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M. C. MABEE

DEVICE FOR HEATING, PASTEURIZING, AND EVAPORATING LIQUIDS

Original Filed Feb. 4, 1915

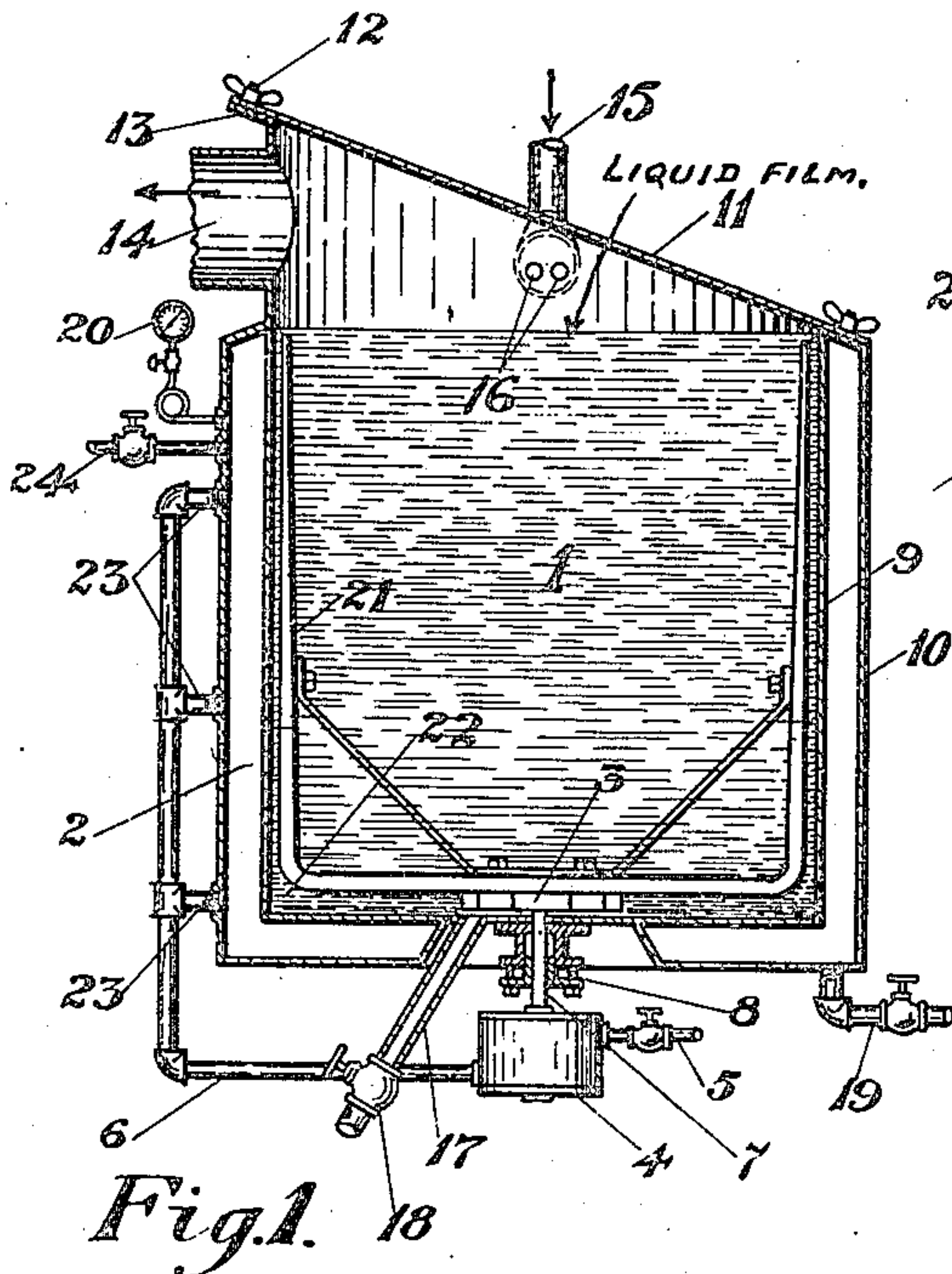


Fig. 1.

