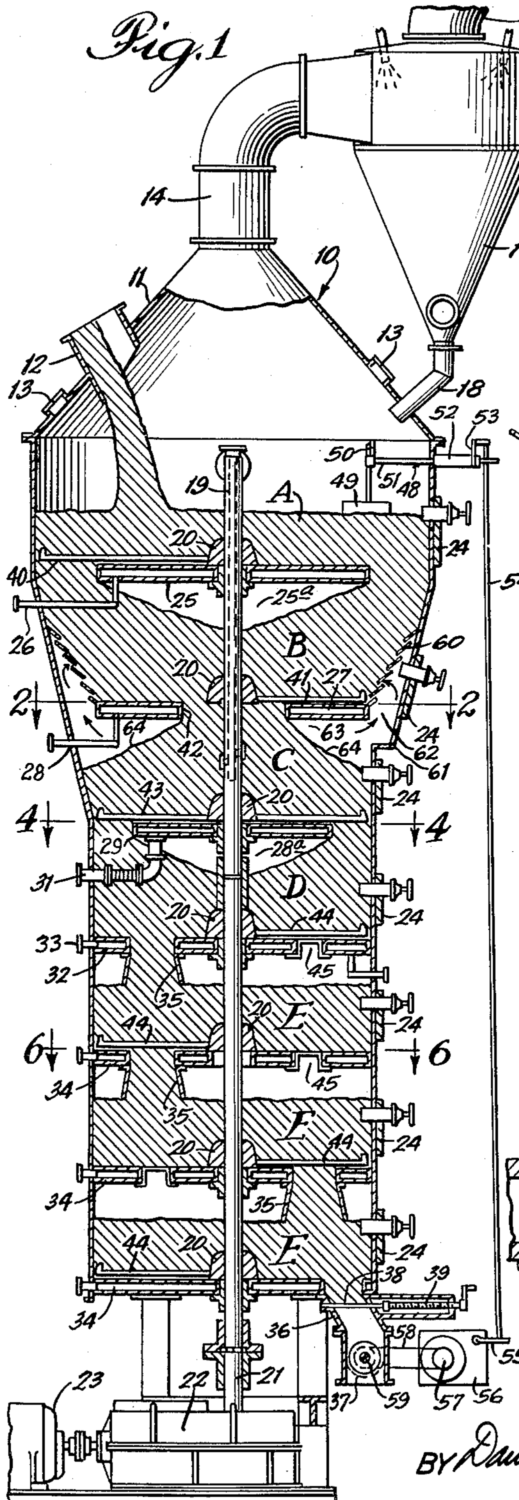
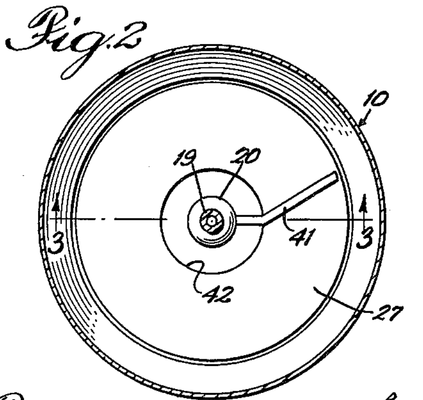
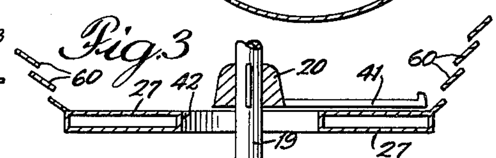
Jan. 30, 1962 N. F. KRUSE ETAL 3,018,564

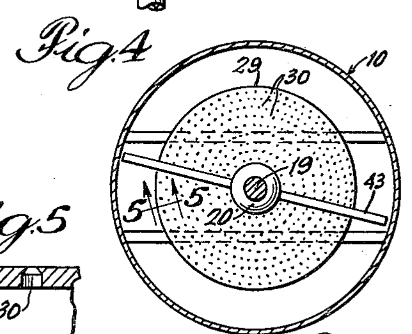
APPARATUS FOR TREATING FLOWABLE MATERIALS

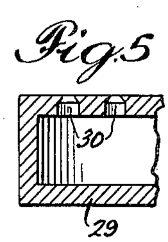
Filed Aug. 1, 1957

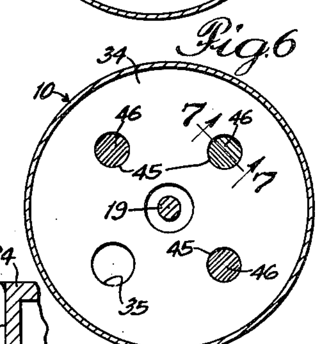


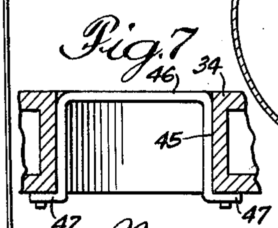












INVENTORS:
Norman F. Kruse and
Norman H. Witte,
BY Dawson, Tilton, Fallon & Lungmus,
ATTORNEYS.

