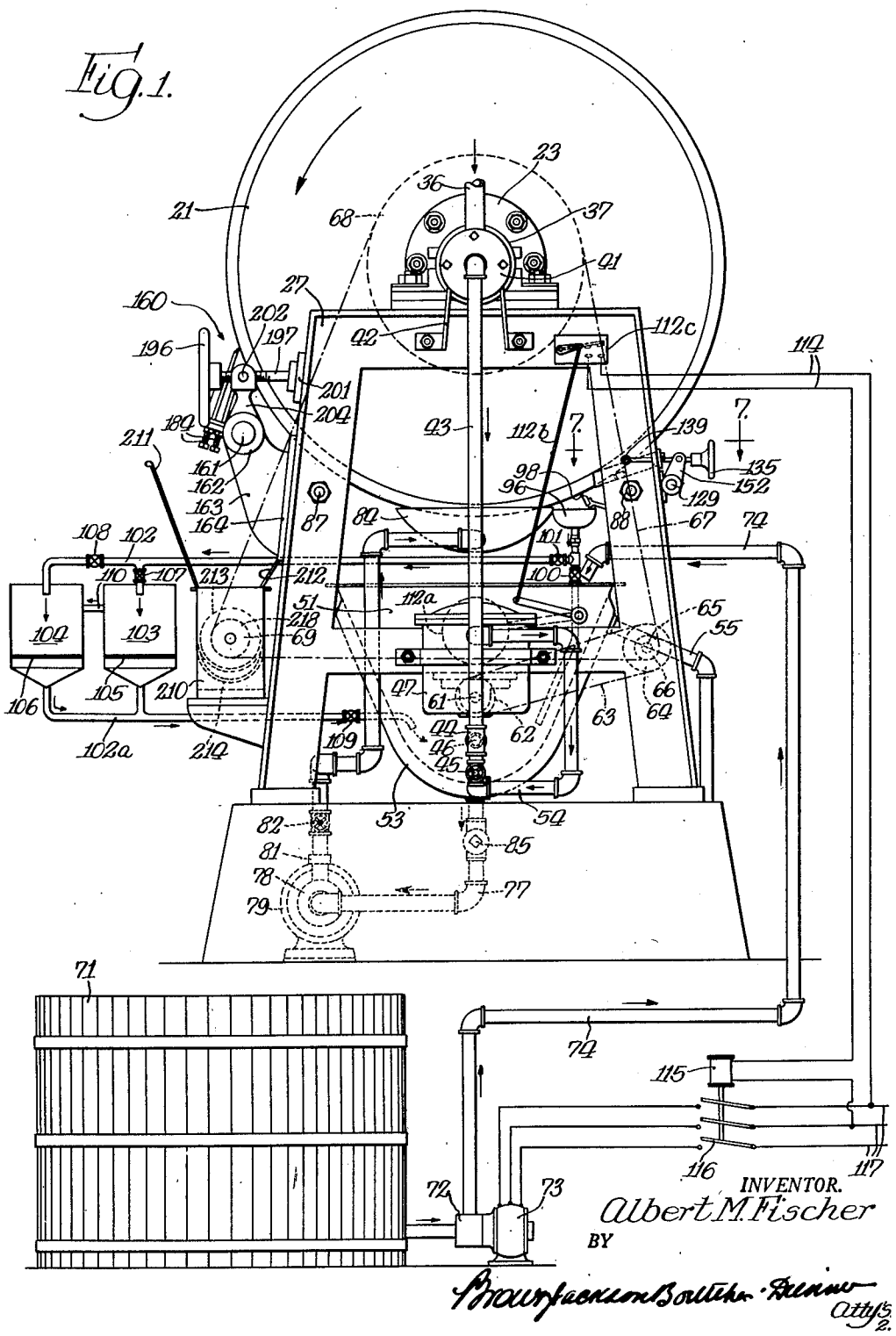
Sept. 12, 1950 A. M. FISCHER 2,521,706

YEAST DRYING APPARATUS

Filed April 14, 1943 7 Sheets-Sheet 1

Fig. 1.



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Sept. 12, 1950 A. M. FISCHER 2,521,706

YEAST DRYING APPARATUS

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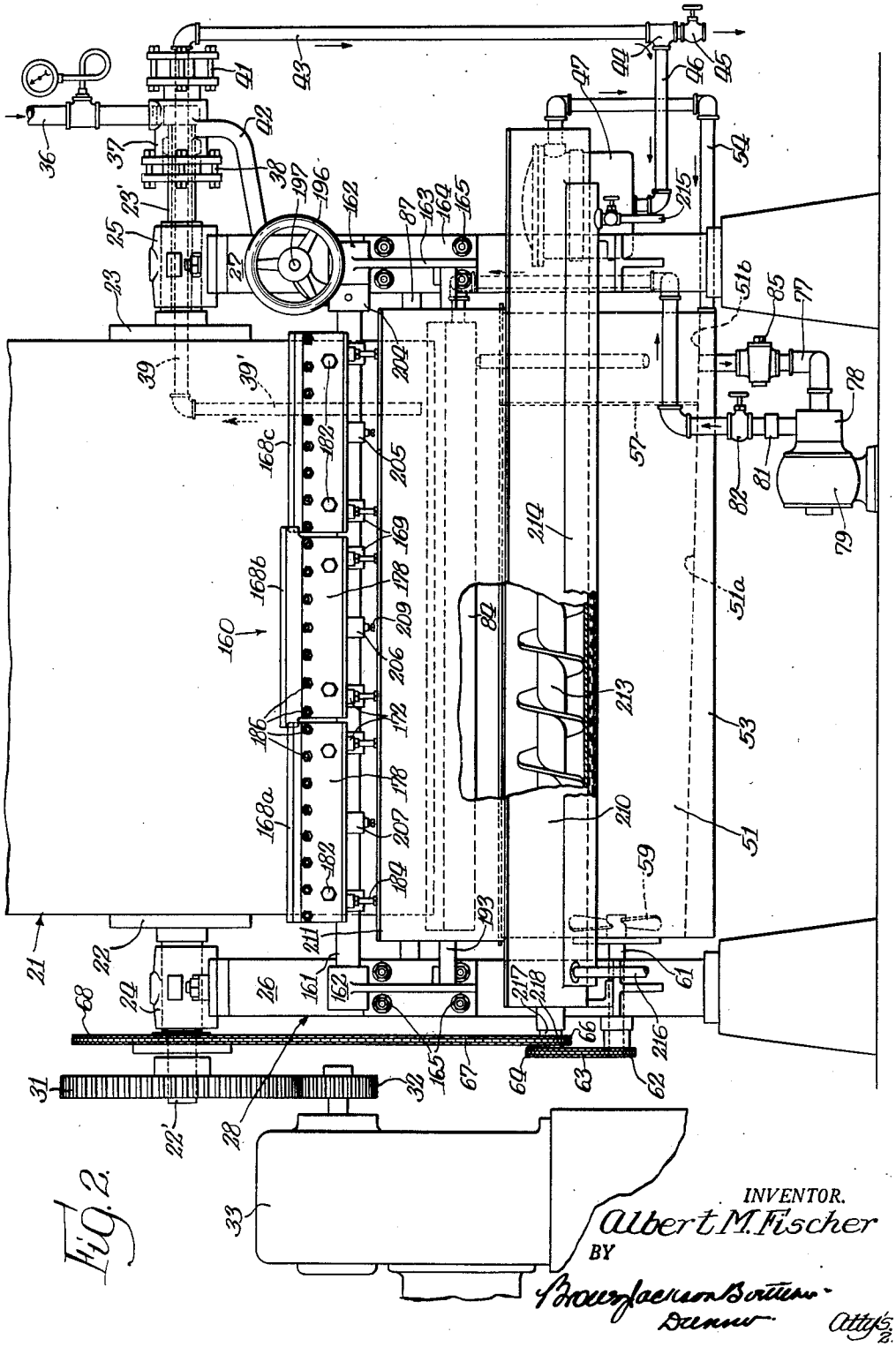


Fig. 2.

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YEAST DRYING APPARATUS

Filed April 14, 1943 7 Sheets-Sheet 3

Fig. 3.