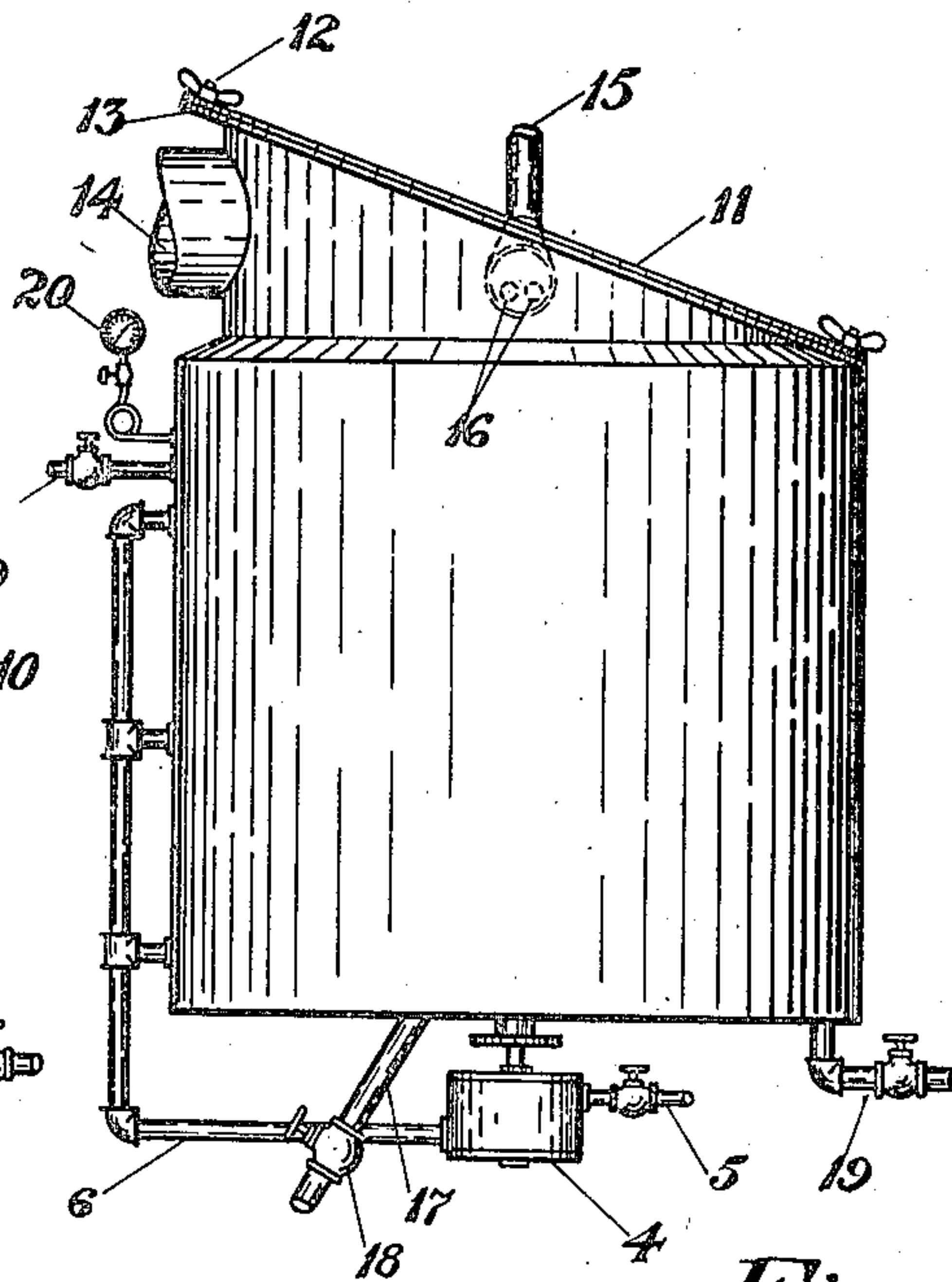


Fig. 2.