3,018,564

APPARATUS FOR TREATING FLOWABLE MATERIALS

Norman F. Kruse and Norman H. Witte, Decatur, Ind., assignors to Central Soya Company, Inc., Fort Wayne, Ind., a corporation of Indiana

Filed Aug. 1, 1957, Ser. No. 675,641
6 Claims. (Cl. 34—173)

This invention relates to a material treating apparatus and process, and more particularly to a means and method for treating meal. The invention is especially useful in the treatment of solvent-extracted meals, including soybean oil meal, but the apparatus and process are also applicable to the treating of other materials and to materials containing solvent or other liquids threon.

By way of example and for the purpose of illustration, the invention will be described herein in connection with solvent-extracted soybean oil meal.

In United States Letters Patent No. 2,585,793, there is set forth a process in which solvent-extracted oil meal containing solvent or other liquid is heated below the boiling-point of water, steam being introduced into the meal to condense steam thereon so as to bring the moisture content of the meal into the range of about 14 to 30% and then cooking the meal at a temperature above the boiling-point of water to produce a toasted meal. In the practice, of the process, a casing provides a vertical series of kettles, and steam is introduced into various of the kettles and passed upwardly through the meal in the kettles. In such a process, it was found that at best only a small fraction of the steam employed in the process could be introduced into the lower kettles, because when a large volume of steam was employed in the lower kettles, flakes of the meal were carried from the topmost kettle into the condenser; as a result it was necessary to introduce the major portion of the steam within the top kettle. It has further been suggested that separate passages be provided around the kettles from the lower kettles to the upper kettles, through which steam and vapors from the lower kettles could be introduced into an upper kettle. While this represents a definite advance in the art, there is still a deficiency in that the vapors and steam traveling from lower kettles are not utilized during this transit by being brought in contact with meal throughout their path of travel. There has long existed a need for an apparatus and process by which vapors and steam leaving the lower kettles could be passed successively through the kettles in their upward travel to intimately contact meal therein while finally condensing the steam in an upper area and while also controlling the temperature of the top portion of the meal for condensing residual portions of the steam.

An object of the present invention is to provide apparatus and means for overcoming the above-described disadvantages and accomplishing the desired new results. A further object is to provide means whereby meal may be caused to follow a unique path of travel while at the same time providing large exposure areas whereby steam may be effectively passed through the meal slowly and in successive steps for effecting efficient condensation upon the meal particles. A still further object is to provide apparatus for maintaining a continuous bed of meal from the top to the bottom of the apparatus while at the same time withdrawing meal at a controlled rate so as to maintain a topmost layer of meal well above a heating zone so that a cooling layer is provided for condensing residual portions of the steam. Yet another object is to provide novel apparatus and process steps wherein liquid-bearing meal is freed of the liquid while at the same time effecting a drying or cooking of the meal under favorable moisture conditions for toasting or cooking

as the meal passes through the apparatus. Other specific objects and advantages will apear as the specification proceeds.

The invention is shown, in an illustrative embodiment, by the accompanying drawing, in which—

FIGURE 1 is a vertical, part-sectional view of apparatus embodying our invention and illustrating the process embodying our invention; FIG. 2, a transverse sectional view, the section being taken as indicated at line 2—2 of FIG. 1; FIG. 3, a broken enlarged sectional view, the section being taken as indicated at line 3—3 of FIG. 2; FIG. 4, a transverse sectional view, the section being taken as indicated at line 4—4 of FIG. 1; FIG. 5, a broken sectional detail view, on an enlarged scale, the section being taken as indicated at line 5—5 of FIG. 4; FIG. 6, a transverse sectional view, the section being taken as indicated at line 6—6 of FIG. 1; and FIG. 7, a detail sectional view, the section being taken as indicated at line 7—7 of FIG. 6.

In the illustration given, **10** designates apparatus providing a series of vertical kettles which are indicated by the letters A, B, C, D and E.

Casing **10** provides at the top of the apparatus an enlarged vapor dome **11** provided with an inlet **12** and with inspection openings **13**. Vapors pass from the dome through the conduit **14** to a vapor scrubber **15**, from the top of which a conduit **16** leads to a condenser. Slurry from the vapor scrubber is returned through pipe **18** to the upper kettle A.

