(No Model.) 3 Sheets—Sheet 1.

C. L. CHAPMAN.

CENTRIFUGAL LIQUID SEPARATOR.

No. 523,105. Patented July 17, 1894.

Fig. 2. Fig. 3. Fig. 1.

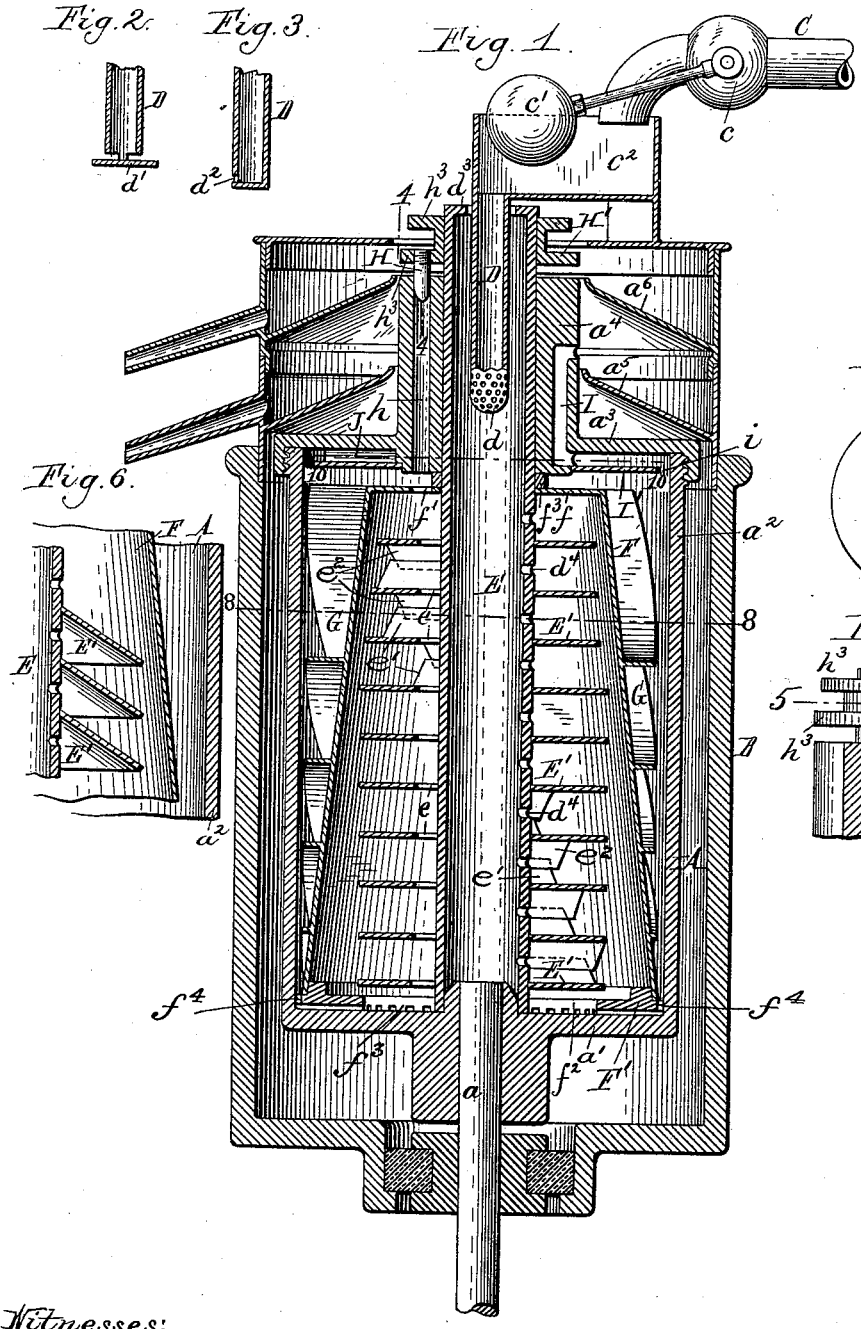


Fig. 5.

