No. 798,324. PATENTED AUG. 29, 1905.

J. C. CROMWELL.

CENTRIFUGAL LIQUID SEPARATOR.

APPLICATION FILED SEPT. 3, 1904.

3 SHEETS—SHEET 1.

Fig. 8.

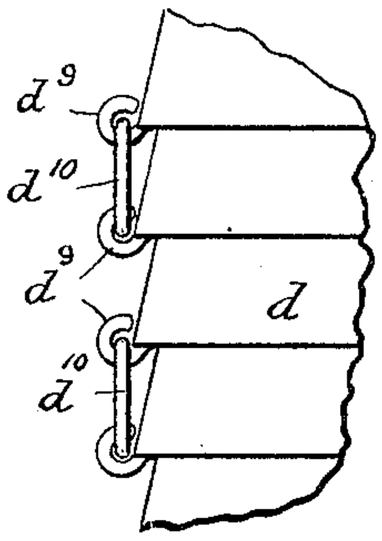

Fig. 1.

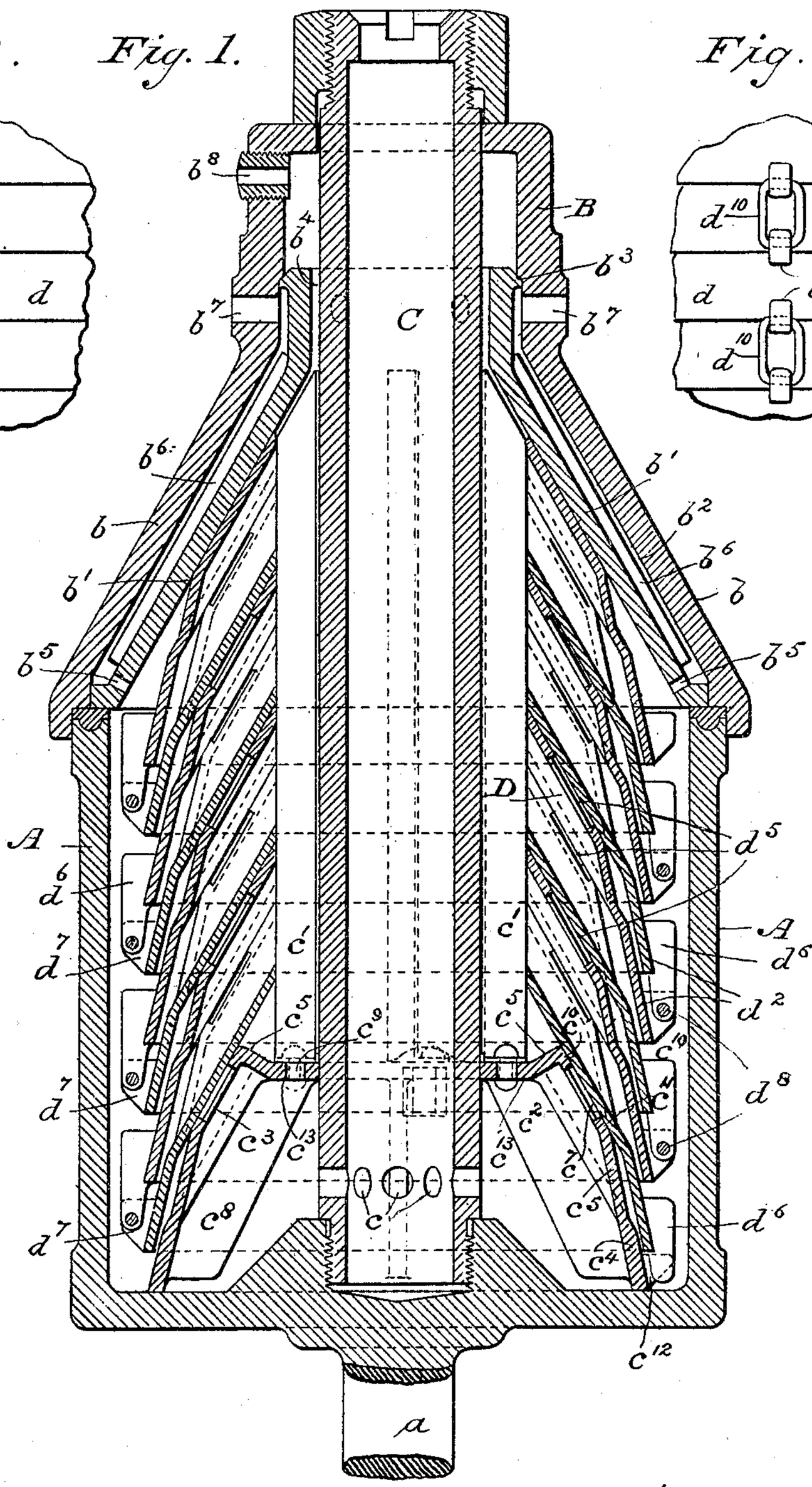

Fig. 9.

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3 SHEETS—SHEET 2.

Fig. 2.