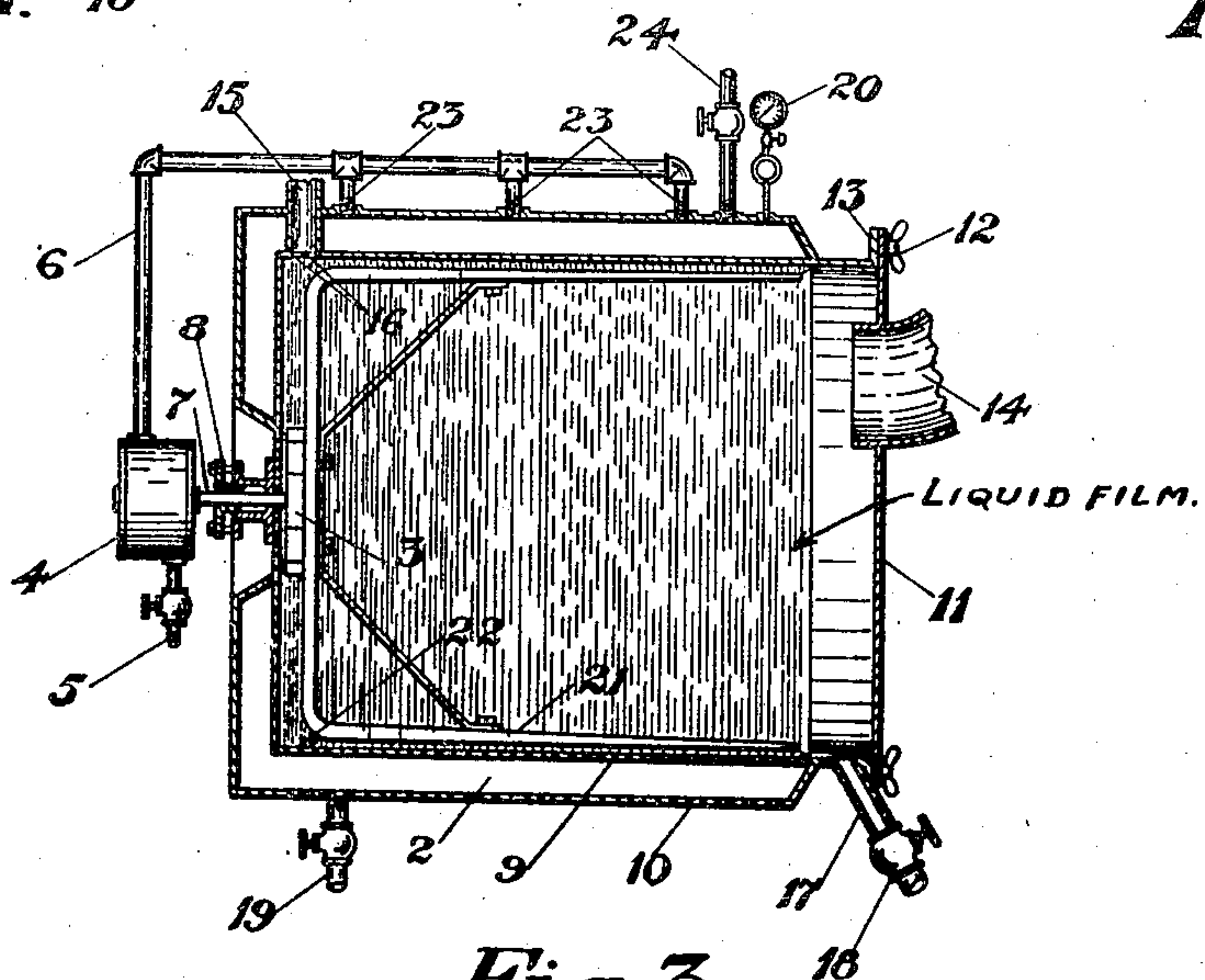


Fig. 3.

Witnesses.
Myrtle Andrews.
Amiel Mason.

Inventor.
M. C. Mabee.

By Stanley Lightfoot.
ATTORNEY.

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UNITED STATES PATENT OFFICE.

MAY C. MABEE, OF TOLEDO, OHIO.

DEVICE FOR HEATING, PASTEURIZING, AND EVAPORATING LIQUIDS.

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To all whom it may concern:

Be it known that I, MAY C. MABEE, of the city of Toledo, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in Devices for Heating, Pasteurizing, and Evaporating Liquids; and I do declare that the following is a full, clear, and exact description of the same.

10 This invention relates to the heating, pasteurizing and evaporation of liquids while the liquid is being spread in the form of a film over a heated surface and moved around the internal walls of a heated cylinder in a rotary direction at high velocity.

15 This invention also relates to the continuous movement of the liquid operated upon through the device while in process of treatment. Also to the simplicity and durability of construction. Also to the accessibility and removable nature of the parts forming the device which may be operated under a vacuum or at atmospheric pressure.