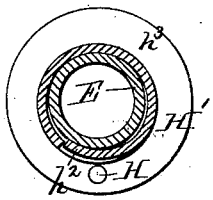
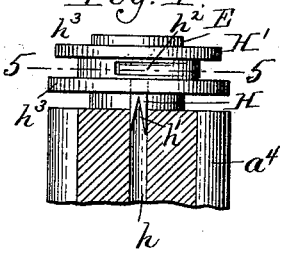


Fig. 6.

Fig. 4.



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(No Model.)

3 Sheets—Sheet 2.

C. L. CHAPMAN.

CENTRIFUGAL LIQUID SEPARATOR.

No. 523,105. Patented July 17, 1894.

Fig. 7.

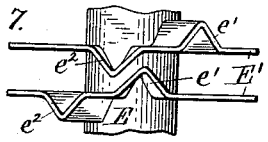


Fig. 8.

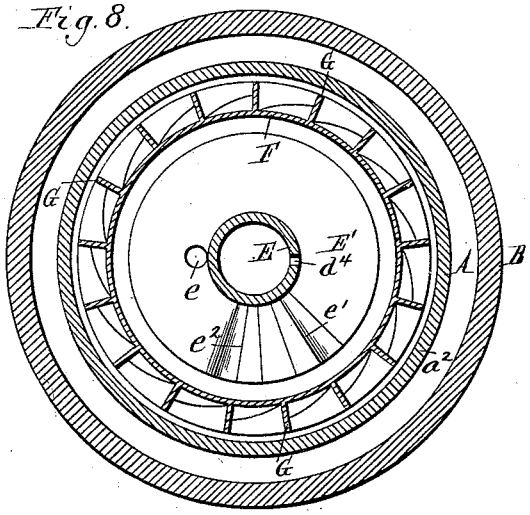


Fig. 9.

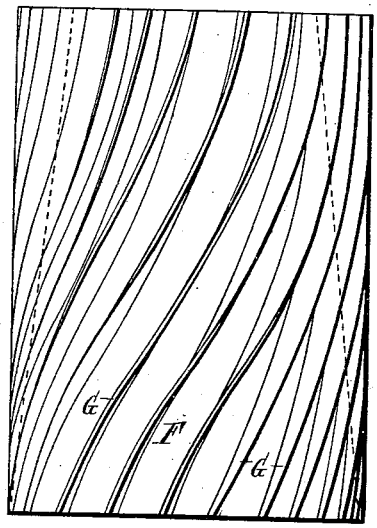


Fig. 11.

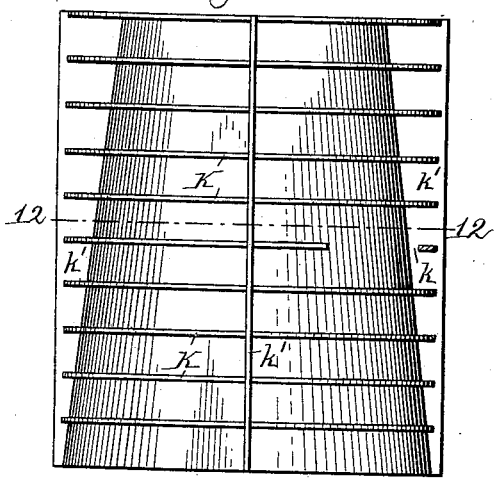


Fig. 10.

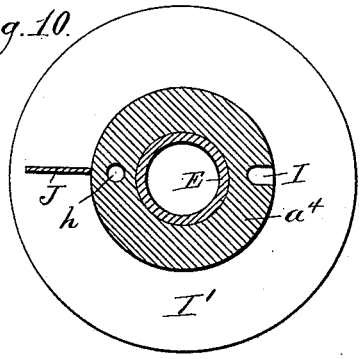


Fig. 12.