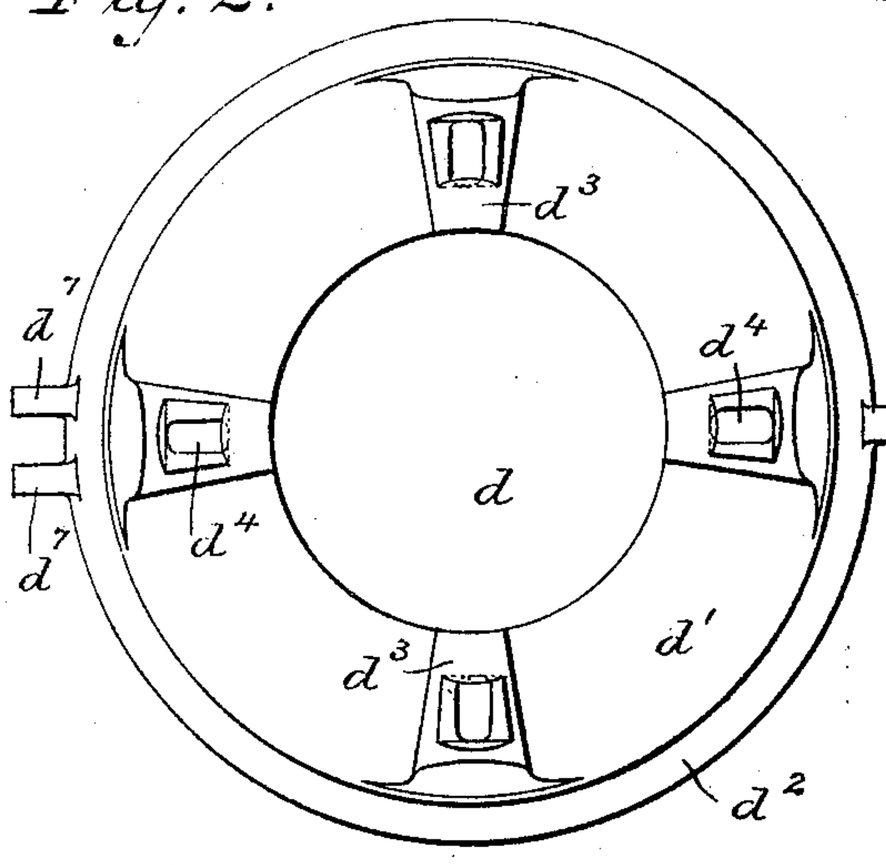


Fig. 4.

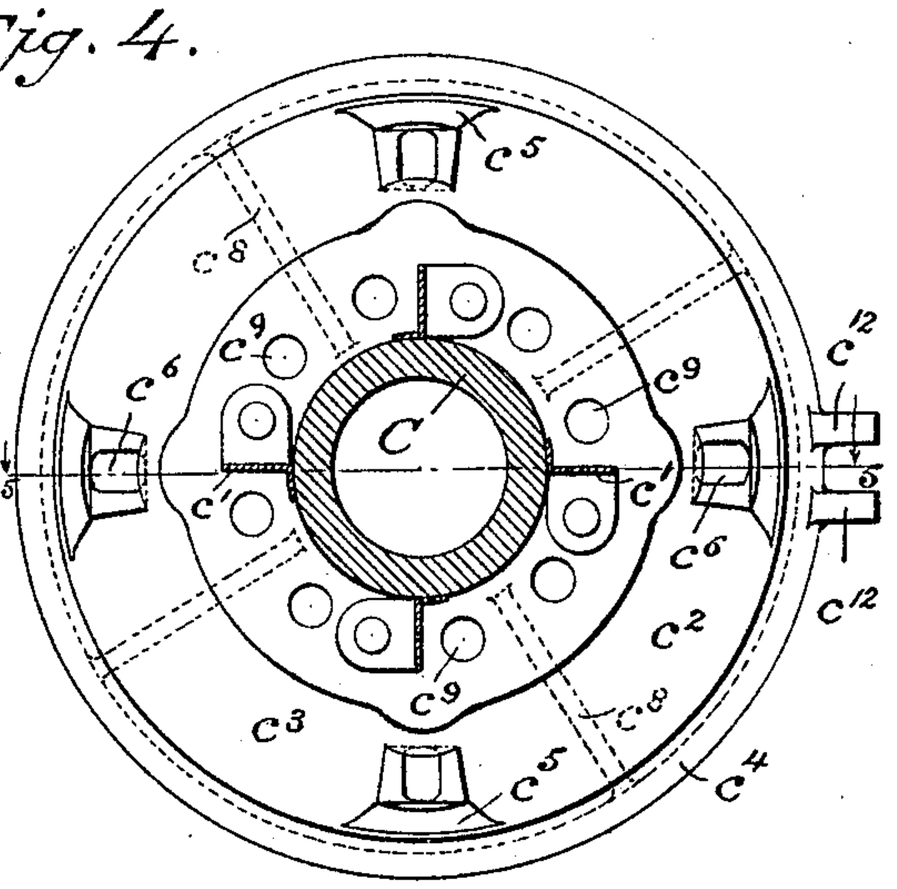


Fig. 3.