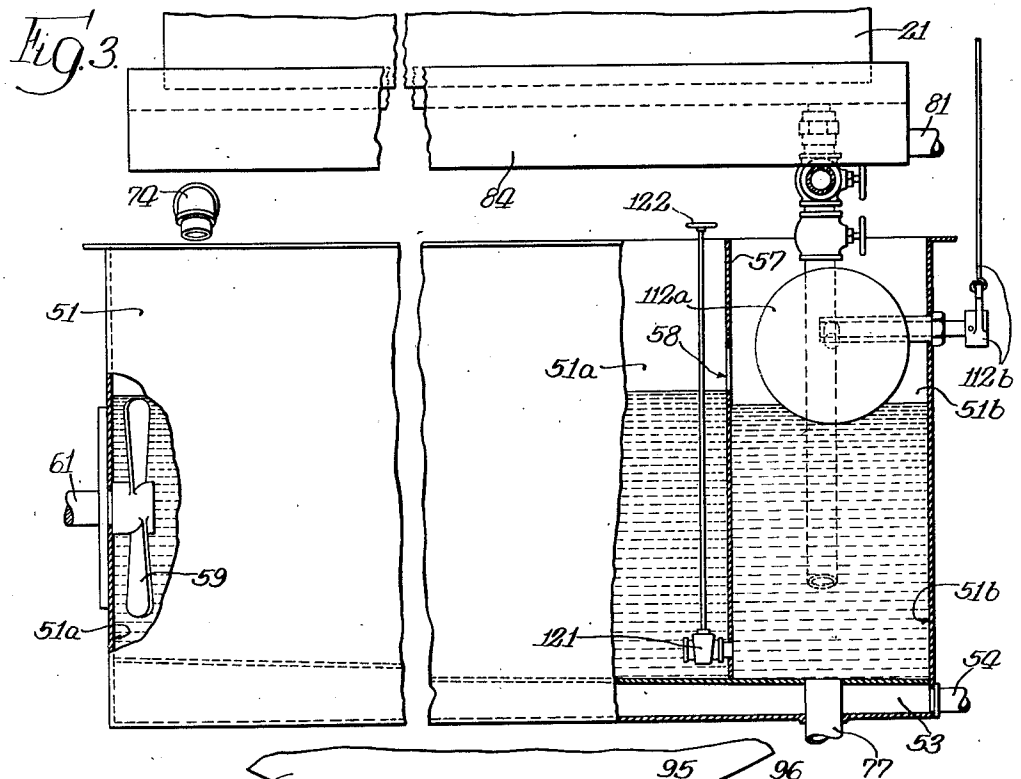
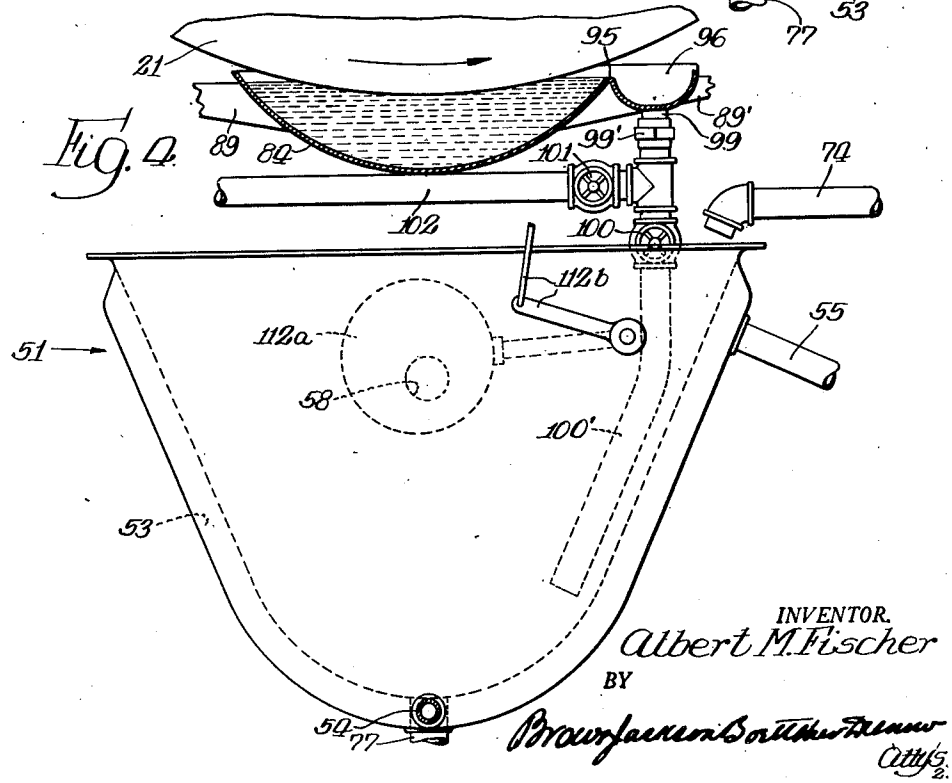


Fig. 4.