20 Among other things this invention also relates to the use of steam turbines and motors for moving liquids over heated surfaces in devices as described.

25 To enable others skilled in the art to which the invention appertains to make and use the same, I will proceed to describe it with reference to the drawings, in which similar reference characters refer to similar parts in all the figures.

30 Figure 1, is a vertical cross-section of my improved device. Figure 2, is a side elevation of the same. Figure 3, is a vertical cross-section of an alternative form of construction of my improved device.

35 Referring more particularly to the drawings, 1 is an upright cylindrical container closed at the bottom and flanged at its upper extremity, as seen at 13, to receive the cover 11 which is held in place by thumb screws 12.

40 A steam jacket 2 encloses the container externally, extending upward to the point to which the products operated upon would rise about the inner surface of said container. This steam jacket is provided with a steam inlet 24, and additional steam inlets 23 which are connected with pipe 6 to receive the exhaust from turbine 4 which is fed with steam through the pipe 5.

The condensation from the steam jacket 2 is taken away through pipe 19. The vapor from said container passes away through pipe 14. The size of the opening formed by the wall or pipe 14 is such that the vapors and gases may find a rapid and unobstructed escape to the outside of the container from a central quiet zone within the layer of material under treatment in the container. The shaft 7 connected with the turbine 4 passes through stuffing box 8 to the rotor 3, to which are attached arms 21.

55 The substance to be heated, pasteurized, or evaporated is supplied to the container through pipe 15 and inlet openings 16, but may be supplied in any other convenient manner, and when the treatment is completed the finished product is removed through pipe 17 which is guarded by valve 18.

60 I have illustrated in Figure 3 another embodiment of the invention in which the container and associated parts are arranged horizontally as distinguished from vertically, as illustrated in the embodiment of Figures 1 and 2. Since the parts of this embodiment of the invention which are given the same reference numerals as similar parts in the embodiments of Figures 1 and 2 are of quite similar construction, it will be unnecessary to refer in detail to the various parts of Figure 3, the foregoing description relative to Figures 1 and 2 being equally applicable to Figure 3. In this latter embodiment of the invention however, it will be observed that the material to be treated is introduced adjacent what might be termed, the front end of the container through the inlet 15, and the outlet end of the container is preferably flat and provided with an intermediate outlet conduit or opening 14 for the escape of vapors and gases which have passed into the central quiet zone maintained within the rotatable volume of material applied to the inner surface of the container. The outlet for the material which has been treated in the embodiment of the invention of Figure 3, is arranged adjacent the rear end of the container and is indicated at 17.

65 It is to be borne in mind that, in both embodiments of the invention illustrated, the material is applied in layer or film formation to the interior surface of the container

and because of the rapidly rotating member 3 and conveyor members 21, such layer of material is subjected to continuous rotation while gradually passing from the inlet to the outlet end of the container. Because of the centrifugal force and pressure, the film is maintained throughout the operation, and a central quiet zone for the escape of vapors is also maintained, and in this connection, the invention is not to be confused with that type of apparatus wherein the material is treated in bulk form and agitators or stirrers are provided, which alternately pass the material into contact with the treating surface and allow the same to fall back to again be taken up by the stirrers etc.

The operation of my device is as follows:

The liquid substance to be treated having been introduced within the container, after the proper motion has been imparted to the rotor 3 and arms 21, the product operated upon has communicated to it, through the revolution of said rotor and arms, a rotary motion which maintains it as a film upon the interior of the cylindrical wall.

The liquid substance being treated is spread in a sheet or film over the heated surface of the container and forced at a high rate of speed in a circular path. The thickness of the film may vary from one-thirty second of an inch to one inch, but, in practice it has been found that the film must be thin otherwise it requires considerable and unnecessary power to pass the liquid at high velocity over the heated surface.

In this device it is desirable that power be transmitted to the rotor through a turbine, or motor, or, if power be transmitted through belts and pulleys, it must be at a high rate of speed in order to secure satisfactory results.

In using a turbine to furnish power the turbine acts as a reducing valve to lower the steam pressure for suitable use in the jacket, and, as exhaust steam contains within ten per cent of the same number of heat units as steam at one hundred pounds pressure the use of a turbine with this apparatus is a feature of great moment, and, one which can be used to effect economies in installation and maintenance.

