C. R. MABEE.

MULTIPLE EFFECT APPARATUS.

APPLICATION FILED OCT. 23, 1915.

1,420,648.

Patented June 27, 1922.

2 SHEETS—SHEET 1.

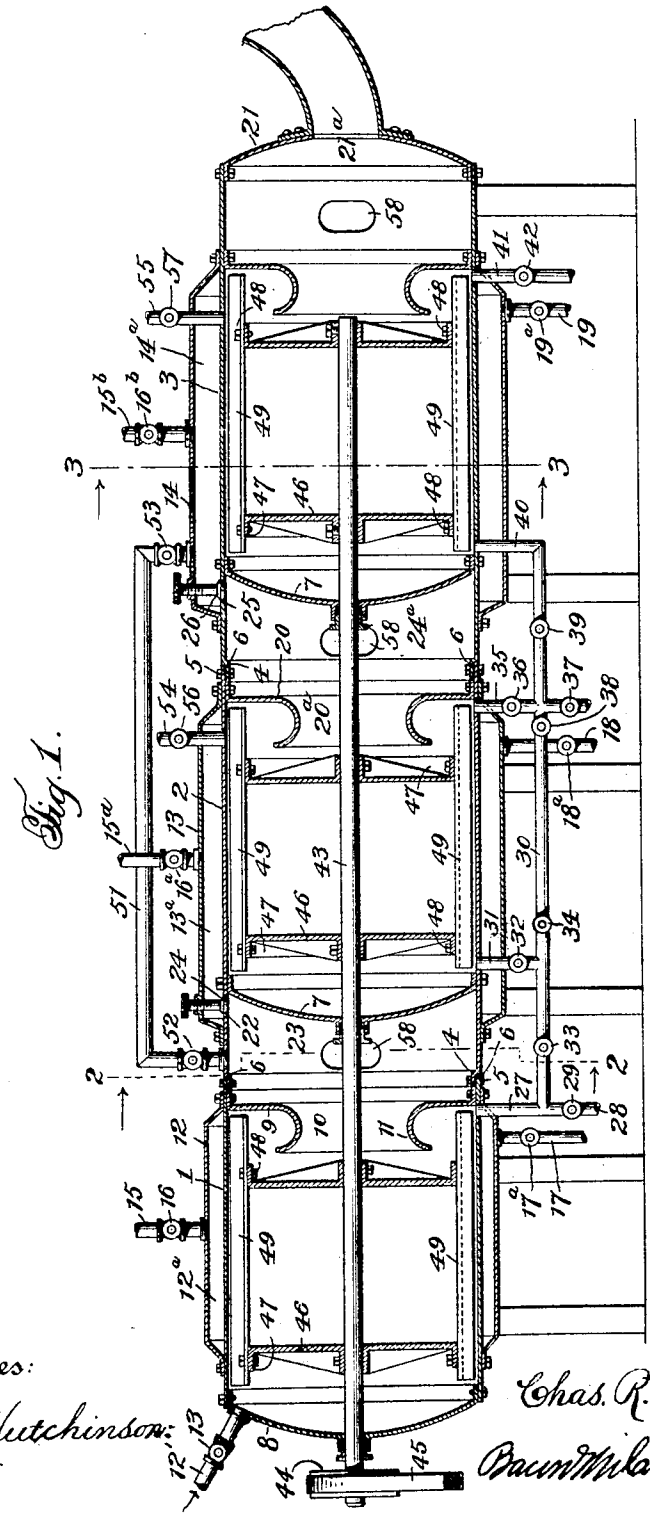


Fig. 1.

Witnesses:

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2 SHEETS—SHEET 2.

Fig. 2.