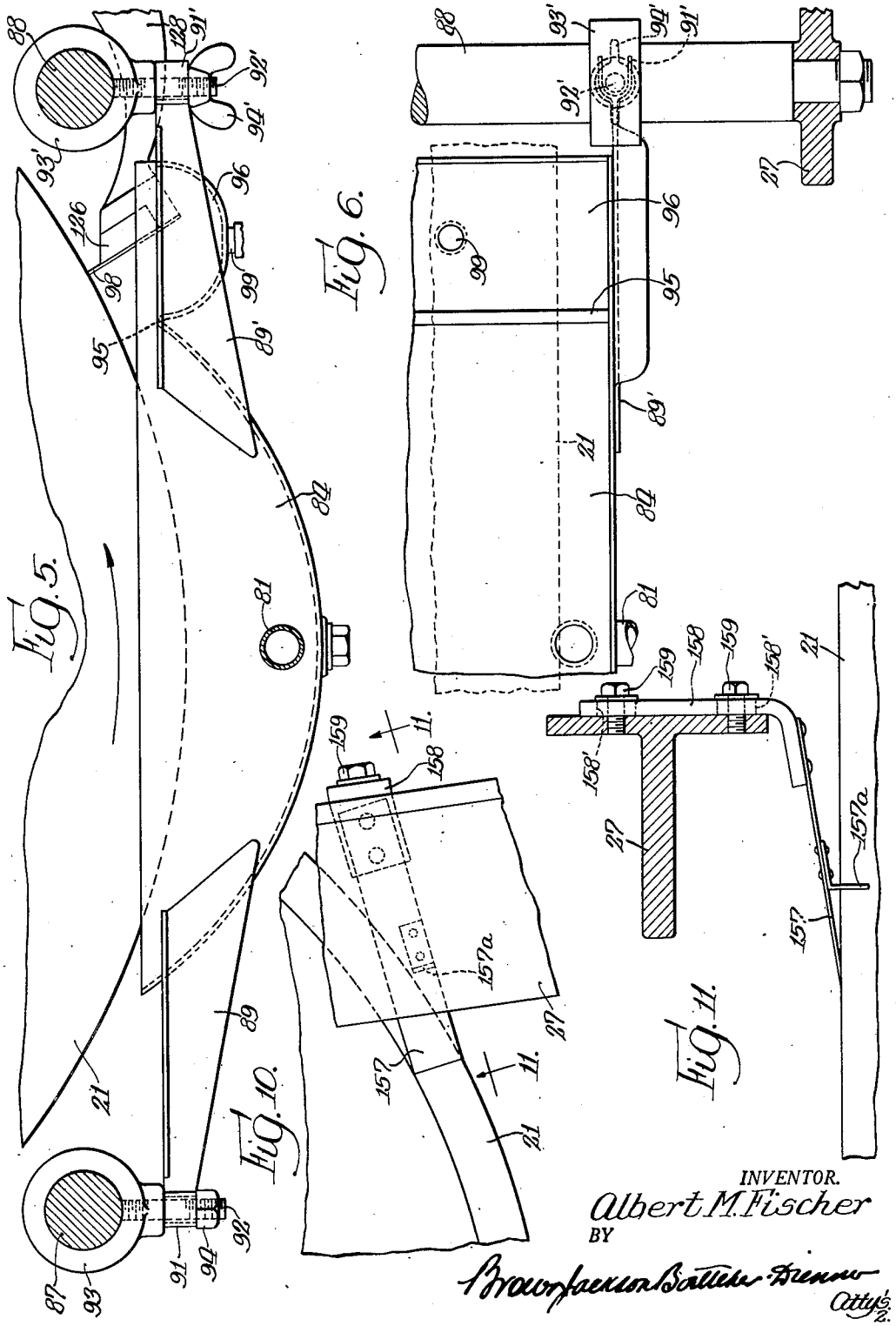


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YEAST DRYING APPARATUS

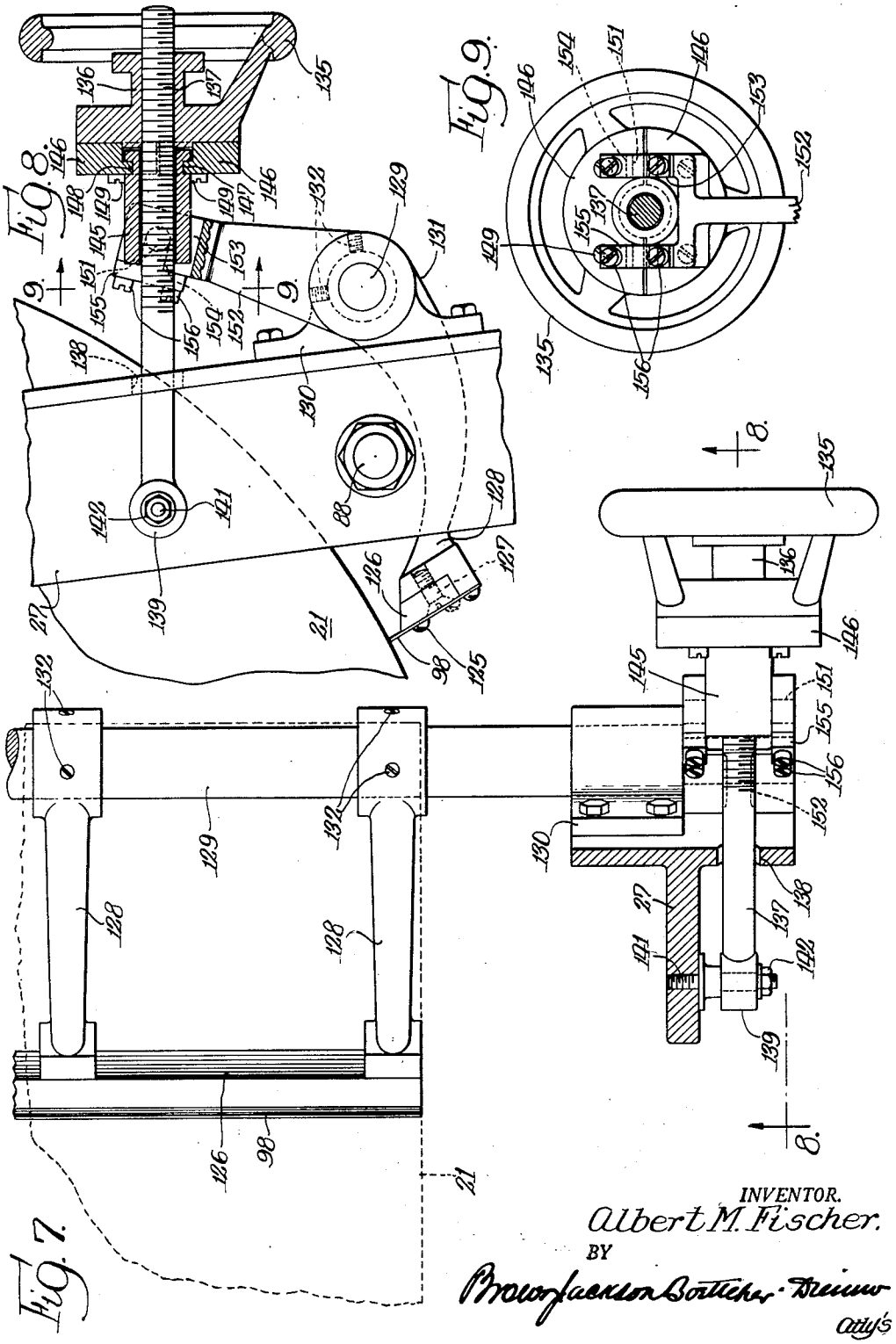
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YEAST DRYING APPARATUS

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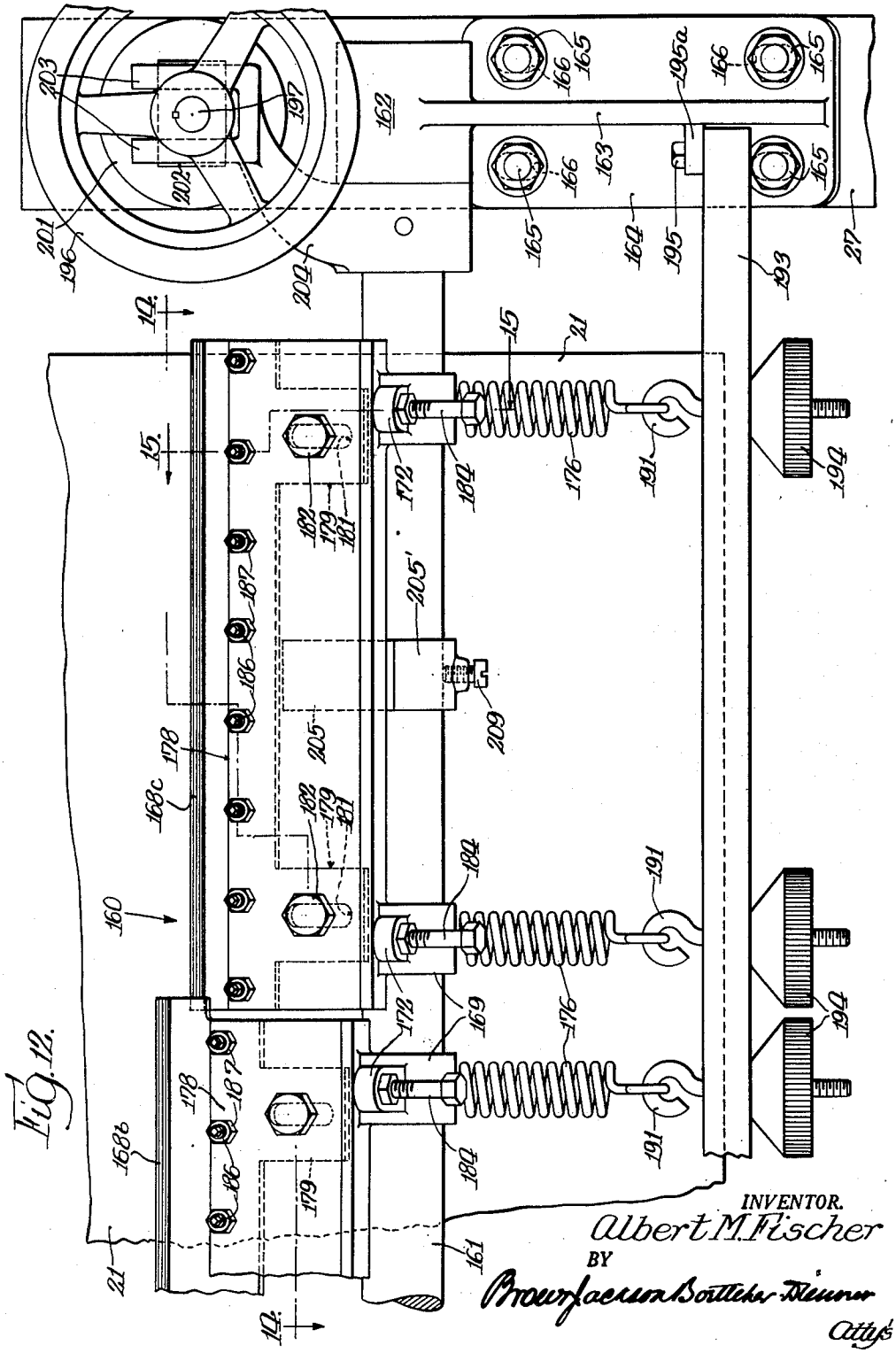


Fig. 12.

Sept. 12, 1950 A. M. FISCHER 2,521,706

YEAST DRYING APPARATUS

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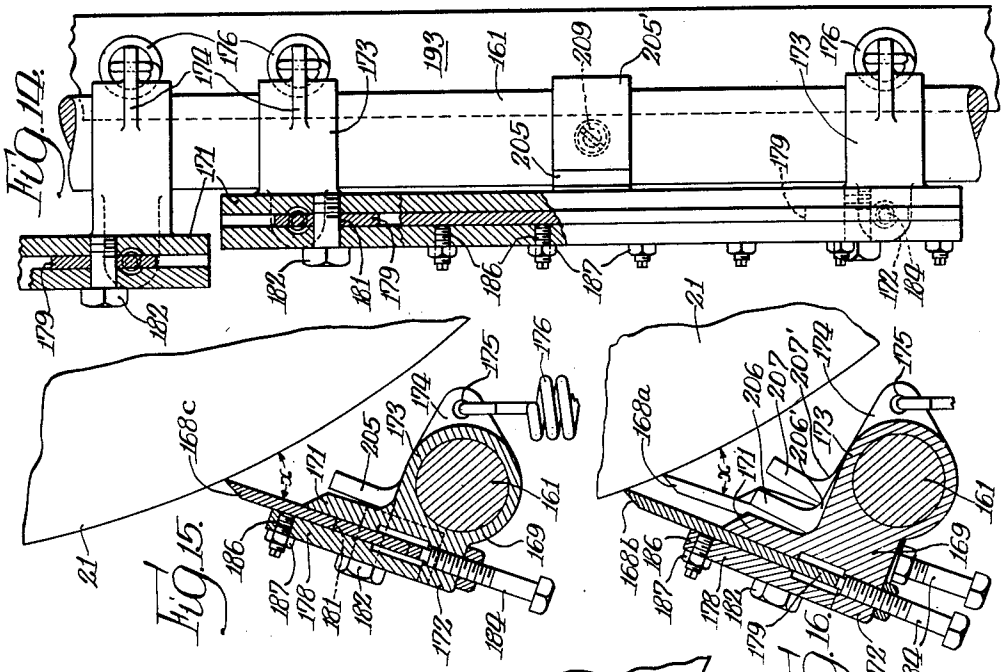


Fig. 12.