During the process of treatment, the gas and vapor of evaporation is separated from the body of liquid by centrifugal force and removed through the off-take pipe 14 by means of internal gas and vapor pressure or the gas and vapor may be removed mechanically by an exhaust fan connected with the off-take pipe 14.

In order to understand the value of this form of construction for an evaporator these facts must be considered,—

The preferable form of construction does away with the necessity for the use of shaft-

ing, belts, pulleys and internal bearings which have heretofore been employed in moving liquids to facilitate motion within containers, in order to increase the transmission of heat from the heating surface to the liquid.

There is a definite limit to the velocity which can be imparted to a liquid through the method of transmitting motion through the medium of belts and pulleys.

An important feature of this invention consists of a form of construction which permits of a high velocity being imparted to the liquid operated upon. Another important feature and one of marked advancement in connection with evaporating apparatus is the use of a turbine to move the liquid and a steam jacket to receive the exhaust from the turbine for the purpose of heating the liquid operated upon.

In cases where there is an available supply of exhaust steam motion may be imparted to the liquid operated upon through the use of an electric motor. In certain cases an available supply of exhaust steam and an electric motor may be substituted for a turbine without departing from that feature of this invention claimed in the use of a turbine for power and the exhaust for heating purposes in combination with a liquid heater, pasteurizer and evaporator.

These features enable a most satisfactory and economical apparatus to be constructed, installed and maintained.

The product to be operated upon enters the device at 15 and emerges slowly through the walls of the container at 16 in such manner that, at a desired pressure, it adheres to the inner surface of the container in its travel downward.

When it reaches the uppermost portion of the film it takes on the velocity and course of travel of the liquid film and gradually descends in a circular path until it reaches the opening in the base of the container for the out-flow of the finished product through pipe 17 which is guarded by valve 18.

This constitutes a continuous operation as to heating, pasteurizing, and evaporation. If the product is to be reduced from three to one by evaporation the valve 18 is set to permit the finished product to flow out of the container in such volume as would represent one-third of the amount coming into the container through pipe 15 and the inlets 16.

While heaters and pasteurizers have been used in continuous operation, the liquid entering and leaving the heater or pasteurizer continuously, yet, no device for these purposes has been employed where sufficient velocity has been imparted to the liquid to form it into a film or sheet of liquid and to maintain the liquid in that form during the operation. By so doing a large capacity

with a reasonable expenditure for power is secured which could not be secured if a body of liquid or layer of three or four inches of liquid were being circulated at a high rate of speed about the inner surface of a cylindrical heater, pasteurizer or evaporator.

By the use of this apparatus combined with a turbine, a minimum amount of the liquid operated upon is moved at a given time and with the most economical device for furnishing power for the purposes desired. Fast motion over a heated surface, pressure against the heated surface, the mechanical separation of gases and vapors from the liquid operated upon, together with the polished condition of the heated surfaces, are all made possible by this form of construction. Likewise, the continuous operation, the accessibility to all parts of the heater, pasteurizer and evaporator, and the economical form of construction, all enter into the features of the device.

While the construction set out is excellently adapted for the employment of my invention in practice, I do not limit myself to the details as they may be modified without departing from the spirit of the invention.

In this invention heat may be applied to the container by direct fire, hot gases, electricity, or other suitable means, as the conditions may vary under which the operation is effected.

This device may be used advantageously with the cover removed.

It will be appreciated that the conveyor means, comprising the arms 21 are free from connection at the upper ends thereof, and are supported wholly from the base of the container, thereby doing away with the usual centrally disposed shaft with the result that a substantially unobstructed quiet central space is provided for the reception of the escape of vapors and gases from the film. These vapors and gases, because of the relatively large vapor outlet 14 find unobstructed and rapid escape from said central zone, thereby facilitating the treatment especially when the apparatus is used for evaporating purposes. Any material which may find its way onto the top or upper surface of the container 11 because of the inclination of the latter, will be conducted back onto the cylindrical treating surface, and said inclined wall also assists in directing the vapors to the discharge outlet 14.

In both of the embodiments of the invention illustrated, it will be observed that the material as delivered to the container directly engages the treating surface, thereby overcoming the possibility of the material falling to the base of the container without treatment, assuming that the container is vertically disposed, and also avoiding spattering of the material on to the treating sur-

face, as might result from feeding the material into the container at a point removed from the treating surface.