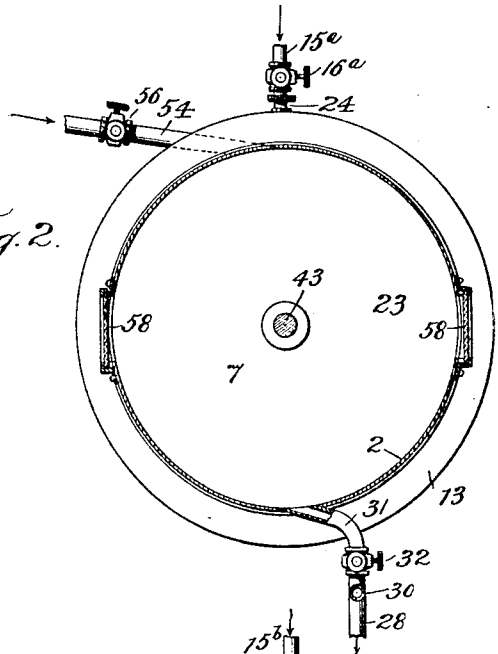
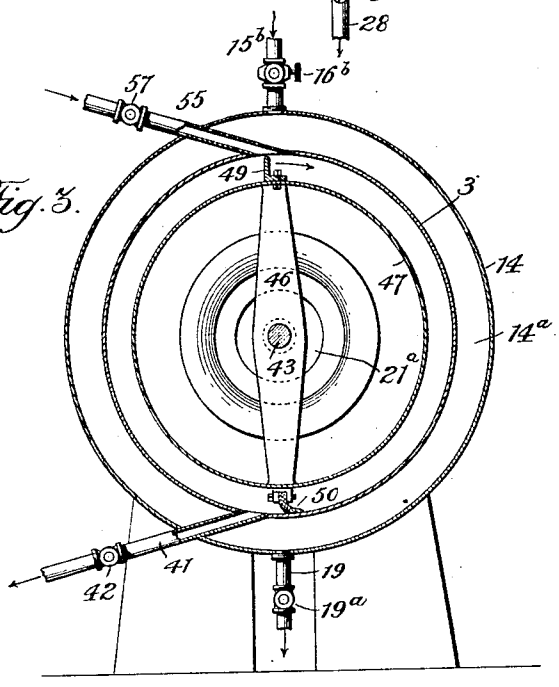


Fig. 3.



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UNITED STATES PATENT OFFICE.

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MULTIPLE-EFFECT APPARATUS.

1,420,648. Specification of Letters Patent. Patented June 27, 1922.

Application filed October 23, 1915. Serial No. 57,472.

To all whom it may concern:

Be it known that I, CHARLES R. MABEE, a citizen of the United States, residing at Toledo, in the county of Lucas and State of Ohio, have invented certain new and useful Improvements in Multiple-Effect Apparatus, of which the following is a specification, reference being had therein to the accompanying drawing.

This invention relates to an evaporating apparatus and more particularly to an apparatus of the multiple effect type, wherein all or a major portion of the vapors arising from the treatment of the material in one effect are utilized and employed as the heating medium for the treating surface of a succeeding effect, and so on throughout the series of effects.

The apparatus is designed for a general use in the treatment of liquid materials, or materials containing liquid, to change the consistency thereof, and is quite serviceable in the treatment of "stick" water from garbage, waste water from distillery machines, beef extract, sugar and salt solutions, and other materials or substances commonly treated in a multiple effect apparatus.

It has been ascertained that by subjecting a circular layer of material to rapid rotatable movement, relative to an externally heated cylindrical container, evaporation may be expeditiously carried on, and it is one of the primary objects of the present invention to adopt this general principle in obtaining multiple effect treatments, and to this end an externally heated cylindrical container is employed with means for causing a relative rotatable movement between the container and a circular layer of material, to be treated, and means for introducing the vapors as they escape into the central zone within the layer of the material, into a heating space for a subsequent effect, and so on throughout the series of effects, means of communication being of course provided between the treating chambers for the material in the several effects.

In multiple effect evaporating apparatus as heretofore constructed, vacuum pans have been largely depended upon, and while structures of this character are satisfactory to a degree, still such as I am familiar with, have been quite complicated and expensive in design and construction, operation and upkeep, and in the improved apparatus under consideration, it is contemplated to vastly simplify constructions of this character, to increase the efficiency thereof, to obviate the usual objections incident to the use of vacuum pans as at present employed, to dispense with the employment of condensers, and to provide an apparatus making possible convenient access to the various parts as desired.

In prior apparatus of the multiple effect type, wherein vacuum was utilized, it was thought the addition of internal pressure to the liquid or material being treated would impede the evaporation. It has been found however, from the operation of the present apparatus, about to be described, that by the provision of means for treating the material under pressure, preferably centrifugal pressure, and maintaining the material under constant movement in layer formation while under pressure over the heated surface, better, more economical and expeditious results are possible.

It is a further object of the invention to provide a multiple apparatus wherein a greater heat transmission is made possible in the several effects than heretofore, and at the same time without subjecting the material to the likelihood of becoming scorched or otherwise injuriously affected in treatment.

The invention also embraces means whereby any of the effects may be singly used for the treatment of certain materials, or whereby any two of said effects will be employed to the exclusion of others, or whereby all of said effects may be employed together, the various operations being determined largely by the character of the material being treated.