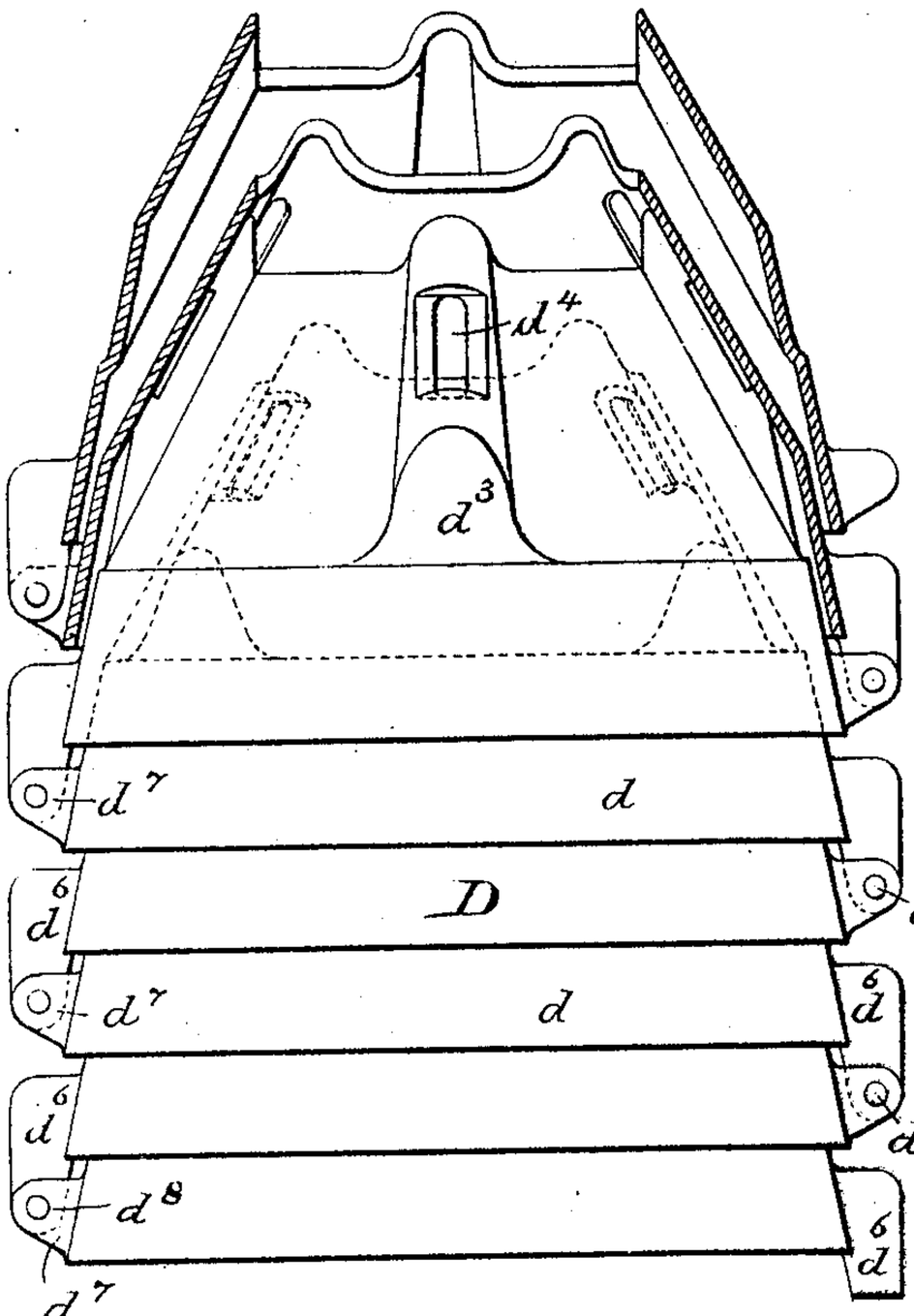
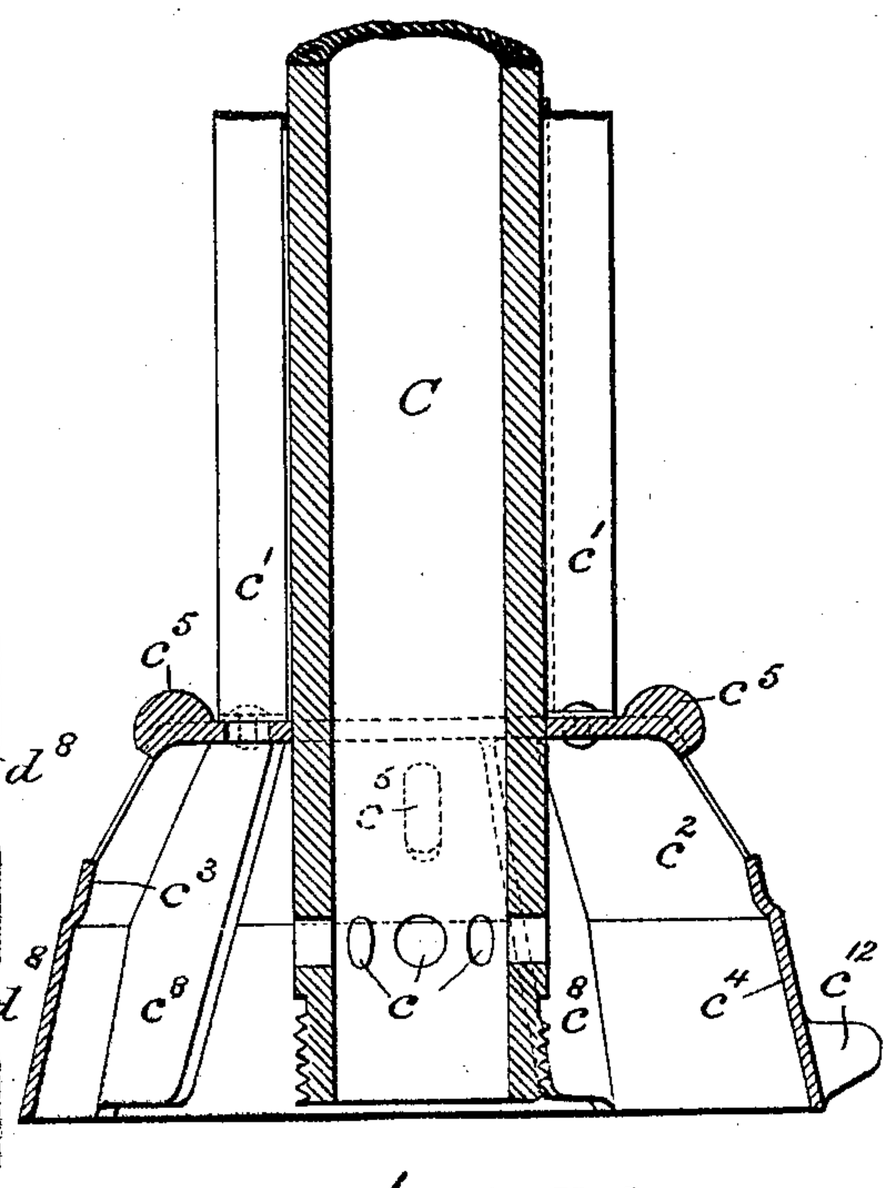


Fig. 5.



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3 SHEETS—SHEET 3.

Fig. 6.