A vertical shaft **19** is supported within bearings **20** within the apparatus and is connected at its lower end to a spur shaft **21** driven by a gear reducer **22** actuated by motor **23**.

The kettles may be formed by a single casing with separations therebetween and with means for passing meal downwardly from one kettle to another, while also passing vapors and steam upwardly through the meal in the kettles. Each kettle consists of a cylindrical shell and a steam-jacketed bottom, and steam and condensate connections are provided for each kettle except as noted later. Each kettle is also preferably provided with a quick-opening inspection door mounted in a larger access door **24**.

Kettle A is a vapor cooling and scrubbing kettle or zone, and it is provided with a jacketed bottom **25** to which steam is supplied by the pipe **26**.

Kettle B is a condensation kettle or zone, and it is provided with an annular heating jacket **27** to which steam is supplied through pipe **28**.

Kettle C is a steam stripping kettle or zone, and the bottom of this kettle is provided by a hollow steam sparging plate **29** provided at its upper side with a large number of steam apertures **30**, as shown in greater detail in FIGS. 4 and 5. Live steam is supplied to this plate through the pipe **31**.

Kettle D is a conditioning kettle or zone, and it is provided with a jacketed bottom **32** to which steam is supplied through pipe **33**.

The lowermost three kettles E are similar in construction, and each is provided with a jacketed bottom **34** heated by steam. These bottoms, like the bottom **32**, each have flared or funnel-like conduits **35** extending downwardly to the surface of the meal in the kettle therebelow, with the exception of the bottommost kettle E, which has an outlet **36** leading to a screw conveyor discharge **37**. In conduit **36**, there is provided a gate valve **38** controlled by a manually-operable thread-and-nut equipped handle member **39**.

Each of the kettles is provided with a sweep for agitating the flakes in the kettle. In kettle A, a sweep **40** is employed. In kettle B, the sweep **41** has a forwardlyinclined end portion for the purpose of directing flakes through the central opening **42** provided by the annular heating jacket **27**. Kettle C is provided with a double sweep **43**, as shown best in FIG. 4. In kettles D and E, single sweeps **44** are employed.

In kettles D and E, each of the jacketed bottoms is provided not only with the funnel-shaped chute, but also with vapor apertures **45** in which are mounted screens **46**. The screens are supported within the apertures **45** by passing cylindrical portions of the screen through the aperture and securing a flanged bottom portion **47** to the bottom of the steam jacket by bolting, or any other suitable means.

Mounted on the cylindrical wall of kettle A is a level control flag **48**, which is connected to a variable speed discharge member by mechanical or electrical linkage to maintain the proper material level in the kettle. In the specific apparatus illustrated, a flat member **49** is supported upon an angularly-extending shaft **50** carried by a rotatable shaft **51**. The shaft **51** extends through a bearing and seal assembly **52** and is provided with a fixed, angularly-extending lever **53**. To the end of the lever is secured a tie element **54** which engages a lever **55** at the lower portion of the machine. The lever controls the operation of a variable speed drive assembly **56** which drives a sprocket shaft **57** connected by chain **58** to a sprocket mounted on the discharge screw **59**. Thus, when the level in kettle A drops below a predetermined point, discharge from the lowermost kettle is reduced until the level is restored; and similarly, when the level in kettle A rises, the motor **56** is speeded up to increase the discharge from the lower kettle and bring the level to the desired point.

The kettle or basket B has enlarged or inclined side walls which are in the form of louvers **60**, as illustrated best in FIGS. 1 and 3. The inclined louver walls **60** diverge from the adjacent casing walls **61** to provide their bottom with an annular steam space **62**. At the same time, there is provided below the steam-jacketed bottom **27** an annular vapor space **63**. The annular body of meal in the kettle C provides a long inclined face **64** adjacent the vapor space **63** so that there is presented in communication two annular spaces **63** and **62** in which the communicating meal surfaces extend at a long angle, with the result that steam or vapor may pass readily through such meal spaces without disturbing the flakes while at the same time permitting the steam to pass from the lower bed of flakes in kettle C into the upper kettle B for intimate contact with the flakes or meal therein and for condensation thereon.

If desired, the outer portion of the kettles may be steam-traced with tubing to provide warm-up heating, or may be steam-jacketed and insulated to prevent heat loss.