The improved construction of multiple effect apparatus embodied herein is of a character wherein the operation may be successfully carried on either in connection with employment of vacuum, or whereby the material is treated under pressure, but it is of advantage to operate under pressure in the treatment of certain substances, in that the condensers are dispensed with and the apparatus may be located at any convenient place, irrespective of large water supply.

More particularly, the invention includes means whereby a layer of material is maintained in layer formation and under pressure while subjected to movement in a circular path over an externally heated cylindrical surface, with means whereby the va-

por accumulating in the central zone maintained within the layer is conducted to the heating space of a subsequent effect to constitute the heat transmitting medium therefor.

It is obvious of course, that any desired number of effects may be employed and that while the various effects are substantially similarly constructed, that is to say in each of the effects, a treating surface of cylindrical formation is preferably employed with means for maintaining a layer of the material while under pressure to relative rotatable movement over said treating surface, at the same time obvious changes in details of construction and arrangement of parts may be made without departing from the spirit of the invention, or the broad underlying features thereof.

Other and further means and novel details in the construction and arrangement of the various parts of the improved apparatus will be appreciated from the description to follow, which for a clear understanding of the invention should be considered in connection with the accompanying drawing, which forms a part hereof, and wherein is disclosed for the purpose of illustration a convenient and satisfactory embodiment of the invention.

In the drawings:

Figure 1 is a longitudinal section of a preferred form of apparatus constructed in accordance with the invention.

Figures 2 and 3 respectively are transverse sectional views substantially on the lines 2—2 and 3—3 of Figure 1.

With more particular reference to the drawings wherein like reference numerals refer to corresponding parts throughout the several views, an elongated cylindrical wall is provided, the same being preferably formed in sections, 1, 2, and 3 and detachably connected to one another as by overlapping flanges 4 secured by removable bolts or the like 5, a suitable packing 6 being medially interposed between said flanges to make air tight joints, and the cylindrical walls of the respective sections when in place constituting in effect substantially uninterrupted continuations of one another. The cylindrical wall just described is partitioned or divided by suitable disks or plates 7 into a plurality of cylindrical containers for the material to be treated, three of such containers being illustrated in the drawings, though it is to be understood that the number and arrangement of the containers may be altered or varied to suit conditions or requirements without departing from certain underlying principles of the invention. The several cylindrical containers or compartments with their associated parts, will be termed the "first," "second," and "third" units or effects in the order of succession from the front end of the apparatus. A closed end wall 8 is provided at the front end of the first unit and an open wall 9 at the opposite end thereof, the opening 10 being preferably centrally arranged and surrounded by a cover or flange 11. An inlet for the material to be treated is provided adjacent the front end wall 8 of the first unit as by the conduit 12′ leading from any source of supply, the same having a valve control or cut-off 13 whereby to regulate the supply and whereby to regulate the depth or thickness of the film or layer of the material to be formed upon the interior surface of the cylindrical surface 1, in a manner to be presently described.

Surrounding the various cylindrical containers are jackets, preferably one for each unit, and indicated at 12, 13, and 14 respectively, the said jackets being of slightly greater diameter than the enclosed walls, whereby to provide between the walls of the containers and jackets, spaces 12^a, 13^a and 14^a respectively for the reception of a heating medium, preferably steam at a high temperature. It is obvious of course that steam may be utilized as the heating medium for each of the containers, and to this end a steam inlet pipe is provided for each jacket, the said pipes being indicated at 15, 15^a and 15^b respectively. Each of these steam inlet pipes is provided with a valve control 16, 16^a, and 16^b respectively, it being obvious that when the vapors from one unit are to be utilized as a heat transmitting medium for another unit, certain of the steam inlet valves will be adjusted to closed position.

Each of the units is provided with an outlet for condensed vapor or steam as shown at 17, 18, and 19 respectively, the said outlet conduits being provided with a valve or other suitable control 17^a, 18^a, and 19^a respectively.

In the units succeeding the first, the partition wall 7 constitutes a closed front wall for said succeeding units, the rear walls being open and of construction similar to the wall 9 of the first unit as indicated at 20 and 21 respectively, whereby to provide the rear end openings 20^a and 21^a.

It is desirable to utilize the vapors accumulating in the treatment of the material in one unit as the heat transmitting medium for a succeeding unit, and to this end the jacket 13 projects forwardly beyond the partition 7 of the section 2, and the cylinder 2 is provided with an opening 22 whereby to afford communication between the space 13^a and the chamber 23 between the walls 9 and 7 of the adjacent unit. A valve control for the opening 22 is indicated at 24. Likewise, in the second effect, the vapors will find an outlet through the opening 20^a into the chamber 24^a, from whence it passes through an opening 25 into the space 14^a

surrounding the cylindrical wall of the third effect, whereby to constitute the heat transmitting medium for said third effect. A valve control 26 is provided for the outlet 25.