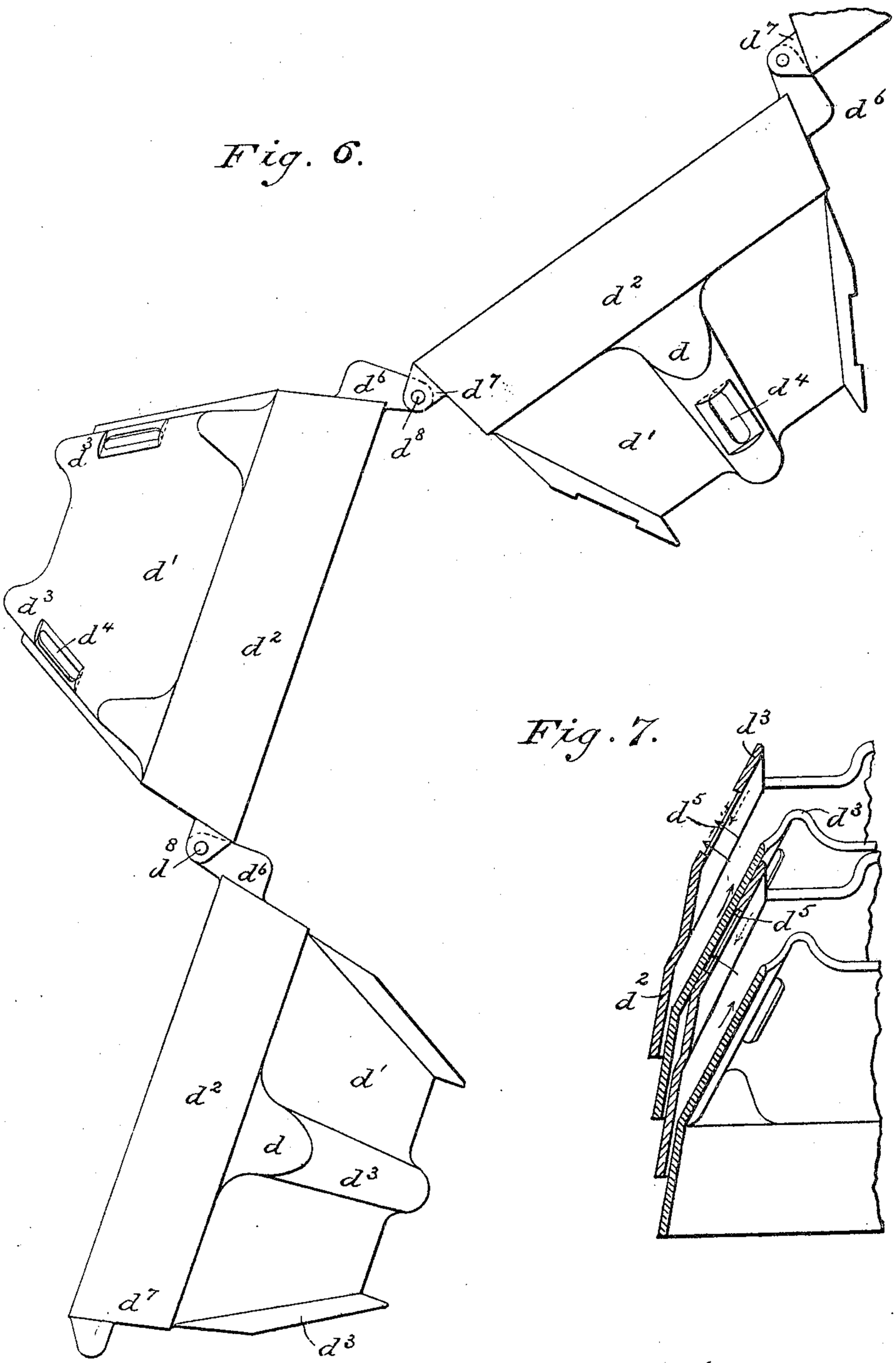

Fig. 7.

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CENTRIFUGAL LIQUID-SEPARATOR.

No. 798,324. Specification of Letters Patent. Patented Aug. 29, 1905.

Application filed September 3, 1904. Serial No. 223,173.

To all whom it may concern.

Be it known that I, JOHN C. CROMWELL, a citizen of the United States, and a resident of Cleveland, county of Cuyahoga, and State of Ohio, have invented a new and useful Improvement in Centrifugal Separators, of which the following is a specification, the principle of the invention being herein explained and the best mode in which I have contemplated applying that principle, so as to distinguish it from other inventions.

My invention relates to centrifugal separators, and particularly to an improvement in that class of the latter which is designed to retain during the separating operation the compound liquid that is being separated completely out of contact with the constituent liquids after the latter have been separated out. There are included also important improvements in other features of a separator, which will be referred to hereinafter. Said invention as a whole consists of means hereinafter fully described, and specifically set forth in the claims.

My invention is adapted to be used in the separation of heterogeneous bodies into their constituent parts, especially in the separation of compound liquids, and I shall describe said invention as particularly utilized in the recovery of cream and skim-milk from whole or full milk, although obviously it may be used in the breaking up of other compound bodies.

It is well understood that the effect of the centrifugal force upon a body of full-milk is to divide the same into concentric layers arranged according to the specific gravities of the constituent liquids, the skim-milk comprising the outer layer, the cream the inner layer, and the full-milk, that is not yet separated, a neutral or intermediate layer. These rings are very closely drawn and exactly arranged and remain so under the action of the centrifugal force. Now it is highly desirable, in order that the condition of these layers may not be disturbed and that there may not be a remix of the different liquids after they are once separated, that the cream and skim-milk as fast as they are separated may be fed directly each to its respective layer and thence drawn off from the separating-machine without intersecting or crossing or interfering in any way with any liquid of a different density and that the full-milk, as yet unseparated, may be retained in its intermediate layer and subjected to the continued effect of the centrifugal action. Further, in order that a complete separation of the cream and skim-milk may take place the full-milk must be subjected to the centrifugal action for a considerable period of time, several seconds possibly, and in order to allow for this it would require a plain separating-bowl of inconveniently large proportions unless a very small amount of milk were being treated. Such a bowl would necessarily be of very large diameter in order to place the milk under the action of an enormous centrifugal force and also would be very deep in order to hold the milk under this force for a period of time of sufficient length to effect a complete separation. However, different interior devices or separating and division members may be placed within a small plain bowl and effect as thorough a separation of the cream and skim-milk as could be accomplished in a plain bowl of larger size. Two classes of these interior division members are concerned with my invention—A a device that will break up the milk into thin strata or layers, and thus allow it to be acted upon more quickly by the centrifugal force, and B a device that will baffle the milk in its course through the bowl, and thus hold it while it is traversing a given distance under the action of the centrifugal force for a longer period. Other conditions which must necessarily be present in order to effect a complete and satisfactory separation of the cream and skim-milk are that the full-milk that is flowing through the bowl must be caused to travel at the same speed as the bowl and be prevented from lagging, that a centrifugal force great enough to effect the different specific gravities quickly must be generated, and means for giving an overflow-opening, which shall be proportionate to the inlet, must be provided. All of these conditions and principles are utilized in my invention, and improved apparatus for carrying them out are provided in my separator, which will now be described in detail.