Fig. 15.

Fig. 16.

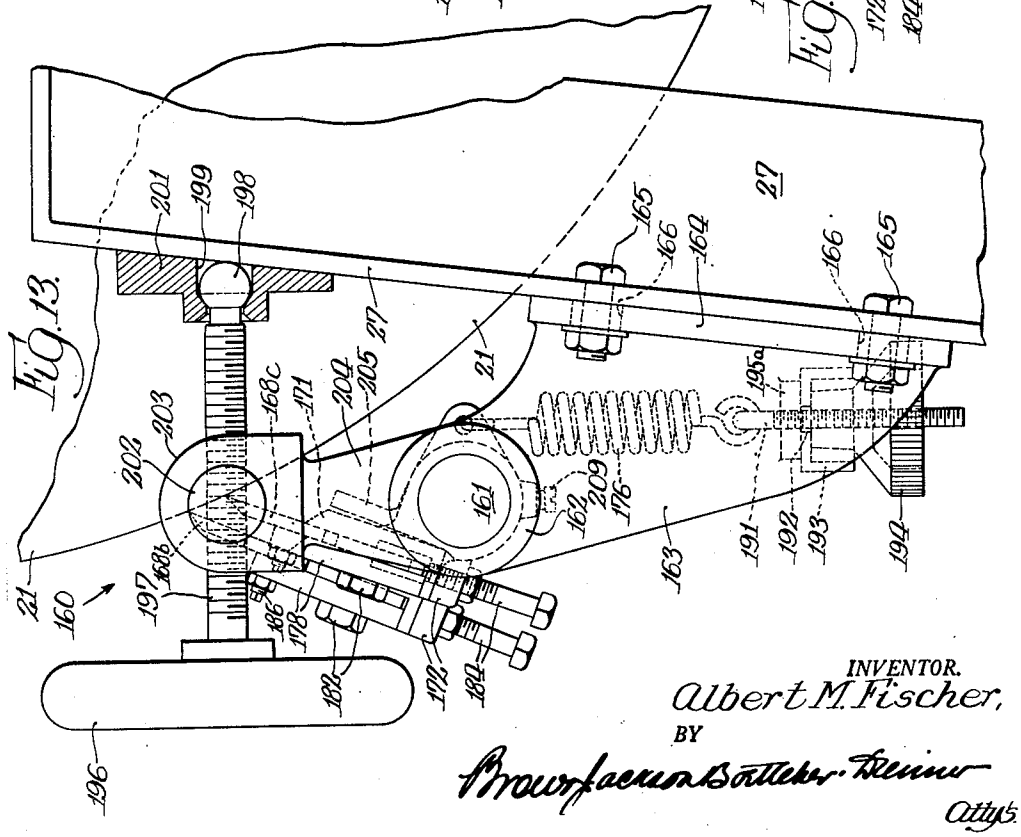


Fig. 13.

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Patented Sept. 12, 1950 2,521,706

UNITED STATES PATENT OFFICE

2,521,706

YEAST DRYING APPARATUS

Albert M. Fischer, Chicago, Ill.

Application April 14, 1943, Serial No. 483,032

4 Claims. (Cl. 159—11)

1

The present invention pertains generally to an improved method of and apparatus for drying yeast. More particularly, the invention is directed to improved yeast drying apparatus of the revolving drum type in which the yeast is dried on the outer surface of a rotating heated drum at atmospheric pressure.

One of the principal objects of the invention is to provide yeast drying apparatus of this general type which is suitable for automatic operation in the drying of brewer's surplus yeast.

Another object of the invention is to provide an improved yeast drying apparatus and method which will preserve to the maximum degree the heat labile vitamins and other food values in the yeast, and which will produce a purer dried brewer's yeast of higher vitamin potency.

In this regard, one of the more important objects of the invention is to provide an improved circulation of the yeast or an improved method of handling the yeast in the operating cycle of the apparatus, whereby to avoid objectionable overheating of the yeast and objectionable overexposure of the yeast to the atmosphere and thereby oxidation, during the time that the yeast is still in the liquid state and is being circulated through the apparatus or is being made ready for the actual drying on the drying drum. I have found that this is quite important in order to preserve to the maximum degree the heat labile vitamins and other food values in the yeast. The yeast passes through four temperature stages in the complete cycle of my improved method. The first temperature is the storage temperature, the second is the intermediate or preheated temperature, the third is the temperature in the circulation stage, and the fourth is the drying temperature. The storage temperature is usually quite low, being generally in the neighborhood of 33° F., so as to inhibit fermentation and/or autolysis of the yeast. However, the yeast is of relatively heavy consistency at this low temperature and it is difficult to circulate it through the apparatus, difficult to screen, etc. Accordingly, my improved apparatus and method embodies the step of raising the yeast to an intermediate temperature before application to the drum. This intermediate or preheated temperature is preferably in the neighborhood of 160° F., although substantial deviations may be made in either direction from this temperature is desired. The preheated circulating volume of yeast is pumped into a dip trough or feed trough through which the lower periphery of the drum revolves, and it is here that the yeast is brought into direct

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contact with the drying drum or into immediate proximity thereto. This, of course, raises the temperature of the yeast to about 190°, and for this reason the quantity of yeast in circulation should be as small as possible, thereby assuring a speedy conversion to the dry state and lowering of the temperature to that of the surrounding atmosphere. Such portions of the circulated volume as do not adhere to the surface of the drum, or are wiped off the drum by the equalizer which prevents an excessive thickness of film accumulating on the drum, are carried over or are dropped into a spill trough from which they flow back to the circulating compartment. As successive quantities of yeast adhere to the drum, so that the circulated volume gradually becomes depleted, the reserve or storage volume of preheated yeast automatically feeds into this circulated volume of preheated yeast so as to maintain an adequate volume for circulation. However, this circulated volume is substantially smaller than the reserve or storage volume of preheated yeast, and accordingly only a relatively small circulated volume is subjected to contact with the high temperature of the drying drum, and to contact with the atmosphere. The drying drum preferably operates at a temperature in the neighborhood of 300° F., which can deleteriously affect heat labile vitamins in the yeast if the liquid yeast is continuously or recurrently circulated into contact with the drum over substantial periods of time before the yeast actually adheres to the surface of the drum in the drying step of the cycle. This deleterious action of the high temperature of the drum on vitamin potency is avoided or minimized by the aforementioned method of dividing the preheated batch of yeast into a substantial reserve volume and a relatively small circulating volume, and only bringing the smaller circulating volume into contact with the drum.

The preheating step of the cycle is also advantageous for screening the yeast. It may be desirable to remove trub and hop resins from the yeast by screening, and this is greatly facilitated by preheating the yeast to obtain ready flow through the screens. Such avoids the objectionable procedure of adding water to the yeast to secure flow through a screen, and having to remove this excess water in the subsequent drying process.

Another object of the invention is to provide an improved manner of applying the liquid yeast to the cylindrical surface of the drum in the form of a thin film.

Another object of the invention is to provide

improved equalizing apparatus for distributing and equalizing the thickness of the film of yeast over the surface of the drum.

Another object of the invention is to provide an improved construction and arrangement of scraper blade mechanism for stripping the dried yeast from the drum. This mechanism includes improved adjustments for adjusting the scraping blades relatively to the drum. It also includes improved lifting apparatus for moving the scraping blades into and out of operative engagement with the drum, the movement of the several blades back into engagement with the drum being a sequential operation in which the blades engage the drum successively instead of simultaneously in order to avoid the placing of an abrupt or abnormal load on the machine.

Other objects, features and advantages of the invention will appear from the following detail description of one preferred embodiment of the apparatus and one preferred method of carrying the invention into effect. In the accompanying drawings illustrating such embodiment:

Figure 1 is an end elevational view of the machine, some of the associated apparatus being illustrated schematically;

Figure 2 is a side or front elevational view of the machine, a portion of the conveyor trough being broken away to show the conveyor screw;

Figure 3 is a fragmentary side view of the preheating chamber, illustrated partly in section to show the reserve compartment and the circulating compartment;

Figure 4 is an end view of the preheating chamber, also showing the dip trough and the spill trough in section;

Figure 5 is a fragmentary end view showing the mounting of the dip and spill troughs, and also showing the relation of the equalizer to the spill trough;

Figure 6 is a fragmentary plan view of the latter arrangement;

Figure 7 is a fragmentary plan view of the equalizing mechanism for distributing and equalizing the film of yeast on the drying drum, and for predetermining the thickness of said film;

Figure 8 is a transverse sectional view taken approximately on the plane of the line 8—8 of Figure 7;

Figure 9 is a detail sectional view taken on the plane of the line 9—9 of Figure 8;

Figure 10 is a fragmentary elevational view of one of the end scrapers;

Figure 11 is a detail sectional view taken on the plane of the line 11—11 of Figure 10;

Figure 12 is a fragmentary front elevational view of the scraper blade mechanism;

Figure 13 is an end view thereof;

Figure 14 is a horizontal sectional view taken approximately on the plane of the line 14—14 of Figure 12;

Figure 15 is a detail section taken on the plane of the line 15—15 of Figure 12; and

Figure 16 is a section similar to Figure 15 but taken at another point along the scraper blade mechanism.