Means of communication between the treating chambers of the respective units for the material is preferably provided as follows:

The partially treated material finds an outlet adjacent the rear end wall 9 of the first unit, a conduit 27 being provided for this purpose and connecting with the cylindrical wall of the unit, said conduit having an outlet 28 with a valve control 29, the outlet 28 leading to any suitable place of deposit whereby the material may be discharged directly from the unit 1 in the event it is not desired to impart further treatment to the material. In the event additional units are operated in conjunction with the first unit, a longitudinally extending conduit 30 for the material is provided, said conduit having a branch 31 adapted to feed the material into the inlet end of the cylindrical container of the second unit, and said branch having therein a valve control 32. The longitudinally extending conduit 30 has valves 33 and 34 one to each side of the branch 31 for a purpose to be presently described. Adjacent the rear end of the second unit is an outlet conduit 35 for the treated material, the same communicating with the longitudinally extending conduit 30 and projecting therebelow, whereby to discharge the treated material at this point if desired. The conduit 35 is provided with valves 36 and 37 one to each side of the point of communication with the longitudinally extending conduit 30, and the conduit 30 is provided with valves 38 and 39 one to each side of the point of communication with the outlet conduit 35. The longitudinally extending conduit 30 has a terminal branch 40 whereby to constitute an inlet conduit for the material adjacent the front end of the cylindrical container of the third unit. The third unit has an outlet conduit 41 for the material, said outlet being preferably valve controlled as indicated at 42.

Preferably each of the inlet and outlet conduits for the material at their point of communication with the cylindrical containers are tangentially arranged as illustrated more particularly in Figures 2 and 3 of the drawings.

Positioned within each of the cylindrical containers of the various units or effects is suitable conveyor mechanism preferably of a character to act upon the material as fed into the respective containers and by a rapid rotatable movement cause the said material to assume a circular layer formation adjacent to or in contact with the inner surface of the exteriorly heated containers, said layer of material being constantly rotated while subjected to the centrifugal force of the conveyor members. By this means, a central quiet zone is maintained within the layer of the material for the escape of vapors, and these vapors in the effect subsequent to the first, constitute the heat transmitting means for the effects in succession.

The conveyor mechanism in the illustrative embodiment of the invention herein, is preferably constructed as follows:

43 is a longitudinally extending shaft projecting through the respective units, whereby a single shaft is common to said units, the said shaft being adapted for rotatable movement at a very high speed as by a pulley 44, fixed upon a projecting end of the shaft which latter is adapted to receive motion, as by a belt 45, driven from any suitable source. The conveyor mechanism within the respective cylindrical containers of the various effects is preferably of the same construction in each instance, and a description of one will suffice for all. 46 are suitable webs or spokes, secured to the shaft 43 and having at their outer ends an annular rim 47. Conveniently two of such webs are used, though it is obvious that an intermediate one or more of such webs may be employed. Projecting between the annular rims 47 as by removable bolts 48 are suitable conveyor members 49, which conveniently take the shape of an angle bar with one edge thereof adjacent to the inner surface of the cylindrical container, and preferably two of such conveyor members are employed, arranged opposite to one another about the periphery of the rim members 47, though it is desired that the number of these conveyor members may be varied as desired. Also if desired one or more of said conveyor members may be provided with a yieldable surface, such as brush, rubber, or the like 50 whereby to engage the inner surface of the conveyor members and tend to wipe any particles of material from the surface should the same adhere thereto.

For a purpose to be presently described, a longitudinally extending by-pass conduit 51 is provided, the same establishing communication between the vapor chamber 23 and the chamber 14^a of the third unit, said conduit being provided with valves 52 and 53 respectively.

Also each unit succeeding the first may be provided with an independent inlet conduit for the material in the event it is desired to operate the various units separately, or in the event it is desired to blend one material with another in the treatment, that in the second unit being illustrated at 54 and in the third unit at 55, said inlets having valve controls 56 and 57 respectively.

If desired, a suction pump or the like, as well as a condenser may be operatively con-

nected with the outlet end of the last unit, and it will be observed that the respective spaces for the reception of a heat transmitting medium surrounding the cylindrical containers gradually increase in size from the first to the last unit, whereby to account for the increased expansion of gases owing to the higher degrees of vacuum, in the event vacuum is employed, and where the apparatus is operated under pressure, this variation in the size of the heat jackets will serve to care for the decreased pressure, it being obvious that in the one case the boiling temperature goes down by increased vacuum, whereas in the other case the temperature goes down by virtue of reduced pressure.