The annexed drawings and the following description set forth in detail certain mechanism embodying the invention, such disclosed means constituting but one of various mechanical forms in which the principle of the invention may be used.

In said annexed drawings, Figure 1 represents a central vertical section of a separating bowl and cover with my improved division member contained therein. Fig. 2 represents a plan view of one of the cone-disks

comprising the division member. Fig. 3 represents a partial vertical section and a partial side elevation of the division member. Fig. 4 represents a plan view of the disk attached to the bottom of the supply-tube, the latter and the wings secured thereto being shown in section. Fig. 5 represents a central vertical section taken upon the plane indicated by the line 5 5, Fig. 4. Fig. 6 represents a perspective view of three of the disks comprising the division member separated and spread out. Fig. 7 is a diagram representing the relative positions of the cream, full-milk, and skim-milk during the separating operation; and Figs. 8 and 9 are broken side and front views, respectively, of a part of the division member, illustrating a modified method of hinging the disks.

My improved separator comprises, broadly, a bowl A, a cover B, with overflow-openings, a supply-tube C, and an interior device or division member D.

The bowl A may be of any ordinary type suitable for the purpose and is connected by a spindle *a*, Fig. 1, with the driving mechanism, (not shown,) which may be operated in any suitable manner to rotate the bowl at a speed great enough to quickly arrange the cream, skim-milk, and full-milk in their respective layers.

The cover B comprises two parts *b b'*, part *b* being an outer shell adapted to close and seal the bowl and the part *b'* being an inner shell adapted to fit within the outer shell, so as to provide a passage b^2 between the outer and inner shells for the separated skim-milk as it passes off from the bowl. The top of the inner shell is a ground seat b^3, snugly fitting the outer shell and sealing the space between the two shells from the cream as the latter passes out of the separator through a central passage b^4 around the supply-tube C. The inner shell is provided with a plurality of rectangular slots b^5 around the bottom, two of which are shown in Fig. 1 opening from the inner periphery of the bowl to the space between the shells *b* and *b'* and allowing the skim-milk to pass from the bowl to the passage b^2, and also strips b^6 between the two shells and adapted to effect the proper upward feed of the skim-milk in such passage by keeping it at the bowl speed and preventing it from slipping or lagging on the inner shell. Proper discharge-orifices b^7 for the skim-milk and a discharge-screw b^8 for the cream are provided in the outer shell *b* of the cover.

The supply-tube C consists of a hollow conduit screwed into the bottom of the bowl A and provided with suitable openings *c* at the bottom, through which the full-milk may flow into the bowl. Secured to this tube C on the outside are four wings *c'*, Figs. 1 and 4, which act as carriers in the open space at the center of the bowl for the division member D, as will be hereinafter fully explained. Secured to the bottom of the wings *c'* is a cone-disk c^2, Figs. 1 and 4, which is so constructed and positioned that it is adapted when the supply-tube C is screwed into the bowl to rest on the bottom of the latter, and thus seal off a compartment under such disk. This disk c^2 comprises a portion c^3, which is a substantially sixty-degree cone, which is the angle that has been found to best serve the purpose, and a portion c^4, which is substantially vertical and forms, in effect, a lower lip upon the disk positioned at a marked angle to the cone proper. On the sixty-degree cone are four convolutions c^5, approximately a quadrant apart, and each convolution is provided with a rectangular opening c^6 in its top, and the metal of the convolution is cut away at each side of the opening for the full length of the opening, thus providing side outlets c^7, Fig. 1, when there is another disk resting upon the disk c^2, as will be hereinafter explained. On the inside of the disk c^2 are four wings c^8, which act as carriers for the full-milk in the disk c^2 when the separator is revolving. In the horizontal surface at the top of the disk c^2 are provided a number of apertures c^9, Fig. 4, opening from the open space that is sealed off under the disk to the central zone of the separator, the purpose of which will be hereinafter fully explained.

The interior device or division member D consists of a plurality of cone-disks *d*, (eight as illustrated in Fig. 3,) which are so constructed and hinged together that they rest one upon the other. They may be made of any metal, either cast or stamped. Although the members *d* are, properly speaking, frusta of cones, I shall refer to them hereinafter as the "cone-disks" or simply "disks" or "cones." Similarly to the disk c^2 each disk *d* consists of a sixty-degree cone *d'* and a bottom lip d^2, Fig. 2. The center of each cone is open to receive the supply-tube C and the wings *c'*, the latter fitting snugly within such opening. Four convolutions d^3, having rectangular openings d^4, Fig. 2, and side outlets d^5, Figs. 1 and 7, similar to the construction of disk c^2, are provided on each disk *d*. The lower of the eight disks *d* is spaced from the disk c^2 by the convolutions c^5 upon the latter, the top and bottom c^{10} and c^{11}, respectively, Fig. 1, of which convolution c^5 rest snugly up against the under surface of the lower cone *d*. Adjacent cones in the series of eight cones *d* are similarly spaced by the convolutions of the lower of any two contiguous cones. In actual construction in the device illustrated each convolution is substantially three-sixteenths of an inch high, and the metal is cut away on each side of the convolution from the top of the same for a depth of about one-sixteenth of an inch to form the side outlets d^5. The construction and relative positions of the cones provide about a one-thirty-secondth-of-an-

inch opening between the lips d^2 of adjacent disks d when they are placed one upon the other. The convolutions upon the topmost disk d are not provided with perforations, as will be noted from the drawings.