Having thus described my invention, what I claim is

1. In an apparatus for treating liquids to change the condition or consistency thereof, the combination of a tubular container having an inlet adjacent one end for the material to be treated and an outlet at the opposite end for the escape of the treated material, and also having at one end a relatively large outlet for the escape of vapors and gases, means for exteriorly heating the container whereby the inner surface thereof constitutes a treating surface, and conveyor means within the container adapted to apply the material in cylindrical layer formation on the treating surface and for causing said layer of material to rapidly move over said surface, said conveyor means extending longitudinally of and adjacent to the treating surface and supported wholly at one end whereby to offer no obstruction centrally of the container, and whereby to provide a quiet zone for the escape of vapors and gases from the layer and through said relatively large outlet.

2. In an apparatus for treating liquids to change the condition or consistency thereof, the combination of a tubular container having an inlet adjacent one end for the material to be treated and an outlet at the opposite end for the escape of the treated material, and also having at one end a relatively large outlet for the escape of vapors and gases, means for exteriorly heating the container, whereby the inner surface thereof constitutes a treating surface, conveyor means within the container adapted to apply the material in cylindrical layer formation on the treating surface and for causing said layer of material to rapidly move over said surface, said conveyor means extending longitudinally of and adjacent to the treating surface and supported wholly at one end whereby to offer no obstruction centrally of the container, and whereby to provide a quiet zone for the escape of vapors and gases from the layer and through said relatively large outlet, and a turbine mounted upon one wall of the container and adapted to impart rapid rotatable movement to said conveyor means.

3. In an apparatus for treating substances to change the condition or consistency thereof, the combination of a tubular container having a surrounding steam jacket whereby the inner peripheral surface of the container constitutes a treating surface, said container having an inlet and an outlet for the material arranged adjacent opposite ends of the container, and also an outlet adjacent one of said ends for the free and unobstructed escape of vapors, a con-

veyor for the material comprising a substantially U-shaped member, the opposed arms of which extend adjacent to and longitudinally of the treating surface substantially from end to end thereof, the said arms being free from connection centrally, a rotor arranged centrally of one end of the container and connected to the base of said U-shaped member and having a shaft projecting through said end of the container, and a steam turbine mounted on the container and connected to said shaft for rotating said conveyor means at a high speed whereby to cause the material under treatment to assume a circular layer formation under rapid movement, and said turbine being operatively associated with the steam jacket of the container.

4. In an apparatus for treating substances containing liquid whereby to change the condition or consistency thereof, the combination of a vertically disposed tubular container having an inner continuous unbroken peripheral surface and a surrounding steam jacket, whereby the inner peripheral surface of the container constitutes a treating surface, said container having a closed bottom wall with an opening for the escape of the treated material, and also having adjacent the upper end an inlet for the treating material so disposed as to deliver the material directly to said treating surface, longitudinally extending conveyor members arranged adjacent the treating surface and continuously rotating substantially coextensive therewith, and means projecting through the base of the container connected to said conveyor members whereby to impart rapid rotatable movement to said members and thereby cause the material as delivered to the treating surface to assume a rapidly movable circular layer formation, the space between said conveyor members centrally of the container being free and unobstructed whereby to receive the vapors and gases from said rotating film of material, and the container having a relatively large outlet opening at one end to permit of the unrestricted discharge of said vapors from said central space.

5. In an apparatus for treating substances containing liquid whereby to change the condition or consistency thereof, the combination of a vertically disposed tubular container having a smooth unbroken inner peripheral surface and a surrounding steam jacket, whereby the inner peripheral surface of the container constitutes a treating surface, longitudinally extending connected conveyor members within the container adjacent said treating surface and substantially coextensive therewith, means for introducing the material to be treated into the top of the container, and directly onto said treating surface. means for continuously

rotating said conveyor members at a high speed whereby the material as delivered onto said treating surface will be spread in the form of a continuous circular film and be subjected to rapid movement, and said container having at one end an outlet for the discharge of vapors and gases as delivered into the central space of the container within said film of material.

