer device is a screw conveyor located in a sleeve.
- 20 12. An apparatus for carrying out a malting process according to any one of claims 8 to 11 wherein the said loading arms rotate substantially in a plane parallel to the grain mass.
- 25 13. An apparatus for carrying out a malting process according to any one of claims 8 to 11 wherein the said loading arms have a curvature whereby the distal end of the arm with respect to the mounted end of the arm trails during each rotation of the shaft, the said curvature corresponding to the curvature of the aforementioned sweeping arm.
- 30 14. An apparatus for carrying out a malting process according to any one of claims 8 to 14 wherein the loading arms are moveable in distance from the sweeping arm.

15. An apparatus for carrying out a malting process according to any one of the preceding claims wherein the vessel is substantially cylindrical in section and is further equipped with a foraminated floor,
5 insulation, air and water inlets and outlets, heat exchangers and means of humidifying the air.
16. An apparatus substantially as hereinbefore described with reference to Figures 1 and 2 of the accompanying drawings.

1/2***Fig. 1***

2/2

**Fig. 2**