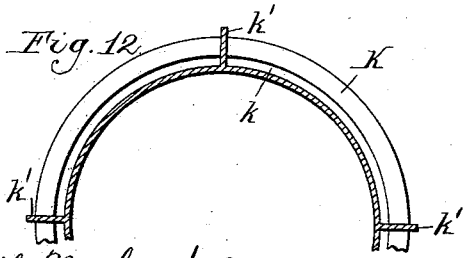
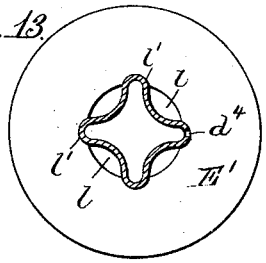


Fig. 13.



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(No Model.) 3 Sheets—Sheet 3.

C. L. CHAPMAN.

CENTRIFUGAL LIQUID SEPARATOR.

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Fig. 14.

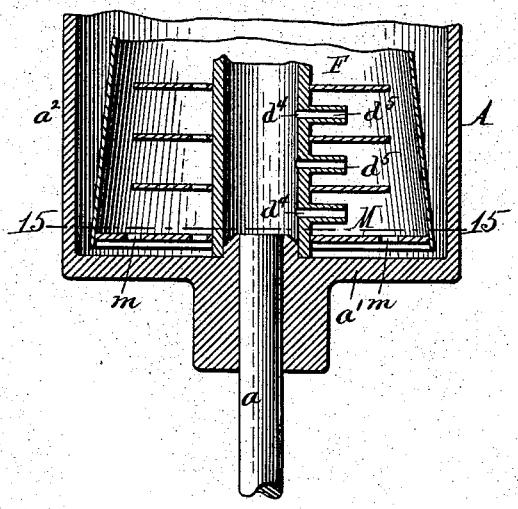


Fig. 16.

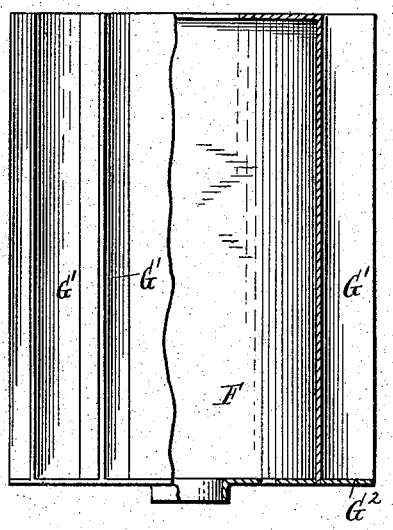


Fig. 15.

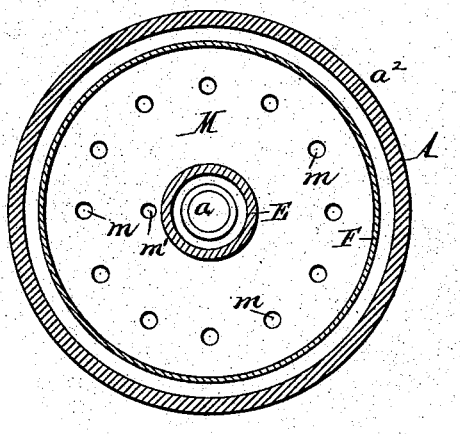
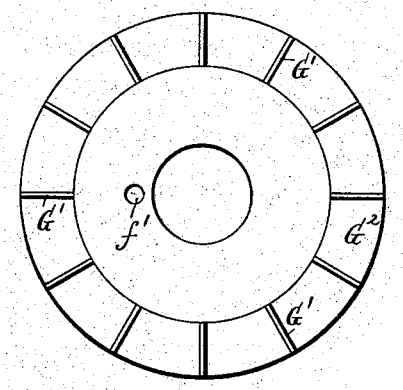


Fig. 17.