The series of disks d are hinged together, and the lowermost one of the series is hinged to the disk c^2, Fig. 1. The method of hinging is as follows: Upon the disk c^2 are two integral lugs c^{12} c^{12}, Figs. 4 and 5, within which upon a small pin is pivoted a downwardly-projecting ear d^6, secured integrally to the lowermost disk d, Fig. 3. Diametrically opposite to the ear d^6 upon the disk d are secured two lugs d^7 d^7, Fig. 2, similar to the lugs c^{12} c^{12} upon the disk c^2, within which is pivoted upon a pin d^8 a downwardly-projecting ear d^6, secured upon the second disk d. This method of hinging is followed out between each two successive disks, and it will be noted that the hinge portions are so fastened to the disks that the convolutions d^3 of any two contiguous disks d alternate or bear a staggered relation to each other and are not one upon the other—that is, there is an angle of forty-five degrees between the vertical plane passing through a convolution of any one disk and the vertical plane passing through the nearest adjacent convolution of a contiguous disk. From Figs. 1 and 7 it will be clearly seen that the side outlets d^5 of each disk lie substantially in the peripheral plane of the conical portion d' of the upper adjacent disk, since the lower surface of such conical portion of each disk lies flush with the top of the side outlets of the disk immediately below. It will be noted that this method of hinging enables the disks d of the division member D to be separated and spread out, as illustrated in Fig. 6, whereby the division member may be easily and thoroughly cleaned. It will also be noted that this construction provides a division member composed of hinged parts which are located in different planes transverse to the axis of the separator, which are horizontal planes in the device illustrated, and I am not aware that a division member has been provided in centrifugal separators heretofore used where the individual parts of the member have been located when in use in different planes transverse to the axis of the separator, but they have been located in different planes parallel to the axis of the separator.

In the modified form of hinge illustrated in Figs. 8 and 9 diametrically opposite sides of the disks d are provided with hooks d^9, which are connected by means of short links d^{10}. This method of hinging enables the division member D to be cleaned more readily, for the reason that the individual disks d can be drawn farther apart.

The operation of my improved separator is as follows: The bowl A is revolved at the proper speed, and milk is allowed to enter the supply-tube C, Fig. 1, whence it escapes through the openings c into the space under the disk c^2. The cream that has been separated out of the full-milk in this short time finds its way to the center of the space under the disk c^2 and rises up through the openings c^9, Fig. 4, into the space between the disk c^2 and the first disk d, whence it has a straight course up through the bowl, around the tube C, to the cream-outlet b^8, Fig. 1. That part of the full-milk which has not been separated under the disk c^2 is held by the centrifugal force in a solid layer against the inner surface of the disk c^2 and escapes therefrom through the side outlets c^7, Fig. 1, which side outlets open up, as has been stated before, into the neutral zone between the disk c^2 and the disk d, so that the full-milk is thus fed directly into its proper position. The full-milk which is held against the inner wall of the disk c^2 cannot escape therefrom through the cream-openings c^9 on account of the angle of the cone c^2 and the short horizontal lip c^{13} on the disk c^2, Fig. 1, between the cone portion of the disk and the openings c^9, so that the full-milk necessarily passes out through the side outlets c^7. Some of the full-milk is separated into cream and skim-milk between the disk c^2 and the lowermost disk d, for it will be noted that the milk as it escapes from the side outlets c^7 is spread out in a thin stratum on the disk d, thus facilitating the separating process, and the cream under the action of the centrifugal force is held against the outer surface of the disk c^2 and passes upwardly along such surface to the central space of the bowl around the supply-tube C, whence it passes directly to the cream-outlet b^8. The skim-milk is held against the inner surface of the lowermost disk d and passes downwardly along this surface until it reaches the lip d^2, Figs. 1, 2, and 6, where it is baffled for a while and held until the weight of the skim-milk following forces it down along such lip and around the under surface of the same, whence it makes a sharp turn and passes directly to the skim-milk outlets b^7. This baffling of the skim-milk upon the lip d^2 extracts most of the cream that may have adhered thereto and not been separated previously, while the sharp turn to which the skim-milk is subjected at the bottom of the lip d^2 whips or cracks off from it the last vestige of cream which is associated with it. However, only a part of the full-milk is thus separated into cream and skim-milk between the disk c^2 and the lowermost disk d, and the remainder must be separated between the remaining disks. It will be noted, as has been explained before, that the side outlets d^5, Fig. 1, of the disks d are so positioned that they tap the neutral layer of liquid or the full-milk between the disk c^2 and the lowermost disk d, so that that portion of the full-milk which is as yet unseparated passes through such side outlets d^5 of the

lowermost disk d and is spread out in a thin layer between the lowermost disk d and the second disk d, where the separation is repeated and a part of the full-milk broken up into cream and skim-milk. This operation takes place in each successive space until the eighth one is reached, by which time all of the full-milk will have been separated into cream and skim-milk.