6. In an apparatus for treating substances containing liquid whereby to change the condition or consistency thereof, the combination of a vertically disposed cylindrical container having a continuous unbroken peripheral wall and a surrounding steam jacket whereby the peripheral wall of the container will constitute a treating surface, said container having adjacent one end an inlet opening for the material and at its opposite end an outlet opening for the material, and said container also having at one end a relatively large outlet opening for the free and unobstructed escape of vapors and gases, and connected conveyor means within the container extending longitudinally of the treating surface at circumferentially spaced points, and continuously rotatable at a speed sufficient to cause the material to assume a movable circular layer formation, whereby the vapors and gases may escape into a central space provided by said layer and through said vapor outlet opening.

7. In an apparatus for treating substances containing liquid whereby to change the condition or consistency thereof, the combination of a vertically disposed cylindrical container having an inner unbroken cylindrical surface and a steam jacket surrounding the periphery thereof whereby the inner cylindrical surface constitutes a treating surface, said container having an outlet for the escape of material at the base thereof, and a relatively large outlet adjacent the top thereof for the escape of vapors, said container also having adjacent the upper end thereof an inlet for the material to be treated, said inlet being constructed and arranged whereby to deliver the material directly onto said treating surface, conveyor means within the container extending longitudinally of the treating surface, and means projecting without the container and offering substantially no obstruction centrally of the container for rotating said conveyor means continuously at a speed sufficient to cause the material as fed directly to the treating surface to assume a movable circular layer formation in contact with said treating surface.

8. In an apparatus for treating substances containing liquid to change the condition or consistency thereof, the combination of a vertically disposed cylindrical container having a surrounding steam jacket and a removable inclined top wall, the peripheral wall of the container adjacent the upper end

of said inclined top wall having an outlet for the escape of vapors, and said peripheral wall also having an inlet at a point remote from said vapor outlet and adjacent the top of the container for the introduction of the material to be treated, said container having an outlet at the base thereof, and means within the container for applying the material so introduced into the container onto the surface of the cylindrical wall of the container in the form of a film of substantially uniform thickness and for imparting movement to said film, said means offering substantially no obstruction centrally of the container whereby to provide a central zone to receive the vapors from the film to permit the same to escape through said vapor outlet.

9. In an apparatus for treating substances containing liquid whereby to change the condition or consistency thereof, the combination of a vertically disposed tubular container having a surrounding steam jacket, and the inner peripheral surface of which constitutes a continuous unbroken treating surface, longitudinal conveyor members within the container adjacent said treating surface and substantially co-extensive therewith, means for introducing the material to be treated from the outside directly on to said treating surface adjacent one end thereof, means for continuously rotating said conveyor members at a high speed whereby the material as delivered onto said treating surface will assume a continuous circular layer formation under circumferential and endwise movement, and said container having at one end a relatively large outlet for the rapid discharge of vapors and gases from the central space of the container formed by said film of material.

10. The art of evaporating liquids such as milk, which consists in introducing the material adjacent one end of a vertically disposed substantially cylindrical container having a continuous unbroken inner surface, causing the material to assume a thin layer formation about the inner surface of the container in the form of a circle, subjecting said circular layer of material to continuous rotatable movement while in contact with said surface and allowing the material to simultaneously move endwise of the container, subjecting the cylindrical wall of the container to heat sufficient to evaporate liquid constituents of the material, maintaining a central unobstructed zone within the container for the escape of the vapors, allowing the material to escape from the container adjacent the end thereof opposite the material inlet end, and allowing the vapors to independently escape from the central zone through a copious opening.

11. The art of treating milk and the like to evaporate the same, which consists in in-

roducing the milk at the top of a substantially vertically disposed cylindrical container having a continuous unbroken treating surface, causing the material to continuously rapidly move over said surface circumferentially and simultaneously lengthwise in the form of a continuous circular thin layer, subjecting the cylindrical wall of the container to heat sufficient to vaporize liquid constituents of the material, maintaining an unobstructed central space for the escape of vapors of evaporation, allowing said vapors of evaporation to quickly and continuously discharge without restriction from the container, and permitting the treated material to continuously discharge from the container adjacent that end thereof opposite the inlet end for the material.

12. The art of treating material to change its consistency, which consists in introducing onto a continuous unbroken inner surface at the upper end of a vertically disposed cylindrical container having a continuous unbroken inner surface, the material to be treated, permitting the material to flow downwardly over the interior surface of the container, maintaining a continuous film of said material under simultaneous, rotatable and endwise movement about a vertical axis over said surface, subjecting the wall of said container to heat sufficient to evaporate liquid constituents of the material, and maintaining a copious discharge opening for the free escape of vapors from the central zone formed by the material.