The operation of the apparatus may be briefly described as follows:

Assuming that it is desired to employ all of the effects in the treatment, the conveyor members are rotated at a high speed, and steam is introduced through the conduit 15, the outlet conduit 17 being at this time open, and the steam being preferably of a high temperature. In this connection, a heating medium other than steam may be employed, providing the temperature is sufficiently high. The material is introduced by the conduit 12′ into the first unit, and as introduced, will be taken up by the conveyor members and subjected to centrifugal pressure while taking the form of a continuous circular layer movable over the heated surface of the container. A central quiet zone within the layer is maintained and the vapors find an escape from said zone through the opening 10 thence through the opening 22 into the jacket 13ª, whereby to constitute a heat transmitting medium for the second effect. The material from the first effect flows through the conduit 27 into the longitudinally extending conduit 30, the valves 29 and 34 being at this time closed and the valves 33 and 32 open with the result that the material will flow into the inlet end of the treating chamber of the second effect. The material being taken up by the conveyor members in the second effect, the same has imparted thereto a continuous circular movement while in layer formation as previously described, the arising vapors escaping through the outlet 25 into the chamber 14ª for the purpose of constituting the heat transmitting medium for the third effect. During this process, it is understood of course that the valves 52 and 53 of the bypass vapor conduit are closed and that the valves 24 and 26 are open. The material after treatment in the second unit finds an outlet into the rear end of the conduit 30, the valves 37 and 38 being at this time closed and the valves 36 and 39 being open, whereby the material will readily pass into the inlet end of the cylindrical container of the third effect. The material as completely treated will find an exit through the outlet 41 adjacent the rear end of the last unit. The construction and arrangement of conduits and valves is such that the units may be independently used if desired, or any plurality of units may be used to the exclusion of others. To illustrate, assuming that it is desired to cut out the second unit, the material will upon its discharge into the conduit 28 flow into the conduit 30, the valves 29, 32, 36 and 38 being at this time closed and the valves 33, 34, 38 and 39 open whereby the material will directly pass into the third unit through the connection 40. Likewise, the vapor from the first unit will be directly fed into the heat transmitting chamber of the third unit through the bypass conduit 51, the valves 24 and 26 being at this time closed and the valves 52 and 53 being open.

Assuming it is desired to employ the first two units in conjunction, the third unit will be cut-off from the second unit by closing the valve 39 of the longitudinally extending conduit 30 and opening the valve 37 to the end that the material will escape through the conduit 35 to the outside directly from the outlet end of the second unit. At this time, the valve 26 will be closed, whereby to shut off communication between the vapor chamber and the heating chamber 14ª.

In the event it is desirable to utilize any of the units singly the various valves are adjusted to proper position in an obvious manner and the steam is directly fed into the heating jacket through any of the conduits 15, 15ª and 15ᵇ, according to the particular unit it is desired to operate.

Each of the vapor chambers 23 and 24 may be provided with a valve controlled outlet, not shown, leading to the outside for the direct escape of all or a portion of the vapors in said chamber. Likewise, each of the effects may be provided with a sight opening 58, whereby to observe at any time the condition of the material and the interior portion of the machine, and these sight openings may be formed as a part of removable closures, whereby to permit of access to the interior of the machine, for cleansing or repair.

In multiple effect evaporating apparatus, it has been found that when the liquid is of certain character, incrustations are apt to form on the treating surface of the liquid containers, and usually adhering particles or incrustations are the greater in proportion to the degree of concentration. Therefore, the peculiar formation of conveyor members, especially when associated with wiping members are of special advantage in evaporators of the multiple effect type, since the interior treating surfaces of

the respective containers are continuously cleansed and maintained in a smooth or polished condition.

Certain features of the invention and methods of procedure herein illustrated and described, though not specifically claimed, are made the subject of claims in copending applications, and in this connection cross-reference is made to my applications Serial No. 718,114, filed August 31, 1912, and its division, Serial No. 277,904, filed February 18, 1919; 738,178, filed December 23, 1912; Serial No. 797,087, filed October 24, 1913 (renewed) as Serial No. 108,956), and its division Serial No. 805,598; and Serial No. 40,757, filed July 19, 1915, and its division Serial No. 77,996, filed February 12, 1916.