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F. Gustav. Wilhelm.

Clarence L. Chapman Inventor.
By Wilhelm & Bonner.
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UNITED STATES PATENT OFFICE.

CLARENCE LEE CHAPMAN, OF LITTLE FALLS, NEW YORK.

CENTRIFUGAL LIQUID-SEPARATOR.

SPECIFICATION forming part of Letters Patent No. 523,105, dated July 17, 1894.

Application filed March 18, 1893. Serial No. 466,617. (No model.)

To all whom it may concern:

Be it known that I, CLARENCE LEE CHAPMAN, a citizen of the United States, residing at Little Falls, in the county of Herkimer and State of New York, have invented new and useful Improvements in Centrifugal Liquid-Separators, of which the following is a specification.

This invention relates to that class of centrifugal liquid separators which are employed for separating compound liquids or emulsions into their constituent liquids of different densities, principally for creaming milk.

The objects of this invention are to provide simple and efficient means by which the separating capacity of this class of separators is increased; to reduce as far as possible, the liability of the bowl getting out of balance, either by the appliances used in the bowl for promoting the separation or by deposits of impurities; to facilitate the cleaning of the drum and the appliances used in it; to provide simple means for regulating the consistency of the discharged cream while the machine is in motion, and to improve the machine in various other respects.

In the accompanying drawings consisting of three sheets:—Figure 1 is a sectional elevation of a centrifugal liquid separator provided with my improvements. Figs. 2 and 3 are vertical sections showing different constructions of the outlet of the stationary feed pipe. Fig. 4 is a sectional elevation of the adjustable device whereby the cream outlet is controlled, the section being taken in line 4—4, Fig. 1. Fig. 5 is a horizontal section in line 5—5, Fig. 4. Fig. 6 is a fragmentary sectional elevation showing the inner disks conical, instead of horizontal, as they are shown in Fig. 1. Fig. 7 is a side elevation of two of the inner disks. Fig. 8 is a horizontal section in line 8—8, Fig. 1. Fig. 9 is a side elevation of the inner drum. Fig. 10 is a horizontal section in line 10—10, Fig. 1. Fig. 11 is a side elevation of an inner drum provided with horizontal external rings and vertical blades. Fig. 12 is a fragmentary horizontal section in line 12—12 Fig. 11. Fig. 13 is a horizontal section showing a modified construction of the feed pipe. Fig. 14 is a sectional elevation of the lower portion of the inner drum, showing a modified construction of the same. Fig. 15 is a horizontal section in line 15—15, Fig. 14. Fig. 16 is a view, partly in elevation and partly in vertical section, of a cylindrical inner drum provided with perpendicular external blades. Fig. 17 is a top plan view thereof.

Like letters of reference refer to like parts in the several figures.

A represents the bowl of the centrifugal separator, and a the spindle upon which the bowl is mounted in any suitable manner.

a' represents the bottom of the bowl, a^2 the peripheral wall thereof, and a^3 its cover provided with an upwardly projecting contracted neck a^4.

B represents the curb inclosing the bowl and supported on the stationary frame of the machine in the usual manner.

a^5 and a^6 represent, respectively, the receptacles for the skim milk and cream supported on the curb, as usual.

C represents the supply pipe through which the milk to be separated is supplied to the machine and which is provided with a cock or valve c which is controlled by a float c'.

c^2 represents the feed cup arranged above the cream receptacle and receiving the milk from the pipe C. The float c' is arranged in this cup and regulates the supply of milk thereto.

D represents the stationary feed pipe by which the milk is conducted from the feed cup into the separator. This pipe depends from the feed cup and is provided at its lower end with a distributer d by which the milk is discharged against the inner side of the rotating feed pipe E, which is secured axially in the bowl. The trend of the discharge is lateral, so that the milk is delivered against the inner surface of the rotating pipe on which it is distributed.