Operation

In the operation of the apparatus, meal, flakes, or other material are passed through the inlet **12** into the dome and thence into kettle A. A bed of meal is maintained upon the steam-jacketed bottom **25** by the level device **49** and at such a distance above the heating member **25** that a cool layer or top portion of meal is maintained for condensing residual portions of the steam so that most of the live steam is utilized in condensing upon the meal. The meal passes downwardly in an annular stream around the bottom **25** and into the condensing zone or kettle B, and from thence the meal passes inwardly through the central opening **42** into the steam stripping zone or kettle C. Here, live steam is introduced into the meal from the sparging plate **29**. The steam rises through the meal, which has now assumed an umbrella shape, and excess steam escapes through the long face **64** of the meal body into the vapor space **63** and thence through the annular vapor space **62** where it enters back into the flakes or meal in kettle B through the louvers **60**. By this means, the steam is introduced along a wide annular area into the body of meal in kettle B so as to be effectively condensed therein. As already stated, the cool top layer of meal maintained in kettle A is effective in completing the condensation of the bulk of the steam. From kettle C, the meal passes downwardly through an annular stream around the central disk bottom **29** into the conditioning zone or kettle D. Here, the meal changes from a doughy condition or stage to a granular meal stage. From kettle D, the meal passes downwardly through the drying and cooking zones or kettles E and is discharged through the screw conveyor **37**.

In the foregoing operation, it will be noted that substantially all of the steam was introduced in the third kettle C, from which flows two important advantages. The feed flakes or meal entering the kettle A contain varying amounts of solvent. If the steam were introduced into the top kettle, there is a possibility that the solvent might pass through the steam area. With the present structure, if the solvent is very rich, the excess is primarily boiled off in the top kettle A so that when the meal reaches kettle C in which steam is introduced, there is a substantially uniform solvent content which is effectively removed by the steam. In other words, the irregularities in solvent content are ironed out by the time they reach the point at which steam is introduced into the system. The second advantage is that the topmost kettle can be kept relatively cool, at least with respect to its topmost portion, so that a much larger part of the steam can be utilized for condensation upon the flakes.

In the foregoing apparatus, there is provided means for maintaining a substantially continuous meal body from the topmost kettle to the lowermost kettle, while at the same time vapor spaces are provided between each of the kettles, the cross-sectional area of the vapor spaces or passages, being larger in the uppermost kettles than in the lower kettles to accommodate the larger volume of vapors which pass through the upper kettles. It will be noted that some of the vapor spaces are annular spaces about the meal, as illustrated by spaces **62** and **63**, while other of the vapor spaces are in the form of pockets enclosed within the meal, as, for example, the pocket area **25***a* below the steam-jacketed bottom **25**, and the space **28***a* below the steam sparging plate **29**. With this arrangement, vapors can be passed upwardly through the kettles without carrying meal with them and without channeling, and while also making intimate contact with the meal particles, and further, this structure permits the steam to condense uniformly upon the meal particle surfaces. At the same time, the bodies of meal in the lower kettles E provide in effect resistance beds which, together with their grids **46** having restricted vapor openings, prevent steam from flowing downwardly and cause it to move upwardly to perform the condensing function required.

By way of a specific example dealing with soybean oil flakes, the flakes from the extractor, containing approximately 0.5 lb. of solvent (hexane) per pound of dry flakes, enter the apparatus through the feed chute **12**. Live steam of good quality is injected through the sparging plate **29** at a rate of approximately 250 lbs. of steam per ton of solvent-free flakes.

The steam flows upwardly through the unit countercurrent to the downward flow of flakes, condensing on the flakes as it rises through the bed. Steam leaving the top of the flakes in kettle C reenters the flakes in kettle B via the louvered panels on the side of kettle B. The heat of condensation vaporizes the hexane from the flakes and raises the flake temperature. The temperature of the flakes in the top section of kettle A is preferably maintained at about 150–170° F. Flakes leaving kettle C (below the sparging plate) are preferably at a temperature of about 210–215° F. and contain about 18–20% moisture and are substantially solvent-free.

In kettles D and E, the flakes are heated by the jacketed bottoms, raising the temperature to about 220–230° F.

and evaporating some of the moisture from the flakes. The steam generated in this drying and toasting zone flows upwardly through the apparatus and joins the steam coming from the sparging plate to be used in the desolventizing action and in the condensing action. The evaporation of steam from the meal in the drying zone thus provides a steam stripping action on the meal to insure complete removal of solvent.

While the lower section of the apparatus is commonly called the "toasting section," actual toasting begins in the top (desolventizing) kettle A as soon as the live steam condenses on the flakes. The rapid condensation of live steam produces a rapid change in the protein structure so that the intermediate sticky stage in the toasting process is largely avoided.