What I claim is:

1. In a multiple effect evaporating apparatus, the combination of a plurality of end to end cylindrical containers, each of said containers having a surrounding jacket forming a heating chamber, said containers having an inlet for the material adjacent one end and outlet for the treated material adjacent the opposite end, and said containers having an end opening of sufficient size to permit vapors to freely and rapidly escape, means for introducing a heating medium into the heating jacket of one container sufficient to evaporate liquid constituents of the material, and the vapor end opening of said container being in communication with the heating chamber of a succeeding container, and the discharge outlet of said container being in communication with the material inlet of a succeeding container, and cooperating movable means in the respective containers constructed and arranged to apply the material as introduced on to the inner surface of the containers under centrifugal force and pressure, and to subject said material while in continuous layer formation to rapid rotatable and simultaneous endwise movement towards the discharge end thereof.

2. In a multiple effect evaporating apparatus, the combination of a plurality of end to end cylindrical horizontally disposed containers, each of said containers having a surrounding jacket forming a heating chamber, said containers having an inlet for the material adjacent one end and outlet for the treated material adjacent the opposite end, and said containers having an end opening of sufficient size to permit vapors to freely and rapidly escape, means for introducing a heating medium into the heating jacket of one container sufficient to evaporate liquid constituents of the material, and the vapor end opening of said container being in communication with the heating chamber of a succeeding container, and the discharge outlet of said container being in communication with the material inlet of a succeeding container, and cooperating movable means in the respective containers constructed and arranged to apply the material as introduced on to the inner surface of the containers under centrifugal force and pressure, and to subject said material while in continuous layer formation to continuous rapid rotatable and simultaneous endwise movement towards the discharge end thereof.

3. In a multiple effect evaporating apparatus, the combination of a plurality of end to end cylindrical containers, said containers having a substantially unrestricted outlet in the outer ends thereof and closed at their inner ends, a heating chamber surrounding each container, the heating chambers of succeeding containers being in direct communication with the unrestricted outlet of a preceding container whereby to receive vapors of evaporation, means for introducing a heating medium into the heating chamber of the first container, means for introducing the material to be treated adjacent the inner end of the first container, means for receiving the treated material from the opposite end of said container and delivering the same into the forward end of a succeeding container, the succeeding container having an outlet for the treated material adjacent its opposite end, and connected mechanism in the respective containers extending longitudinally of and adjacent the inner surface of the containers, adapted to rotate at a high speed whereby to apply and maintain under centrifugal force a continuously rotating and simultaneous endwise movable layer of the material with a quiet central zone for the reception of vapors which rapidly find escape through the outlet opening therefor.

4. In a multiple effect evaporating apparatus, the combination of a plurality of end to end cylindrical horizontally disposed containers, said containers having a substantially unrestricted opening in the outer ends thereof and closed at their inner ends, a heating chamber surrounding each container, the heating chambers of succeeding containers being in direct communication with the unrestricted outlet of a preceding container whereby to receive vapors of evaporation, means for introducing a heating medium into the heating chamber, of the first container, means for introducing the material to be treated adjacent the inner end of the first container, means for receiving the treated material from the opposite end of said container and delivering the same into the forward end of a succeeding container, the succeeding container having an outlet for the treated material adjacent its opposite end, and connected mechanism in the respective containers extending longitudinally of and adjacent the inner surface of the containers, and means for rotat-

ing said mechanism at a high speed whereby to apply and maintain under centrifugal force a rotating and simultaneous endwise movable layer of the material with a quiet central zone for the reception of vapors which rapidly find escape through the outlet openings therefor.

5. In a multiple effect evaporating apparatus, the combination of a plurality of horizontally disposed abutting cylindrical containers, a central shaft projecting centrally through the containers and rotatable at a rapid speed, longitudinally extending conveyor members mounted on the shaft for movement therewith and extending substantially from end to end of the containers adjacent the inner surface thereof, a forward container having an inlet for the material adjacent one end, and an outlet for the treated material adjacent its opposite end in communication with the front end of a succeeding container, which succeeding container has an outlet for the treated material adjacent its opposite end, the forward container also having a central opening at its rear end of sufficient size to permit vapors to freely escape, a heating jacket surrounding each container, means for supplying heat to the forward jacket, and the succeeding jacket being in communication with the vapor outlet opening of the forward container.

6. In a multiple effect evaporating apparatus, the combination of a plurality of units comprising cylindrical end to end containers forming treating chambers, a shaft common to the plurality of containers, conveyor members mounted upon the shaft and projecting longitudinally of the containers adjacent the inner surface of the wall thereof, means for heating the wall of one container, and means whereby the walls of succeeding containers are heated by vapors from the material under treatment in the treating chamber from the preceding container.