As shown in Fig. 1, the distributer d consists of a perforated head or rose jet, which construction is preferred because it tends to distribute the milk vertically over the inner surface of the rotating feed pipe, but if desired, a deflecting disk d' may be arranged below the open end of the stationary feed pipe, as represented in Fig. 2, or a simple lateral discharge d^2 may be employed, as repre-

sented in Fig. 3. The upper end of the rotating feed pipe may be provided with an inwardly projecting flange d^3, as represented in Fig. 1, to prevent the milk from being thrown out of the upper end of the pipe by centrifugal force, or this pipe may be otherwise constructed in a well known manner for the same purpose.

The rotating feed pipe is provided with a vertical series of fine openings d^4 through which the milk is delivered in numerous fine streams into the bowl.

E′ represents rings or annular disks secured to the outer side of the rotating feed pipe, one above the other, preferably in such manner that each space between two disks is supplied with milk by one of the feed openings d^4 of the rotating pipe. *e* represents openings formed in these disks, near the central feed pipe, for the purpose of permitting the separated cream to pass upwardly to the cream outlet. These disks are provided with projections which compel the milk between the disks to rotate with the bowl. I prefer for this purpose the construction represented in Figs. 7 and 8, in which the disks are provided on their opposing sides with oblique projections, e' e^2, forming an oblique and constricted passage between them. These oblique projections compel the milk to rotate nearly with the speed of the bowl, but they do not form positive stops and avoid the formation of inward and outward currents which are formed on both sides of positive stops or blades and which disturb the body of milk and so interfere with the separation.

F represents a drum arranged within the bowl and outside of the disks E′. As shown in Fig. 1, the drum F tapers upwardly and is provided at its upper end with an inwardly projecting flange *f*, having an opening f' so arranged that the cream, which is separated in the space within this drum, can pass upwardly through this opening to the cream outlet of the bowl. F′ represents the bottom plate of this drum, which plate is annular in form and supports the lower end of the peripheral wall of this drum near its margin, which is located at a short distance inwardly from the peripheral wall of the bowl. The bottom plate F′ is provided on its under side with radial ribs or other suitable projections f^3 which support the plate at a short distance above the bottom plate of the bowl, and at its marginal edge with similar projections f^4 which fit into the bowl. These ribs are separated by intervening spaces through which the partially skimmed milk passes from the space inclosed by the drum into the outer bowl, the bottom plate being provided with a central opening f^2 of suitable size for this purpose. The upper flange *f* of the drum fits snugly around the rotating feed pipe and the drum is held down by a collar f^3 surrounding this pipe and interposed between the drum and the cover of the bowl.

G represents radial blades or wings secured to the outer surface of the drum F in an oblique or spiral direction and having their outer edges separated from the peripheral wall of the bowl by an unobstructed flow space. These spiral blades may be inclined in either direction with reference to the direction in which the bowl rotates, but I prefer a spiral lead in advance of the travel of the bowl, because with such a lead a current cannot flow toward the top of the bowl, as it would have to travel faster than the rotation of the bowl and it cannot back down against the current that is continually flowing upwardly outside of the wings.

h represents the cream outlet passage formed vertically in the contracted neck of the bowl, and opening into the cream receptacle at the upper end of said neck. The escape of the cream from this passage is regulated by a bolt H, Figs. 1, 4 and 5, which projects downwardly into the upper portion of this passage, and is provided in its lower end with an angular notch h', so that by raising and lowering the bolt, the outlet orifice can be more or less obstructed, as may be desired. This bolt is attached to a collar H′ which surrounds the rotating feed pipe above the neck of the bowl and on which it is frictionally held by a yielding lip h^2, which impinges against the rotating pipe and which may be formed in one piece with the collar, as represented in Figs. 4 and 5, or by other suitable means. The collar is provided with two annular flanges h^3 between which a stick or other implement can be inserted, while the machine is running, for raising and lowering the bolt, thereby regulating the density of the cream which is delivered by the machine. It is obvious, however, that the discharge of the cream can be regulated by the ordinary cream screw, in which case the machine must be stopped for making the adjustment.