In the diagram Fig. 7, illustrating the relative flows of the cream, full-milk, and skim-milk between adjacent disks, it will be noted that the section of the topmost disk shown in said diagram is taken through one of the convolutions of said disk, and hence the section of the next disk in the same plane is taken through the latter disk intermediate of two of its convolutions by reason of the staggered relation of convolutions of adjacent disks. In said diagram it will be noted that the flow of the cream upon the outside surface of the disks is denoted by the full arrows. The flow of the skim-milk is denoted by the dotted arrows on the inside surface of the disks, the arrows being dotted to denote that the skim-milk would be descending upon such surface in planes to the rear of the plane in which the diagram is taken. Of course it will be understood that the skim-milk is descending upon such inside surface of the disks also in planes in front of the plane in which the diagram is taken—that is, the skim-milk is descending upon the whole inside surface of the disks except those portions of such surface as are immediately contiguous to the perforations d^4. The flow of the full-milk from the space between two adjacent disks to the next space is denoted by the transverse arrows, and it will be noted that the full-milk is tapped by the perforations d^4, Fig. 2, of the convolutions at the lower part of the skim-milk layer or at the top of the neutral layer and that when the full-milk has passed through said perforations d^4 it encounters the inner surface of the next disk, and consequently turns and escapes into the next space, where it is spread out in a thin stratum through the side outlets d^5, as denoted by the dots or plan view of the transverse arrows in the diagram.

The improved separator, which has been hereinbefore described and which effects the separation of the cream and skim-milk in the manner noted, presents very material advantages in the art of centrifugal separation which will now be pointed out in detail. First, the full-milk never leaves the neutral zone from the time it enters the disk c^2 until it is separated into cream and skim-milk, which latter are immediately conducted to their respective zones and not again commingled with any liquid of a different density. By thus retaining the full-milk in the neutral zone it is always introduced into a liquid of the same specific gravity, whereby its relative location cannot be disarranged, as it would be if it were introduced into the cream, in which case it would sink down through the lighter liquid until it found its level, or if it were introduced into the skim-milk it would rise through the heavier liquid. Secondly, in this construction of apparatus the effect of the centrifugal force upon the neutral layer is always allowed for by retaining the full-milk in the neutral zone, and it is not necessary to make a correction for the effect of this force, as it would be if the full-milk were introduced into the neutral zone at different points in the division member instead of being retained in such neutral layer during the whole process of separation; also, although the construction shown provides means for retaining the full-milk continuously in the neutral layer, still it is not given a straight upward flow through the division member, but is caused to traverse a tortuous path due to the relative arrangement of the disks d. The full-milk is not crowded in the lower spaces between the disks d, leaving the upper spaces comparatively free and thus delaying the separating operation; but it is free to pass through the side outlets d^5 up into the higher spaces, thus dividing the milk up into thin uniform strata, whereby the efficiency and capacity of the machine is increased. In fact, the full-milk as yet unseparated is not only free to pass up into the spaces between the higher disks, but it is forced to by said construction of disks, so that there is no possibility of a crowding of the full-milk into the lower spaces, and the full-milk thus crowded up into the higher spaces meets no opposition from cream or skim-milk in passing upwardly, for it is constantly retained in the neutral layer, to which layer neither cream nor skim-milk have access after they have been separated. It will be noted that the practical effect of this construction of the division member is to provide what is substantially but one compartment for the full-milk, but which compartment is so subdivided and the parts so connected that the milk is divided therein into thin strata, and thus easily acted upon, the amount of milk in each stratum being automatically adjusted by the amount of milk which is being treated and there being an easy and natural passage for the milk from one stratum to the next, but on account of the alternate arrangement of the convolutions not a direct passage, which would carry the milk too fast through the division member. As fast as the cream and skim-milk are separated out from the full-milk they are conducted directly to their respective layers, and there is then delivered into each successive space only that part of the full-milk which is as yet unseparated. Special care has been taken in this construction of division member to protect the cream from any commingling with full-milk, and it will be noted from Fig. 7 that the side outlets d^5 tap the full-milk at about

the top of the neutral layer or at the bottom of the skim-milk layer, by which construction there may be a commingling of a very little of the skim-milk with the full-milk, but absolutely no commingling of the cream and full-milk, for the whole neutral layer is interposed between the cream and the side outlets d^5. The construction shown is also composed of few parts, and these are provided with plain surfaces which may be readily and easily cleaned.

Other modes of applying the principle of my invention may be employed instead of the one explained, change being made as regards the mechanism herein disclosed, provided the means stated by any one of the following claims or the equivalent of such stated means be employed.

I therefore particularly point out and distinctly claim as my invention—

1. In a centrifugal separator, a disk provided with convolutions, each convolution having a perforation in its top portion located in the neutral zone of the separator.

2. In a centrifugal separator, a disk comprising a conical part and a second part positioned at an angle to said conical part, and the latter being provided with convolutions, each convolution having a perforation in its top portion located in the neutral zone of the separator.

3. In a centrifugal separator, a disk comprising a conical part adapted to separate the liquid under treatment into its constituents, and a substantially vertical part adapted to baffle said liquid, one of said parts being provided with convolutions, each convolution having a perforation in its top portion located in the neutral zone of the separator.

4. In a centrifugal separator, a disk comprising a conical part adapted to separate the liquid under treatment into its constituents, and a substantially vertical part adapted to baffle said liquid, said conical part being provided with convolutions, each convolution having a perforation in its top portion located in the neutral zone of the separator.

5. In a centrifugal separator, a division member formed of a plurality of superimposed disks each provided with outlets located in the neutral zone of the separator and lying in substantially the peripheral plane of an adjacent disk.

6. In a centrifugal separator, a division member formed of a plurality of superimposed disks each provided with convolutions and with outlets in said convolutions located in the neutral zone of the separator, the outlets of each disk lying in substantially the peripheral plane of an adjacent disk.

7. In a centrifugal separator, a division member formed of a plurality of superimposed disks each provided with convolutions and with outlets in said convolutions located in the neutral zone of the separator, the outlets of each disk lying in substantially the peripheral plane of the upper adjacent disk.

8. In a centrifugal separator, a division member formed of a plurality of superimposed disks each provided with convolutions forming spacing members between adjacent disks and with outlets in said convolutions located in the neutral zone of the separator, the outlets of each disk lying in substantially the peripheral plane of the upper adjacent disk.