7. In a multiple effect evaporating apparatus, the combination of a plurality of units comprising cylindrical end to end containers forming treating chambers, adapted to receive material adjacent one end and to discharge the treated material adjacent the opposite end, said containers having at one end a free opening for the rapid escape of vapors, a shaft common to the plurality of containers, and combined conveyor and wiper members mounted upon the shaft and projecting longitudinally of the containers adjacent the inner surface of the wall thereof, means for heating the wall of one container, and means whereby the wall of a succeeding container is heated by the vapors escaping through said opening from the material under treatment in a preceding container.

8. In a multiple effect evaporating apparatus, the combination of a cylindrical container having a surrounding heating jacket, and an end opening for the escape of vapors, a plurality of connected members within the container for applying the material in layer formation and subjecting the same to endwise movement over the inner surface of the container, and means for supplying heat to said heating jacket comprising a second container of circular cross-section connected directly to the first mentioned container, means for introducing a substance to be treated adjacent one end of the second container, means for permitting the discharge of the substance at a point adjacent the opposite end of the container and for delivering the same into one end of the first mentioned container, a plurality of connected members for positively causing the substance so introduced to assume the form of a layer on the inner surface of the container and for rapidly moving the layer circularly over the surface and simultaneously endwise of the container to the discharge, means for heating the walls of the second container sufficient to vaporize, and means for permitting the escape of generated vapors from the end of the said second container into the heating jacket of the first mentioned container.

9. In a multiple effect evaporating apparatus, the combination of a cylindrical container having means for imparting rapid movement to the material therein, said container having a surrounding heating jacket, and means for supplying heat to said jacket comprising a second cylindrical container arranged end to end with the first mentioned container, said second container having means adjacent one end for introducing material to be treated and a discharge opening at its opposite end in communication with the treating chamber of the first mentioned container, a plurality of connected circumferentially spaced members within the second container for engaging material at the point of entry and simultaneously moving the same outwardly circularly and longitudinally of the container to the discharge, means for heating the walls of the container and means for permitting vapors driven off from the heat of the material to freely escape from the container independent of the discharge of the material therefrom, and to be delivered into the heating jacket of the first mentioned container.

10. In a multiple effect evaporating apparatus, the combination of a plurality of end to end containers of circular section, means for permitting the introduction of material at one end of the containers, means for permitting the escape of the treated material at the opposite end of the treating surface of the containers, means located inwardly from the discharge for permitting vapors to escape from the interior of preceding containers and to pass over the outer

surface and constitute a heating medium for succeeding containers, and rotatable combined conveyor and wiping means for centrifugally shaping the material to the walls of the containers, simultaneously wiping the walls and causing the same to move circularly over the surfaces and simultaneously longitudinally thereof, means for heating the wall of the first container of the plurality of containers, and the escape for the treated material of the first container being in communication with the inlet part of the treating material of a succeeding container.

11. In a multiple effect evaporating apparatus, the combination of a first container and a second container, said containers being arranged end to end and of circular section and having end walls, one of which is provided with a vapor escape of substantial area, means for introducing the material at one end of the first container, means adjacent the periphery of the container for permitting the removal of the material after treatment from the opposite end of the first container and for introducing the treated material in the one end of the second container, which said container has an opening adjacent its opposite end for the additionally treated material, means for heating the wall of the first container, a jacket surrounding the second container forming a heating chamber, means establishing communication between said heating chamber and the vapor escape of the first container, a rapidly rotatable shaft common to the containers, and means mounted on the shaft within the respective containers constructed and arranged for forcibly projecting the material onto the heated walls, causing the same to circulate thereover, and to simultaneously move longitudinally thereof from the point of introduction.

12. In a multiple effect evaporating apparatus, the combination of a first container and a second container, said containers being arranged end to end and of circular section and having end walls one of which is provided with a vapor escape of substantial area, means for introducing the material at one end of the first container, means adjacent the periphery of the container for permitting the removal of the material after treatment from the opposite end of the first container and for introducing the treated material into one end of the second container, which said container has an opening adjacent its opposite end for the additionally treated material, means for heating the wall of the first container, a jacket surrounding the second container forming a heating chamber, means establishing communication between said heating chamber and the vapor escape of the first container, a rapidly rotatable shaft common to the containers, and means mounted on the shaft within the respective containers for forcibly projecting the material onto the heated walls, simultaneously causing the same to circulate thereover, and to move longitudinally thereof from the point of introduction, and to simultaneously maintain the treating surface in a cleansed or polished condition free from adhering particles.