I represents the skim milk discharge passage formed vertically in the neck of the bowl and opening at its upper end outwardly into the skim milk receptacle. I′ represents a horizontal annular diaphragm arranged at a short distance below the lower or inlet end of this passage and extending from the neck of the bowl, to which it is secured, nearly to the peripheral wall of the bowl. This diaphragm is separated from the peripheral wall of the bowl by an annular opening *i*, through which the skim milk enters the space between the diaphragm and the cover, and whereby the skim milk is drawn uniformly from the entire circumference of the bowl. This avoids the formation of a well defined current or currents which are created in the bowl when the skim milk is drawn by a pipe from one or more points and which run from the milk inlet of the bowl toward this point or points of discharge and disturb the body of milk and shorten the time during which the milk is exposed to centrifugal action.

J represents a blade arranged radially, or nearly so, in the space between the diaphragm I′ and the cover, and extending outwardly nearly to the edge of the diaphragm. As the skim milk is forced inwardly toward the axis of rotation, between the diaphragm I′ and the cover of the bowl it moves from the circumferential part of the bowl, which has the greatest peripheral speed, toward the part which is nearer the axis and has, therefore, a smaller peripheral speed. The skim milk rotates at the circumferential wall of the bowl with the peripheral speed of that wall and encounters on its inward course the blade J, which, being nearer the axis, rotates with a smaller circumferential speed and so operates upon the more rapidly rotating layer of skim milk somewhat like a stationary skimmer and skims off the inner layer of skim milk circumferentially around the bowl and does not draw merely from one point, whereby the uniform removal of the skim milk all around the bowl is promoted.

The full milk entering the rotating feed pipe is distributed through the vertical series of perforations of this pipe to the several annular compartments between the disks surrounding the pipe. This divides the volume of ingoing milk into numerous small streams. The disks act as guides for the several streams and assist in distributing the milk vertically in the bowl, thereby preventing the formation of heavy currents running directly toward the outlet of the inner drum in any part of that space which is inclosed by the inner drum. The milk would be distributed in a measure by the vertical series of openings in the rotating feed pipe in the absence of rings intervening between these openings, but the presence of these rings greatly promotes a uniform distribution. The full milk, which is so introduced into the space surrounded by the inner drum, is prevented by the drum from passing directly toward the outlets of the bowl and is separated in the drum. The cream moves inwardly between the rings and upwardly through the openings, provided in the rings for that purpose, to the cream discharge, while the blue milk, or partially skimmed milk, moves outwardly against the inner side of the drum and moves downwardly between the outer edges of the rings and the drum to the bottom thereof.

The disks in the upper part of the drum are preferably made of increasing diameter downwardly corresponding with the bevel of the drum, while the lower disks are made of uniform diameter. This forms a space or pocket of considerable width between the outer edges of the lower disks and the drum, which space serves as a pocket for the deposit of solid or semi-solid impurities which are separated in the inner drum from the milk and which are thereby prevented from reaching the outer drum, while sufficient space is left between the edges of the lower disks and the deposit of impurities to accommodate the downwardly moving current of partially skimmed milk.

The bottom ring of the drum, which is provided on its under side and on its peripheral edge with numerous passages through which the partially skimmed milk flows into the separating space of the bowl, distributes the milk into numerous small streams evenly around the peripheral wall of the drum.