Referring first to Figures 1 and 2, the heated drying drum is indicated at 21, this drum being hollow for the circulation of steam or other heating medium therethrough. Secured to opposite ends of the drum are supporting trunnions 22 and 23 (Figure 2) which are journaled for rotation in bearings 24 and 25 which are mounted on the end standards 26 and 27 of the supporting frame 28. The bearings 24 and 25 are preferably of the self-aligning type so as to facilitate assembly and minimize bearing wear. The bearing shaft 22' of the left hand trunnion 22 carries a large spur gear 31 which is driven by a driving pinion 32 which is adapted to be driven at any selected speed through a variable speed drive mechanism 33, the latter receiving its power in-put from an electric motor or other driving source. The ability to adjust the speed of rotation of the drum 21 through the instrumentality of the variable speed unit 33 enables the apparatus to be adjusted to different temperatures, humidity conditions, and other operating conditions.

Steam for heating the drum 21 is conducted through supply pipe 36 to a manifold housing 37 which is assembled over the end of the right hand trunnion shaft 23'. This right hand trunnion shaft is hollow for the circulation of steam therethrough into the rotating drum 21, and the inner end of the manifold housing 37 is provided with an adjustable stuffing gland 38 for maintaining a steam-tight joint at this point where the manifold housing engages over the end of the rotating trunnion shaft 23'. The discharge of condensate and exhaust steam from the drum occurs through a discharge pipe 39 which passes axially through the hollow trunnion 23' in spaced relation to the bore of this hollow trunnion. As indicated in dotted lines, the inner end of this discharge or condensate pipe 39 is provided with a downwardly extending end 39' or any other equivalent device which is adapted to draw the condensate and exhaust steam from the lower interior portion of the drum, these devices being well known and serving to prevent the accumulation of an excessive amount of condensate within the drum. The discharge pipe 39 rotates with the drum and has its outer end extending into manifold housing 37, this outer end being surrounded by an adjustable stuffing gland 41 carried by the manifold housing 37. Said manifold housing has attachment to the end frame member 27 through a mounting bracket 42. A drain pipe 43 screws into the outer member of the stuffing gland, in communication with the condensate pipe 39, and conducts the condensate and discharge steam from the end of said condensate pipe down to a T connection 44. Leading from the lower end of T connection 44 is a vent valve 45 which acts as a vent for the drying drum 21 and which serves to discharge condensate, even in the absence of steam pressure. Leading from the lateral port of the T connection 44 is a pipe 46 which is adapted to conduct condensate and exhaust steam into a steam trap 47. From this steam trap the condensate is conducted to the heating jacket of a preheating chamber disposed below the drum 21, as I shall now describe.

This preheating chamber, designated 51 in its entirety, is of approximately V shaped trough formation (Figure 1) disposed directly below the drying drum 21 and detachably mounted by suitable slide brackets to the end frame members 26 and 27. These slide brackets enable the chamber 51 to be slid sidewise out from under the drum. Surrounding the bottom and both sides of this preheating chamber is a heating jacket 53 which receives condensate at its lower right hand end through pipe 54, leading from the outlet end of the steam trap 47. The condensate is discharged from the heating jacket 53 at an elevated point adjacent to its left hand end through waste pipe 55 (Figure 1). As shown in Figures 2

and 3, the preheated chamber 51 is divided by a transverse partition 57 into two longitudinally spaced compartments 51a and 51b, compartment 51a being a heated storage compartment for the yeast, and compartment 51b being a heated circulating compartment for the yeast. A spill opening 58 extends through the partition 57 at a relatively high level (Figure 3) so that the heated yeast at the upper level of the batch in the storage compartment 51a overflows through said opening into the circulating compartment 51b. As shown in Figure 2, an agitator 59, of the propeller or any suitable type, is mounted at the left hand end of the storage compartment 51a for impelling a circulating flow of yeast toward the partition 57, the floor of this storage compartment 51a sloping downwardly toward said partition for draining purposes. The shaft 61 of the propeller agitator 59 extends out through a gland packing in the end of the compartment 51 and carries a sprocket wheel 62 at its outer end. Trained over this sprocket wheel is a sprocket chain 63 which passes over an intermediate transmission sprocket 64 (Figure 1) mounted on a stub shaft 65 projecting from the end frame 26. The sprocket wheel 64 is driven by a relatively small sprocket pinion 66 secured thereto, over which sprocket pinion is trained a main drive chain 67. The chain 67 passes up over a relatively large driving sprocket 68 which is mounted on the left hand trunnion 22' of the rotating drum, said main chain also passing around a pinion 69 which drives the feeding screw of the conveyor, as will be later described. The ratio between the large driving sprocket 68 and driven sprocket 66, and the ratio between the driving sprocket 64 and driven sprocket 62, are such that the agitator propeller 59 is rotated at a relatively high speed, compared to the slow rotation of the drying drum 21.

The yeast is supplied at a relatively cold state to the preheating chamber 51 from a low temperature storage vat 71, as shown in Figure 1. This storage vat stores the brewer's surplus yeast which results as a by-product of the brewing operation, and such vat may be located on a different floor level of the brewery than the yeast drying apparatus. A fluid pump 72 driven by the electric motor 73 draws the cold yeast from the vat 71 and pumps the same up through the supply pipe 74 to the preheating chamber 51, preferably discharging into the storage compartment 51a at a point adjacent to the propeller agitator 59. The yeast is drawn from the low temperature vat 71 at a temperature of approximately 33° F., and, accordingly, the pump 72 is preferably of the positive displacement rotary type to handle the viscosity of the yeast at this temperature, the pump also being of a type of preclude gravitational flow therethrough in situations where the storage vat 71 may be at a higher level than the preheating chamber 51. The operation of the pump motor 73 is governed by a float control switch which responds to the level of the yeast in the circulating compartment 51b, as I shall now describe.

As the yeast becomes heated in the preheating compartment 51a, it rises to the level of the overflow opening 58 and spills over into the circulating compartment 51b. From here the yeast flows down through take-off pipe 77 to a circulating pump 78 driven by electric motor 79. Because of the more fluid state of this preheated yeast (preferably ranging between 150 to 200° F.) the pump 78 may be a centrifugal pump, although a positive displacement pump may be employed if desired. The outlet of said pump is connected with pipe 81 in which is interposed a throttling valve 82 for governing the rate of circulatory flow of the preheated yeast to the dip or feed trough 84. A 3-way valve 85 may be interposed in the take-off pipe line 77. The dip or feed trough 84 is best shown in Figures 4 and 5, from which it will be seen that it is of open top arcuate form and is positioned immediately below the drying drum 21 so that the periphery of this rotating drum dips down into said trough for picking up yeast therefrom. The dip trough is suspended between two horizontal tie rods 87 and 88 extending between the ends frames 26 and 27 on each side of the drum 21. As best shown in Figure 5, supporting arms 89 project to the left from each end of the dip trough and carry vertical mounting bosses 91 at their ends. Studs 92 extend up through these bosses and tap into collars 93 which are rotatable about the supporting rod 87. Nuts 94, threading over the lower ends of the studs 92, serve to secure the mounting bosses 91 to the collars 93. At the opposite side the dip trough is provided with similar supporting arms 89' carrying forked yokes 91' at their ends for engaging over studs 92' which thread up into collars 93' rotatably mounted on the outer supporting rod 88. Wing nuts 94' releasably hold the forked yokes 91' over the studs 92'. By merely releasing the wing nuts 94' at each end of the dip trough, the trough can be swung down to a relatively accessible position for the purpose of cleaning out the trough at predetermined intervals or after the running of a predetermined batch. The feed pipe 81 which conducts the yeast up from the pump 78 into the dip trough 84 has an easily releasable coupling interposed therein near the trough, which enables the pipe to be disconnected from the trough when the trough is to be swung down into its lower position for cleaning.