13. In a multiple effect evaporating apparatus, the combination of a plurality of horizontally disposed end to end containers, means for heating the walls of one container, a jacket surrounding the wall of a second container to form a heating space, means for permitting the introduction of the material at one end of the first container, means for permitting the escape of the treated material adjacent the opposite end of said container, means located inwardly of the discharge for permitting the vapors to freely escape from the interior of the first container into the surrounding heating space of the second container, means for conducting the treated material from the discharge of the first container into the interior of the second container, a rapidly movable drive shaft projecting through both containers, and means mounted on said shaft within both containers for centrifugally shaping the material to the walls of the containers and causing the same to move circularly over the surface and simultaneously longitudinally thereof.

14. In a multiple effect apparatus for treating liquids for evaporating and similar purposes, the combination of succeeding containers of circular cross section, means for permitting the introduction of the material at one end of the container, means for permitting the escape of the treated material adjacent the opposite end thereof into the inlet end of a succeeding container, means located forwardly from the discharge ends of both containers for permitting vapors to escape, and for permitting the vapors to escape to constitute a heat medium for the walls of a succeeding container, a plurality of circumferentially spaced connected means within both containers for positively causing the entire body of material as introduced to assume the form of a layer on the inner surface of the containers and for rapidly moving the layer circularly over the container and simultaneously endwise of the containers to the discharge, and a common drive shaft projecting through said containers for said means.

15. In a multiple effect evaporating apparatus, the combination of a plurality of units comprising horizontally disposed cylindrical end to end containers forming treating chambers, a shaft common to the plurality of containers, conveyor members mounted upon the shaft and projecting longitudinally of the containers adjacent the inner surface of

the wall thereof, means for heating the wall of one container and means whereby the walls of succeeding containers are heated by vapors from the material under treatment in the treating chambers of preceding containers.

16. In a multiple effect evaporating apparatus, the combination of a plurality of units comprising horizontally disposed cylindrical end to end containers forming treating chambers, a shaft common to said containers, conveyor members mounted upon the shaft and projecting longitudinally of the containers adjacent the inner surface of the wall thereof, means for heating the wall of one container, means whereby the walls of succeeding containers are heated by vapors arising from the material under treatment in the treating chambers of preceding containers, means for rotating said shaft and connected conveyors at a high rate of speed, and wiper means operatively associated with said conveyor members and adapted to engage the interior surface of the containers.

17. The method of evaporation, which consists in applying a continuous layer of material to be treated to the interior surface of an externally heated cylindrical container, causing said layer of material to positively move continuously in a circular and simultaneously endwise path over said surface while maintaining a central zone for the escape of vapors, introducing the material as treated into an auxiliary container, and causing the material in the auxiliary container to be heated by vapors from the central zone within said layer of material.

18. The method of evaporation which consists in positively subjecting a continuous circular layer of material to rotatable and simultaneously endwise movement at a high speed over the inner surface of an externally heated cylindrical container, maintaining a central quiet zone for the escape of vapors within said layer of material, introducing the treated material into an auxiliary container, and causing the vapors from said central quiet zone of the first mentioned container to envelop the wall of the second container and constitute a heat transmitting medium for the latter.

19. In a multiple effect apparatus of the character described, the combination of a horizontally disposed cylindrical container divided to form a plurality of end to end treating chambers, each chamber having a surrounding heating space, connected and simultaneously movable means within the respective treating chambers for causing the material to rapidly move in layer formation circularly and simultaneously endwise over the interior surface of the cylindrical walls of the treating chambers and for maintaining a central zone for the escape of vapors, means of communication between the treating chambers for the material, and means of communication between the vapor zone of one treating chamber and the heating space surrounding a succeeding chamber.

20. The method of treating substances to change the consistency thereof which consists in introducing the same into a horizontally disposed cylindrical container, imparting to the substance so introduced the form of a concaved cylindrical sheet continuously rotatable and simultaneously endwise movable, maintaining said form of the sheet through the operation, simultaneously wiping the inner surface of the container and imparting to the walls of the container a temperature different from that of the substance, allowing the treated material to pass into an auxiliary cylindrical container, subjecting the material to movement over the interior surface of the auxiliary container, and causing the vapors arising from the material under treatment in the first container to rapidly escape and surround the walls of the auxiliary container.

In testimony whereof I hereunto affix my signature.

CHARLES R. MABEE.