The partially skimmed milk is further separated in the space between the peripheral wall of the bowl and the outer side of the inner drum. The separated cream moves inwardly into the quiescent spaces formed between the external wings or flanges of the drum and moves slowly upwardly in these spaces toward the cream outlet of the bowl, while the skim milk flows upwardly through the unobstructed flow space between the outer edges of the wings and the bowl. This flow space may be of greater or less width, but I have found that in a drum having an internal diameter of four inches, a flow space seven thirty-seconds of an inch in width produces very good results. The cream globules which have escaped the separating action in the inner drum are readily collected in these quiescent spaces and the skimming of the milk is thereby completed. The cream separated within the inner drum and that separated outside thereof unite above the drum and pass off together through the cream outlet of the bowl. These devices, by which quiescent spaces are formed on the outer surface of the inner drum, and an unobstructed flow space for the skim milk is formed along the inner surface of the bowl, may be varied in many ways without departing from my invention. For instance, the construction represented in Figs. 11 and 12 may be adopted, in which horizontal rings K are arranged, one above the other, upon the outer side of the inner drum. The horizontal rings are separated from the outer surface of the drum by narrow spaces *k* through which the separated cream moves upwardly along the outer side of the drum. The outer edges of these horizontal rings are separated from the inner surface of the bowl by the flow space through which the skim milk flows. These horizontal rings are supported by vertical blades *k′* which also compel the milk to rotate with the bowl. This construction forms very effective quiescent spaces but the device is not as readily cleaned as that represented in Figs. 1, 8, and 9.

The drum may be made cylindrical instead of conical, but I prefer the conical form because it promotes the movement of the heavy liquid toward the large end of the drum.

In the construction represented in Figs. 16 and 17, the drum is made cylindrical and provided on its outer surface with perpendicular blades G′ between which the quiescent cream spaces are formed and which are separated at their outer edges from the bowl by an un-

obstructed flow space for the skim milk. The lower end of this drum is provided with a horizontal flange G^2 extending outwardly to the edges of the blades, or nearly so, to assist in preventing strong upward currents from entering the quiescent spaces between the blades.

The construction of the rotating feed pipe may be varied. For instance, this pipe may be corrugated lengthwise, as represented in Fig. 13, to form upright depressed flow spaces l on its outer surface through which the separated cream can flow upwardly, thereby dispensing with openings in the disks for that purpose. In this construction of the feed pipe, the outlet openings d^4 are arranged in the salient portions of the corrugations which project into recesses l' formed in the inner openings of the rings, and whereby the ingoing currents of milk are prevented from interfering with the cream flowing farther inwardly through the spaces formed by the depressed portions of the corrugations.

The construction of the bottom plate of the inner bowl may be varied. For instance, the perforated disk M, represented in Figs. 14 and 15, may be substituted for the grooved plate represented in Fig. 1. In this construction the lower disk M is soldered or otherwise secured to the rotating feed pipe and the lower end of the tapering drum rests upon the peripheral edge of this disk, and is thereby supported at a short distance above the bottom of the bowl. The disk M is provided at a suitable distance inwardly from the peripheral wall of the drum with openings m through which the partially skimmed milk passes from the interior of the drum into the bowl, and near the feed pipe with an opening m' through which the cream globules, separated in the space below the disk, can pass upwardly toward the cream outlet. The outlet openings d^4 of the feed pipe may be provided with discharge tubes d^5 which extend outwardly beyond the cream wall, in order to prevent interference of the ingoing currents of milk with the cream wall.

The construction of the disks surrounding the rotating feed pipe may be varied, for instance, by making the same beveled or conical, as represented in Fig. 6, instead of horizontal, as represented in Fig. 1.

I claim as my invention—

1. The combination with the bowl of a centrifugal liquid separator, of a feed pipe which is secured to the bowl and rotates therewith and which is provided with a vertical series of feed openings, and a drum arranged in the liquid space of the separator between the perforated feed pipe and the peripheral wall of the bowl, substantially as set forth.

2. The combination with the bowl of a centrifugal liquid separator, provided at its top with discharges for the separated liquids, of a feed pipe which is secured to the bowl and rotates therewith and which is provided with a vertical series of feed openings, and an upwardly tapering drum arranged in the liquid space of the bowl between the perforated feed pipe and the bowl and provided at its upper end with a passage for the light separated liquid and at its lower end with a passage for the partially separated liquid, substantially as set forth.