The rotation of the drying drum 21 down through the dip trough 84 tends to carry yeast up over the right hand edge 95 of the dip trough, as viewed in Figure 4. To catch this overflow or spill portion of the yeast, the feed trough 84 is formed with a smaller spill trough 96 extending along its right hand edge. This right-hand spill edge 95 is lower than each of the edges around the other three sides of the dip trough 84 so that all excess yeast pumped into the dip trough spills over this overflow edge 95 into the overflow trough 96, in addition to the yeast which is carried by the drum periphery over into the overflow trough. An equalizing blade 98 extends along the entire length of the drying drum 21 for equalizing and predetermining the thickness of the yeast film carried upwardly on the surface of the drum. This equalizing blade is preferably adjusted to a position spaced a relatively minute distance from the drum, so that only a thin film of yeast is carried upwardly by the drum beyond this equalizing blade. Such equalizing blade is positioned above the overflow trough 96 so that all excess yeast which is stripped from the drum by the equalizing blade drops down into the spill trough 96. The apparatus for adjustably mounting the equalizing blade 98 will be later described. It will be seen from the foregoing that the spill trough 96 functions (1) to receive the excess yeast which spills over the overflow edge 95 irrespective of motion of the drying drum, (2) to receive excess yeast which is carried up on the periphery of the ro-

tating drum and which falls from said periphery before encountering the equalizing blade, and (3) to receive the excess yeast which is stripped from the predetermined film on the drum by the action of the equalizing blade 98.

The excess yeast accumulating in the spill trough 96 may be immediately returned by a direct path to the circulating compartment 51b of the preheating tank 51, for prompt recirculation through the circulating pump 78 back to the dip trough 84; or this excess yeast in the spill trough may be conducted through a separate screening path to suitable screening apparatus, from whence the screened yeast is then conducted back to the circulating compartment 51b for recirculation through pump 78 up to the dip trough 84 again. Referring to Figure 4, a return pipe 99 leading from the spill trough 96 conducts the excess yeast to two valves 100 and 101. Any suitable arrangement of releasable coupling 99' enables the spill trough to be released from the piping for downward swinging movement with the dip trough 84. Opening the valve 100 causes the excess yeast to take the direct path through pipe 100' immediately back to the circulating compartment 51b. Opening the other valve 101 causes the excess yeast to take the screening path through pipe 102 to the two screening units 103 and 104. A return pipe 102a in the screening circuit returns the yeast from the screens 103, 104 to the circulating compartment 51b. A fractional opening of both valves 100 and 101 may be resorted to for causing part of the yeast to take the direct return path and part to take the screening return path. Screening of the yeast is frequently desirable or essential in order to obtain the most satisfactory quality of dried yeast. For example, in some situations the yeast may contain an objectionable amount of trub and hop resins which it is desirable to remove. To remove these substances the yeast usually has to be passed through a screen of approximately 40 or 50 mesh. When the yeast is in a cold state, as exemplified by the condition of the yeast when it is pumped from the low temperature storage vat 71, its consistency is too heavy to be passed through such a screen, at least without the addition of a substantial quantity of water. When following such prior procedure of adding water, the quantity of water to be added must at least be equal to approximately the weight of the yeast. The added surplus water has to be removed, either by settling out of the yeast and decanting of the supernatant water, or by mechanical separation, or by separate evaporation in a vacuum pan, or during drying. Some yeasts do not settle out at all and stay in suspension so that mechanical separation or evaporation becomes a necessity. It will be noted that by interposing the screening units 103 and 104 in that part of the circulatory path of the system which handles the yeast in a preheated state, the aforementioned dilution with water can be completely avoided. My improved process of producing a purified dried brewer's yeast utilizes the fact that wet yeast, upon heating, releases part of its cell content, and, therefore, flows very readily. The screening of the yeast, and thereby the removal of the trub and hop resins, is therefore accomplished by my improved apparatus during the drying operation without loss of time or without requiring additional labor. Each screening device 103 and 104 is provided with a removable straining screen 105 and 106, which may be of the same mesh or of different mesh. Separate control valves 107 and 108 govern the flow to the two filters, and a shut-off valve 109 is interposed in the return portion 102a of the circulating pipe 102 which conveys the strained yeast back to the circulating compartment 51b. A cross-connection 110 between the two separating devices 103 and 104 is provided so that in the event the screening or separating element in one of these devices becomes clogged the yeast will automatically overflow through the cross-connection 110 into the other device and pass through its screening or separating element. The capacity of the circulating pump 78 is preferably such that the entire volume of yeast in the circulating compartment 51b can be pumped over the screen or screens in the separating units approximately once every three minutes. It will hence be seen that any trub and hop resins arriving in the preheating tank 51 can therefore be screened out within a short time.

The supply of yeast to the preheating compartment 51a, and the liquid levels in the preheating compartment 51a and in the circulating compartment 51b are governed by a float controlled switch 112. This float controlled switch comprises a swinging float 112a mounted in the circulating compartment 51b to respond to the level of yeast therein, this swinging float being connected through suitable operating linkage 112b with an electrical switch 112c. The operating relation is such that when the float 112a falls to a predetermined level, the switch 112c is closed, and when the float rises to a predetermined level the switch is opened. The pilot switch 112c governs a pilot circuit 114 which controls the energization of an electromagnet 115 serving to actuate a power switch 116. The power switch 116 controls the connection of the power circuit 117 to the electric motor 73 which drives the yeast supply pump 72. The pilot circuit 114 may tap off the power circuit 117. The operating relation is such that when the level of the yeast in the circulating compartment 51b falls to a predetermined low point, the descending float 112a closes the pilot switch 112c and operates through the electromagnet 115 to close the power switch 116. Thereupon the electric motor 73 drives the supply pump 72 to pump an additional quantity of yeast from the storage vat 71 to the preheating chamber 51 so that more of the preheated yeast will flow from the preheating compartment 51a through the spill opening 58 into the circulating compartment 51b. When the quantity of yeast in the circulating compartment 51b is restored to its desired high level, the rising of float 112a will open the pilot switch 112c and, in turn, open the power switch 116 to interrupt continued feed of yeast to the preheating chamber.

Referring to Figure 3, a connecting valve or cock 121 is provided adjacent to the bottom of the partition 57 so as to establish communication between the preheated storage compartment 51a and the preheated circulating compartment 51b at the end of a yeast drying operation. This cock is actuatable by an operating handle 122 accessible at the top of the preheating tank 51. When approaching the end of a given batch of yeast or the end of a predetermined yeast drying cycle, the cock 121 is opened so as to drain substantially all of the preheated yeast from the storage compartment 51a into the circulating compartment 51b, thereby enabling substantially

all of the yeast in both compartments to be circulated up to the dip trough 84 for application to the drying drum. As a very sensitive switch is employed, the liquid level in the compartment 51b is maintained within ⅛ inch, thereby avoiding variations in the temperature of the yeast in the circulating compartment.

Referring again to the equalizing blade 98 which predetermines the thickness of the film of yeast adhering to the drying drum, the adjustable mounting for this equalizing blade is illustrated in Figures 7, 8 and 9. Said equalizer blade is preferably one or more long, thin strips of stainless steel secured by screws 125 to a backing bar 126. At spaced points along its length this backing bar 126 is secured by screws 127 to mounting arms 128 which are carried by a rotatable mounting shaft 129. Said shaft 129 is journaled in bearing brackets 130 secured to the end frame standards 26 and 27. The hub 131 of each mounting arm 128 is adjustably secured to the shaft 129 by one or more set screws 132. By loosening these set screws and separately adjusting the mounting arms 128, the backing bar 126 may be shifted until it is parallel to the drum. Still further, the mounting screws 125 pass through elongated slots in the equalizer blade 98, so that by loosening these screws the blade, or any portion thereof, may be shifted upwardly or downwardly relatively to the backing bar 126. Thus, the equalizing blade may be minutely adjusted at different points along its length so as to maintain a relatively accurate predetermined spacing from the surface of the drum. The thin stainless steel blade projects substantially beyond the mounting bar 126 so that the stripping edge of the blade has some resiliency relatively to the mounting bar, and hence can yield if it should be pressed against the surface of the drum.