Vapors leaving the dome will be at a temperature of about 150–180° F. and will contain .06 to .20 lb. of steam per pound of hexane vapor. This small portion of the steam will not condense because the partial pressure of the steam in the vapors is substantially equal to the vapor pressure of water at the temperature of the flakes in the top kettle. However, by maintaining the top portion of the meal relatively cool, as above described, the residual portions of the steam which can be condensed are utilized by condensing the same on the flakes in the top layer referred to.

While, in the foregoing specification, we have set out specific apparatus and method steps in considerable detail for the purpose of illustrating the invention, it will be understood that such details of structure and of operation may be varied widely by those skilled in the art without departing from the spirit of our invention.

We claim:

1. In apparatus for treating free-flowing material containing liquid, a casing providing a chamber, trays supported in said casing in fixed spaced-apart relation to divide said chamber into a plurality of superposed compartments having communicating material-conveying passageways therebetween, whereby material extends from the bottom of said chamber to the top level of the material in the uppermost compartment, rotating means adjacent the upper surfaces of said trays for moving the material to the passageways, one of said trays in an upper compartment being spaced from said casing and having a horizontal annular shape providing a large central passageway for flow of material therethrough, side louvers spaced from said casing and extending upwardly between said upper compartment tray and said casing to provide a passageway about said upper compartment communicating with the compartment below, and the tray of said last-mentioned compartment having a horizontal, centrally-located supporting surface in spaced relation to said casing whereby one of said above-mentioned communicating passageways provides an annular material-conveying passageway to another compartment immediately subjacent therebelow, said centrally-located surface supporting said material in a central cone merging with the central passageway of said first-mentioned annular tray, and pipe means for supplying steam into the bottom of said central cone of material said louvers being inclined, superposed and overlapping inwardly to contain the material while permitting through flow of vapors.

2. The structure of claim 1 in which the uppermost compartment is enlarged to a diameter substantially greater than the diameter of the casing therebelow.

3. The structure of claim 2 in which the uppermost compartment is provided with a tray having a centrally-

located floor providing an annular passage communicating with said compartment immediately subjacent therebelow provided with said annular tray.

4. In meal-treating apparatus, a casing and trays providing a vapor dome and a plurality of superposed kettles therebelow, an upper kettle thereof having an annular horizontal tray providing a central large passageway for flow of meal therethrough, side louvers spaced from said casing and extending upwardly to form side walls about the lower portion of the upper kettle, said louvers spaced from the casing providing a passage about said upper kettle communicating with the kettle immediately subjacent therebelow, said louvers being inclined, superposed and overlapping inwardly to contain the material while permitting the through flow of vapor, a kettle therebelow having a centrally-located tray in spaced relation to said casing to provide an annular passageway to another kettle therebelow, said centrally-located tray supporting said meal in a central cone merging with the central passageway of said first-mentioned kettle, meal-stirring means adjacent the upper surface of said tray for moving the meal toward said passageways, and means for supplying steam into the bottom of said central cone of meal.

5. The structure of claim 4 in which said vapor dome is of greater diameter than the casing portion therebelow and in which said casing portion below said vapor dome tapers downwardly and inwardly, the inclined portion of said casing providing said passage about the louvers of said upper kettle.

6. In apparatus for treating free-flowing material, a casing providing a vertical chamber, trays supported in said casing in fixed spaced-apart relation to divide said chamber into a plurality of superposed compartments having communicating passageways therebetween, whereby material extends from the bottom of said chamber to the top level of the material in the uppermost compartment, rotating means adjacent the upper surface of said trays for moving the material to the passageway, one of said trays in an upper compartment being spaced from said casing and having a horizontal annular shape providing a large central passageway for flow of material therethrough, material-containing means comprising side louvers spaced from said casing and extending upwardly between said upper compartment tray and said casing to provide a passageway about said upper compartment communicating with the compartment immediately subjacent therebelow, and the tray in said last-mentioned compartment having a horizontal, centrally-located, supporting surface in spaced relation to said casing to provide an annular passage to another compartment immediately subjacent therebelow, said centrally-located supporting surface being provided with apertures and supporting said material in a central cone merging with the central passageway of said first-mentioned annular tray, and pipe means for supplying steam through the apertures of said centrally-located supporting surface into the bottom of said cone of material.

References Cited in the file of this patent

UNITED STATES PATENTS

654,093	Emerick	July 17, 1900
2,178,750	Garland	Nov. 7, 1939
2,585,793	Kruse	Feb. 12, 1952
2,766,534	Schaub et al.	Oct. 16, 1956
2,776,894	Kruse	Jan. 8, 1957