13. The process of treating material such as milk to evaporate liquid constituents thereof, which consists in introducing the material into a substantially vertically disposed cylindrical container at the upper end of said container at the periphery thereof, which said container has a continuous unbroken inner surface causing said material to assume a substantially uniform circular layer formation in contact with the inner surface of the container, and subjecting said circular layer of material to continuous circumferential movement over said surface of the container, permitting the treated material to escape from the lower end of the container, subjecting the container to an external application of steam whereby the treating surface of the container is highly heated and liquid constituents of the material are evaporated, maintaining a quiet zone for the escape of the material, and at all times maintaining a large vapor escape opening communicating with the central zone.

14. The method of evaporating milk and the like consisting in introducing the milk into a vertically disposed container of circular cross section and which container has a continuous unbroken inner surface, heat-

ing the milk in said container to a high temperature sufficient to evaporate liquid constituents of the material, shaping the milk in the form of a continuous layer upon the surface of the container, rapidly and continuously moving the layer circumferentially over the surface and simultaneously causing the body of material to move from the point of introduction towards the opposite end of the container, maintaining a continuous central quiet zone, permitting the vapor to escape inwardly from the layer into said quiet zone, and allowing the vapor to have unrestricted escape from the central quiet zone through a copious discharge opening at the upper end of the container.

15. The art of treating substances containing liquid to change the consistency thereof which consists in forming a thin layer of the substance upon a continuous unbroken treating surface of a vertically disposed container of circular cross section, subjecting the treated surface to heat sufficient to evaporate liquid constituents of the material, rapidly moving the layer continuously circularly over the surface, maintaining a substantially uniform distribution of the substance throughout its length in layer formation during treatment, permitting the material to escape at the base of the container, and permitting the vapors and gas to freely escape from the layer towards the center of the container and finally from the container independently of the substance through a discharge opening considerably larger than the outlet for the treated material.

16. The art of treating material to change the consistency thereof, which consists in causing the material to assume a circular layer formation about the inner surface of a substantially vertically disposed cylindrical container, having a continuous unbroken treating surface, subjecting the cylindrical surface of the container to uniform heat sufficient to evaporate liquid constituents of the material, subjecting said circular layer of material to continuous rotatable and simultaneous lengthwise movement, continuously introducing new material into the upper end of the container at the periphery thereof whereby the same will directly commingle with the layer of material in contact with said periphery, allowing the treated material to continuously escape through an opening

at the bottom of the container, maintaining a central quiet zone within the layer of material for the escape of vapors, and allowing said separated vapors to freely pass out of one end of the container through a discharge opening at a point removed from the outlet for the treated material and of increased area relative to said outlet.

17. In an apparatus for treating liquids, the combination of a tubular container having a surrounding steam jacket, said container having an inlet at one end for the introduction of the material to be treated, and an outlet at its opposite end for the discharge of the treated material, and said container also having at one end a large opening for the free escape of vapors, and means for engaging the material as introduced and subjecting the same to continuous rotatable movement in the form of a layer over the peripheral treating surface of the container, said means including a plurality of circumferentially spaced members extending longitudinally of the container adjacent the peripheral wall thereof, and means connected to one end of said members for imparting rotary movement thereto, the members being otherwise unconnected whereby to maintain a central unobstructed zone for the vapors.

18. In an apparatus for treating liquids to change the consistency thereof, the combination of a vertically disposed tubular container having an inlet at its upper end for the introduction of the material to be treated and an outlet at the lower end for the discharge of the treated material, said container also having at one end a relatively large vapor escape opening, conveyor means within the container comprising longitudinally extending arms arranged adjacent the peripheral wall of the container and spaced from one another circumferentially of the container, and means connected to the lower end of said arms for rapidly rotating the same, the arms being otherwise free from connection, whereby to maintain a substantially unobstructed central zone for the accumulation of vapors.

Signed at Toronto, in the county of York, in the Province of Ontario, in the Dominion of Canada, this second day of February, 1915.

MAY C. MABEE.

Witnesses:

C. S. LIGHTFOOT,
S. M. ANDREWS.