The equalizing blade can be adjusted toward or away from the drum to vary the thickness of the adhering film of yeast by the manipulation of a hand wheel 135. This hand wheel is provided with an internally threaded hub 136 which is adapted to screw back and forth along a threaded shaft or pintle 137 as the hand wheel is rotated. The inner end of this threaded shaft passes through a vertical slot 138 in the adjacent flange of the frame standard 27, and is formed with a pivot eye 139 at its inner end. A shouldered pivot stud 141 screws into a tapped hole in the transverse flange of the end standard, and has its outer end passing through the pivot eye 139 and receiving a nut 142 on its reduced end. Such mounting of the threaded shaft 137 holds the shaft against axial rotation but enables it to oscillate vertically around the pivot stud 141. A shifter collar 145 is coupled to the hub of the hand wheel 135 by the split halves of a coupling collar 146 which compel the shifting collar 145 to move endwise with the hand wheel but do not compel it to rotate therewith. The collar halves 146, 146 are formed with inwardly extending flanges 147 which seat in an annular groove 148 formed in the shifter sleeve 145. Screws 149 detachably secure the collar halves 146, 146 to the hub portion 136 of the hand wheel. The inner end of the shifter collar 145 has two trunnion pins 151 projecting outwardly from opposite sides thereof. Secured to the adjusting shaft 129 is an actuating arm 152 which is formed with spaced yoke arms 153 at its upper end arranged to embrace the shifter sleeve 145. Slots 154 extend in laterally from one side edge of each yoke arm, and the trunnion pins 151 seat in the bottoms of these slots. A retaining plate 155 is then secured over this edge of each yoke arm by cap screws 156. Each of these retaining plates has a lug portion extending inwardly into its slot 154 for confining the trunnion pins in the lower ends of said slots. The above described construction establishes a close fitting operating connection between the shifter sleeve 145 and the actuating arm 152 so that there will be no play between these parts to destroy minute adjustments of the equalizing blade 98. It will be evident that as the hand wheel 135 is screwed outwardly or inwardly along the threaded shaft 137, the equalizer blade 98 will be adjusted toward or away from the drying drum 21, the threaded shaft 137 swinging vertically around the pivot stud 141 to accommodate the angular motion of the actuating arm 152.

By reason of the fact that the drying drum 21 is dipping down into the dip trough 84 in its continuous rotation, it necessarily picks up liquid yeast on each of its end surfaces. This has the advantage of increasing the evaporating surface of the drum, corresponding to the areas of these end surfaces immersed in the yeast. However, the accumulation of yeast must be removed from these end surfaces, otherwise it will continue to cake thereon to an objectionable thickness. Figures 10 and 11 illustrate an improved form of end scraper, designated 157, employed at each end of the drum for removing the end film of yeast. This scraper is in the form of a spring steel blade which has its outer end riveted to an adjustable bracket 158 secured by cap screws 159 to the nearby leg of the adjacent end frame 26 or 27. The bracket 158 has enlarged circular holes or elongated slots 158' for receiving the cap screws 159, whereby to facilitate adjustments in the angle and tension of the scraper blade. The scraper is preferably adjusted so that its contact against the end of the drum produces hardly any friction. For this purpose, the circular outer area of each drum head passing through the liquid yeast must be accurately machined so that the scraper blade 157 will have a smooth machined surface against which to bear. It will be understood that the outer cylindrical surface of the drum also has a smooth machined and ground surface. Projecting laterally inwardly from the lower portion of the end scraper 157 is a small auxiliary equalizer 157a which acts to equalize or prevent objectionable accumulations of yeast on the peripheral surface of the drum adjacent to the end heads. This auxiliary equalizer has its operating edge spaced from the periphery of the drum a distance corresponding to the desired thickness of yeast film on the drum. When the yeast is removed from the end of the drum by the end scraper 157, some of the liquid yeast will accumulate on the edge and will flow by gravity to the cylindrical surface of the drum and will work back along the cylindrical surface an appreciable distance. Inasmuch as the cylindrical surface is already covered with yeast at this point, the additional yeast coming from the end scraper will not dry by the time it reaches the scraper blades or knives at the far side of the drum's rotation. The auxiliary equalizers 157a avoid this condition by spreading excess yeast from the cylindrical surface of the drum adjacent to the end heads, thereby enabling it to dry by the time it reaches the scraper blade. The yeast which is removed from the left hand end of the drum

by the scraper and equalizer 157—157a at this end of the machine drops down into the preheated storage compartment 51a, for recirculation back into contact with the drum, while the yeast which is removed from the right hand end of the drum by the scraper and equalizer 157—157a at this end of the machine drops down into the preheated circulating compartment 51b, and possibly into the spill trough 96 as well, also for recirculation back into contact with the drum. This yeast is partly dehydrated and is removed from the ends of the drum in cake-like consistency. It will thus be seen that the two end surfaces of the drum are utilized as drying surfaces for increasing the dried content of the liquid material being circulated into contact with the drum.

Referring now to the scraper blade mechanism for removing the dried yeast from the drying drum, this mechanism is indicated collectively at 160 in Figures 1 and 2, from which it will be seen that it extends across the front of the machine to bear against the lower front side of the drying drum. The scraper mechanism is assembled on a rotatable mounting shaft 161 which extends parallel to the drying drum adjacent to the lower front side thereof. The ends of this shaft are journaled in bearing bosses 162 which are formed integral with webs 163 projecting outwardly and upwardly from adjustable mounting brackets 164. Each mounting bracket 164 is secured by bolts 165 to the front flange of its respective end frame 26 or 27. The bolts 165 pass through vertically extending slots 166 in the mounting bracket 164, whereby the mounting bracket can be shifted upwardly or downwardly to different adjusted positions along the inclined front flange of the end frame. This vertical adjustment of the mounting brackets and of the mounting shaft 161 enables the angle between the scraper blades or knives and the cylindrical surface of the drum to be adjusted as desired, i. e., to adjust the intercepted angle between the scraper knives and the surface of the drum as viewed from the end of the machine. The scraper knife means 168 is preferably divided into a plurality of blade lengths disposed approximately end to end along the length of the drying drum. By dividing the knife apparatus into a purality of sections these sections can be arranged to engage the drum progressively so as to reduce the shock load when starting up the operation of the machine, and the sections are also easier to adjust relatively to the drum, and are cheaper to make and sharpen. In the illustrated embodiment I have shown the knife assembly divided into three knife sections, consisting of a middle knife 168b and two end knives 168a and 168c on each side thereof. The middle knife 168b is disposed slightly higher than the end knives so that it can overlap the adjacent extremities of the end knives and thereby avoid leaving any line of the drum which is not stripped by a scraping knife. Each knife section is mounted by substantially the same form of mounting holder or bracket and associated cover plate, and hence I shall only describe one of these assemblies. Each mounting bracket or holder 169 comprises a tilted plate portion 171 which extends horizontally substantially the length of its individual knife or blade. A right angle flange 172 projects outwardly from the lower edge of the plate portion 171, preferably along substantially the entire length of the holder. Adjacent to each end of the holder circular bosses 173 are formed integral with the plate and shelf portion 171—172 and project rearwardly for mounting on the adjustable supporting bar or shaft 161. These mounting bosses 173 are freely rotatable on the mounting shaft 161. Lugs 174 projecting inwardly from the mounting bosses 173 are apertured at 175 for receiving the hooked upper ends of tension springs 176 extending downwardly for attachment to spring tensioning devices which I shall presently describe. The action of these springs is that of continuously urging the scraper blades 168a—168c resiliently against the surface of the drying drum.

Each knife or blade is assembled against the front face of the plate portion 171 and is secured thereto by a clamping cover 178. Referring to Figure 12, each knife or blade 168a—168c is provided with downwardly projecting extensions or clamping lugs 179, as indicated in dotted lines. These extensions are provided with vertical slots 181 adapted to receive the shanks of cap screws 182. These cap screws pass through circular holes in the cover plate 178, and then pass through the vertical slots 181, and then tap into threaded bores in the upwardly extending flange portion 171 of the blade holder 169.

Provision is made for effecting three different scraping adjustments of each scraper blade relatively to the surface of the drum: viz, (1) an independent adjustment of either end of the blade toward or away from the drum substantially in the plane of the blade or in a plane parallel thereto; (2) an independent adjustment of either end of the blade toward or away from the drum in a plane substantially at right angles to the plane of the blade; and (3) an adjustment of the angle intercepted between the plane of the blade and the surface of the drum, this angle being indicated at x in Figures 15 and 16. The first of these adjustments, made in a plane coincident with the plane of the blade, or in a plane parallel thereto, is effected by the two downwardly extending adjusting screws 184 provided at each end of the blade holder 169. These adjusting screws thread through tapped bosses projecting down from the lower edge of the blade holder 169, the upper ends of these screws passing up through the step flange 172 and abutting against the lower edges of the slotted lug extensions 179 projecting down from the blade. It will be evident that upon loosening the clamping screws 182 the adjusting screws 184 can be operated selectively to shift either the left hand end or the right hand end of the blade upwardly or downwardly across the face of the mounting flange 171, thereby adjusting the cutting edge of the blade at either end toward or away from the surface of the drum in a plane coincident with the plane of the blade. After the desired adjustment has been obtained in this plane, the clamping screws 182 are then retightened to retain the blade in its set adjustment.