9. In a centrifugal separator, a division member formed of a plurality of superimposed disks each comprising a conical portion adapted to separate the liquid under treatment into its constituents, and a second portion positioned at an angle to said conical portion and adapted to baffle said liquid, the conical portion being provided with outlets located in the neutral zone of the separator and lying in substantially the peripheral plane of the conical portion of the upper adjacent disk.

10. In a centrifugal separator, a division member formed of a plurality of disks spaced apart and each comprising a conical portion and a second portion substantially vertical, adjacent disks being adapted to overlap along their vertical portions, whereby separating-spaces are formed between the conical portions of adjacent disks and contracted liquid-passages between the vertical portions thereof.

11. In a centrifugal separator, a division member formed of a plurality of overlapping disks each comprising a conical portion and a second portion positioned at an angle to said conical portion and constructed to baffle one of the separated liquids, the conical portion of each disk being provided with a plurality of convolutions and with perforations in said convolutions located in the neutral zone of the separator.

12. In a centrifugal separator, a division member formed of a plurality of overlapping disks each provided with convolutions and with perforations in said convolutions, the convolutions of adjacent disks being arranged in a staggered relation to each other.

13. In a centrifugal separator, a division member formed of a plurality of overlapping disks each provided with convolutions and with perforations in said convolutions located in the neutral zone of the separator, the convolutions of adjacent disks being arranged in a staggered relation to each other.

14. In a centrifugal separator, a division member formed of a plurality of overlapping disks each provided with convolutions forming spacing members between adjacent disks and with perforations in said convolutions, the convolutions of adjacent disks being arranged in a staggered relation to each other.

15. In a centrifugal separator, a plurality of overlapping disks arranged in different

planes transverse to the axis of the separator and hinged together to form a division member.

16. In a centrifugal separator, a plurality of overlapping disks arranged in different planes transverse to the axis of the separator, hinged together to form a division member, and provided with convolutions and with perforations in said convolutions located in the neutral zone of the separator.

17. In a centrifugal separator, a division member formed of a plurality of disks each provided with convolutions and with perforations in said convolutions, the metal of said convolutions laterally of said perforations being cut away to form side outlets through said convolutions from a space between two contiguous disks to the next adjacent space.

18. In a centrifugal separator, a division member formed of a plurality of disks each comprising a conical portion and a second portion positioned at an angle to said conical portion, said disks adapted to overlap at a point upon said angular portion, each disk provided with convolutions and with perforations in said convolutions located in the neutral zone of the separator, the metal of said convolutions laterally of said perforations being cut away to form side outlets through said convolutions from a space between two contiguous disks to the next adjacent space.

19. In a centrifugal separator, a division member formed of a plurality of disks each comprising a conical portion and a lower lip positioned at any angle to said conical portion and adapted to baffle the separated skim-milk, said disks adapted to overlap at a point upon said angular portion, the conical portion of each disk being provided with a plurality of convolutions forming spacing members between adjacent disks, perforations in said convolutions, the metal of said convolutions laterally of said perforations being cut away to form side outlets through said convolutions from a space between two contiguous disks to the next adjacent space.

20. In a centrifugal separator, a division member formed of a plurality of overlapping disks arranged in different planes transverse to the axis of the separator, each disk being hinged at opposite points to the next adjacent disks, respectively, upon both sides.

21. In a centrifugal separator, a division member formed of a plurality of overlapping disks each provided with convolutions and with perforations in said convolutions located in the neutral zone of the separator, each disk being hinged at opposite points to the next adjacent disks, respectively, upon both sides.

22. In a centrifugal separator, a division member formed of a plurality of disks each comprising a conical portion and a lower lip positioned at an angle to said conical portion and adapted to baffle the separated skim-milk, each disk provided with convolutions and with perforations in said convolutions, and being hinged at diametrically opposite points to the next adjacent disks, respectively, upon both sides.

23. In a centrifugal separator, a division member formed of a plurality of disks each comprising a conical portion and a second portion positioned at an angle to said conical portion, said disks adapted to overlap at a point on said angular portion, the conical portion of each disk being provided with a plurality of convolutions forming spacing members between adjacent disks, perforations in said convolutions, the metal of said convolutions laterally of said perforations being cut away to form side outlets through said convolutions from a space between two contiguous disks to the next adjacent space, each disk being hinged at diametrically opposite points to the next adjacent disks, respectively, upon both sides.

24. In a centrifugal separator, the combination with a supply-tube provided with suitable openings for the escape of the full-milk and with a conical disk upon its lower portion, of a plurality of overlapping disks adapted to fit over such conical disk, each provided with convolutions and with perforations in such convolutions in the neutral zone of the separator, the convolutions of adjacent disks being staggered relatively to each other, said conical disk being provided with suitable discharge-openings for cream in the central zone, and with suitable discharge-openings for full-milk in the neutral zone.

25. In a centrifugal separator, the combination with a supply-tube provided with suitable openings for the escape of the full-milk and with a conical disk upon its lower portion having a substantially vertical lip, of a plurality of superimposed disks adapted to fit over such conical disk and each comprising a conical portion adapted to separate the liquid under treatment into its constituents, and a substantially vertical portion adapted to baffle said liquid, each of said superimposed disks provided with convolutions in its conical portion and with perforations in such convolutions in the neutral zone of the separator, said first-mentioned conical disk being provided with suitable discharge-openings for cream in the central zone, and with suitable discharge-openings for full-milk in the neutral zone.

26. In a centrifugal separator, the combination with a supply-tube provided with suitable openings for the escape of the full-milk and with a conical disk upon its lower portion adapted to seal off upon the bottom of the separator a compartment into which such full-milk escapes, said disk being provided with a horizontal lip having discharge-openings for

the cream into the central zone of the separator, and also provided with convolutions having perforations located in the neutral zone of the separator, of a plurality of overlapping disks adapted to fit over such conical disk, constructed to receive the full-milk from the latter, and each provided with convolutions and with perforations in said convolutions located in said neutral zone of the separator.

Signed by me this 30th day of August, 1904.

JOHN C. CROMWELL.

Attest:

D. T. DAVIES,

G. W. SAYWELL.