3. The combination with the bowl of a centrifugal liquid separator having a rotating feed pipe provided with a vertical series of discharge openings, of a vertical series of rings or annular disks surrounding said pipe, and a drum arranged between said disks and the peripheral wall of the bowl, substantially as set forth.

4. The combination with the bowl of a centrifugal liquid separator having a rotating feed pipe provided with a vertical series of discharge openings, of rings surrounding said pipe and provided near the pipe with passages for the separated cream, and a drum arranged between said rings and the peripheral wall of the bowl, separated from said rings by an unobstructed passage, through which the partially skimmed milk flows downwardly, and having at its top an outlet for the cream and at its bottom an outlet for the partially skimmed milk into the separating space outside of said drum, substantially as set forth.

5. The combination with the bowl of a centrifugal liquid separator having a rotating feed pipe provided with a vertical series of discharge openings, of a drum arranged between said perforated pipe and the peripheral wall of the bowl and having at its upper end an outlet for the separated cream and at its lower end a bottom plate provided with numerous passages through which the partially skimmed milk is delivered into the separating space outside of said drum, substantially as set forth.

6. The combination with the bowl of a centrifugal separator having a rotating feed pipe provided with a vertical series of discharge openings, of a drum arranged between said pipe and the peripheral wall of the bowl, and a vertical series of rings or disks surrounding said pipe and separated from the lower portion of the peripheral wall of the bowl by a space of increased width forming a pocket for the deposit of impurities, substantially as set forth.

7. The combination with the bowl of a centrifugal separator having a rotating feed pipe provided with a vertical series of discharge openings, of an upwardly tapering drum arranged in said bowl and around said feed pipe, and rings or annular disks surrounding said feed pipe, the upper disks being of gradually decreasing diameter upwardly, and the lower disks being of uniform diameter, substantially as set forth.

8. The combination with the bowl of a centrifugal separator, of disks or rings arranged within the bowl, one above the other, and pro-

vided on their opposing faces with projections extending partly across the space between the disks or rings and arranged at a less distance from each other than the distance between the disks or rings, whereby a contracted passage is formed between the projections, substantially as set forth.

9. The combination with the bowl of a centrifugal liquid separator, of an internal drum provided on its outer surface with oblique wings having their outer edges separated from the peripheral wall of the drum by an unobstructed flow space, substantially as set forth.

10. The combination with the bowl of a centrifugal liquid separator, of an internal drum which receives the milk and is provided at its upper end with an outlet for the cream and at its lower end with an outlet for the partially skimmed milk, and projections or obstructions arranged on the outer side of said drum, forming quiescent spaces and separated from the peripheral wall of the drum by an unobstructed flow space, substantially as set forth.

11. The combination with the bowl of a centrifugal liquid separator, having a rotating feed pipe provided with a vertical series of discharge openings, of rings or annular disks surrounding said pipe, a drum surrounding said rings or disks and provided at its upper end with an outlet for the cream and at its lower end with an outlet for the partially skimmed milk, and projections or obstructions arranged on the outer side of said drum, forming quiescent spaces and separated from the peripheral wall of the drum by an unobstructed flow space, substantially as set forth.

12. The combination with the bowl of a centrifugal liquid separator having its top or cover provided with an outlet for the skimmed milk, of a diaphragm arranged in the bowl below said outlet and having its peripheral edge separated from the peripheral wall of the bowl by an annular opening, and a wing or partition arranged between said diaphragm and said cover and extending inwardly toward said skim milk outlet, substantially as set forth.

Witness my hand this 10th day of March, 1893.

CLARENCE LEE CHAPMAN.

Witnesses:
ALBERT STORY,
W. C. FITCH.