The second adjustment which occurs in a plane substantially at right angles to the plane of the blade is effected by a plurality of small adjusting screws 186 extending in a horizontal row across the upper edge of the cover plate 178. These adjusting screws thread into tapped bores in the cover plate 178, and are provided with lock nuts 187 adapted to abut against the outer surface of the cover plate. The inner ends of these adjusting screws are adapted to be forced against the outer surface of the blade or knife 168a—168c, whereby to flex any desired portion of the blade toward or away from the surface of the drum

in a plane extending at right angles to the plane of the blade. These adjusting screws 186 enable relatively minute adjustments of each blade to be made relatively to the surface of the drum. In practice, I place a source of light in the space between the back side of each blade and the surface of the drum, and then actuate the adjusting screws 184 and 186 until all points along the entire edge of the blade are in such accurate contact with the surface of the drum that no light passes therebetween. The third adjustment for varying the intercepted angle x (Figures 15 and 16) is effected by loosening the bolts 165 and sliding the mounting brackets 164 for the mounting shaft 161 upwardly or downwardly along the inclined side surfaces of the end frames 26 and 27, the slots 166 in the bracket 164 permitting such up and down sliding adjustment. Because of the angular slope of the front surface of each end frame 26, 27, and the angular relationship between the other parts of the assembly, this shifting of the mounting shaft 161 enables the blade to be adjusted for a greater or lesser intercepted angle x. The angle x can also be adjusted by turning the two screws 184. These screws will move the blades up or down, thereby decreasing or increasing the angle x. The screws 184 serve also to compensate for wear on the blades due to regrinding or sharpening. Either bracket 164 can be adjusted independently of the other, so that either end of the mounting shaft 161 can be adjusted slightly relatively to the other end.

The aforementioned tension springs 176 act on each end of the blade holder and tend to hold the blade against the drum with a resilient pressure during the scraping operation. As shown in Figures 12 and 13, the lower ends of these springs are hooked to eye bolts 191 which pass down through apertures 192 in a channel bar 193 and thread through tapped bosses of adjusting nuts or knobs 194, the latter bearing against the under side of the channel 193. The ends of the channel 193 are secured by bolts 195 to lugs 195a projecting from the webs 163 of the mounting bracket 164. Adjustment of the nuts or hand wheel knobs 194 enables the tension of the spring 176 to be increased or decreased for causing either end of the scraper blade to be pressed with a greater or lesser pressure against the surface of the drum.

At the conclusion of an operating cycle it is preferable to swing the blades 168a—168c outwardly to inoperative positions, out of contact with the drying drum. This is accomplished by rotation of a hand wheel 196 disposed at the right hand end of the machine. This hand wheel revolves a threaded shaft 197 provided with a spherical head 198 at its inner end, this spherical head seating in a spherical socket 199 formed in a bracket 201 which is bolted to the end frame 27, such mounting of the shaft 197 permitting the shaft to rotate and also to swing upwardly and downwardly through a limited arc. The threaded shaft screws through a threaded bore in a horizontally extending trunnion pin 202. The ends of the trunnion pin are journaled in the forked upper end 203 of an actuating arm 204 which is pinned to the mounting shaft 161. It will hence be seen that rotation of the hand wheel 196 is operative to oscillate the mounting shaft 161. Such motion of the mounting shaft is adapted to lift the blades 168a—168c progressively from the surface of the drum through the instrumentality of three different lifting arms 205, 206 and 207 which are set to act in sequence on the respective blade holders. Each lifting arm is formed as an integral upwardly projecting extension from a collar 205', 206' and 207'. Each of these collars is fixedly secured to the mounting shaft 161 by a set screw 209 (Figure 12). The lifting arm 205 is positioned to lift blade 168c from the drum; the lifting arm 206 is positioned to lift blade 168b from the drum; and the lifting arm 207 is positioned to lift the blade 168a from the drum. As shown in Figures 15 and 16, the arm 205 normally stands spaced a slight distance from the plate portion 171 of its respective holder, and the other two lifting arms 206 and 207 normally stand at increasingly greater distances from the flanges 171 of their respective holders. Hence, these lifting arms come into action progressively for lifting the scraping blades progressively from the surface of the drum, and, conversely, in the operation of restoring the blades to scraping position the blades engage the drum successively, thereby minimizing any possibility of imposing an abrupt or shock load on the drum and driving mechanism. When the drying machine is started up after having been shut down for a substantial interval, it is desirable that the drying drum be rotated slowly while it is being brought up to temperature by the steam entering through supply line 36, this preliminary rotation serving to bring about uniform heating and expansion of the drum surface. During this preliminary rotation the scraping blades or knives should not be allowed to contact the drum inasmuch as there is substantial likelihood of damaging the surface of the drum if the scraping blades are permitted to press against the drum when the drum is not carrying any protective film of yeast. As the yeast is brought into contact with the drum, there may result several idle revolutions of the drum in arriving at proper operating temperatures, adjustments of the equalizer blade 98, etc. This may result in a relatively thick film of yeast becoming encrusted on the drum before the scraping knives 168a—168c are brought into contact with the drum. If the knives were all allowed to engage the drum simultaneously, against this relatively hard encrusted film of yeast, there would result a substantial shock load in the operation of the machine. This is objectionable and is entirely avoided by the above described arrangement of the lifting fingers which result in the blades being brought into operative engagement with the drum in a progressive sequence so that only one blade is brought to bear against the encrusted film at one time.

As the dried yeast is stripped from the surface of the drum it falls outwardly over the outer surfaces of the scraping blades and drops down in the form of shreds into a longitudinal conveyor 210 which extends along the front side of the machine below the scraping blades (Figure 1). Front and rear deflector panels 211 and 212 direct all of the yeast down into the conveyor. A feed screw 213 extends along the arcuate bottom surface of the conveyor trough, and serves to propel the dried yeast toward one end of the trough. A cooling jacket 214 embraces the lower portion of the trough and is provided with suitable pipe connections 215 and 216 (Figure 2) for conducting cold water or other cooling medium through said jacket. It is desirable to cool the dried yeast before it is fed to the pulverizer. The left hand end of the feed screw 213 is provided with a shaft 217 projecting beyond this end of the conveyor trough 210. The shaft 217 carries a sprocket wheel 218 over which passes the drive chain 67

which is driven by the sprocket wheel 68 on the trunnion shaft 22' of the drying drum. The feed screw 213 conveys the flaked yeast toward the right hand end of the trough, from whence the yeast is conveyed in any suitable manner to a pulverizer or to a place of storage. In typical or preferred installations, the trough 210 is arranged to discharge into an elevator which carries the pulverized yeast up to an elevated inlet of a motor-driven pulverizing unit which breaks up the flaked yeast into very small particles. From this pulverizer the yeast can be conveyed to a place of storage, or can be packaged in bags, boxes or the like.

While I have illustrated and described what I regard to be the preferred embodiment of my invention, and the preferred method of carrying the invention into effect, nevertheless it will be understood that such are merely exemplary and that numerous modifications and rearrangements may be made therein without departing from the essence of the invention.

The feature of my improved adjustable scraper blade mechanism is being made the subject matter of a divisional application.

I claim:

1. In drying apparatus, the combination of a rotating drying drum, a dip trough into which said drum dips, means for preheating the liquid material, a circulating chamber for the preheated liquid material, circulating means for causing the preheated liquid material to flow from said circulating chamber to said dip trough, and for causing the excess liquid material to flow through a return path back to said circulating chamber, means for keeping the liquid material in the circulating chamber automatically at a desired level, and screening means interposed in said return path for screening the liquid material while the latter is in a preheated state.

2. In apparatus for drying brewer's surplus yeast, the combination of preheating means adapted to receive the liquid yeast from a source of supply and to preheat the same, said preheating means comprising a preheating storage compartment and a circulating compartment, said storage compartment discharging into said circulating compartment, a float responsive to the level of the liquid yeast in said circulating compartment, means responsive to said float for controlling the flow of yeast from said source of supply to said storage compartment, a rotating drying drum, a feed trough into which said drum dips, and means for circulating the preheated yeast from said circulating compartment to said feed trough and thence back to said circulating compartment.

3. In drying apparatus, the combination of a rotating drying drum, a dip trough into which said drum dips for receiving the liquid material, a main equalizing blade for equalizing the thickness of the film adhering to the cylindrical surface of said drum, end scrapers having direct contact with the ends of the drum for removing the semi-liquid material from the ends of said drum, and auxiliary equalizing blades carried by said end scrapers and extending over and spaced slightly from the cylindrical surface of the drum for removing excess liquid material flowing from the ends of said drum around onto the cylindrical surface thereof.

4. In drying apparatus, the combination of a pre-heating chamber for pre-heating the liquid material, heating means for heating said chamber, agitating means in said pre-heating chamber for agitating the liquid material in said pre-heating chamber, a circulating chamber, means for heating said circulating chamber, spill means connecting said pre-heating chamber with said circulating chamber for supplying the warmer liquid from the upper levels in said pre-heating chamber to said circulating chamber, a dip trough, pump means for causing the liquid material to flow from said circulating chamber to said dip trough, a rotating drying drum dipping into said dip trough, a spill trough disposed adjacent to said dip trough for receiving excess liquid material from said dip trough, and means for causing said excess liquid material to flow through a return path from said spill trough back to said circulating chamber.

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