Feb. 29, 1944. H. G. SCHWARZ 2,342,973

CENTRIFUGAL EXTRACTOR

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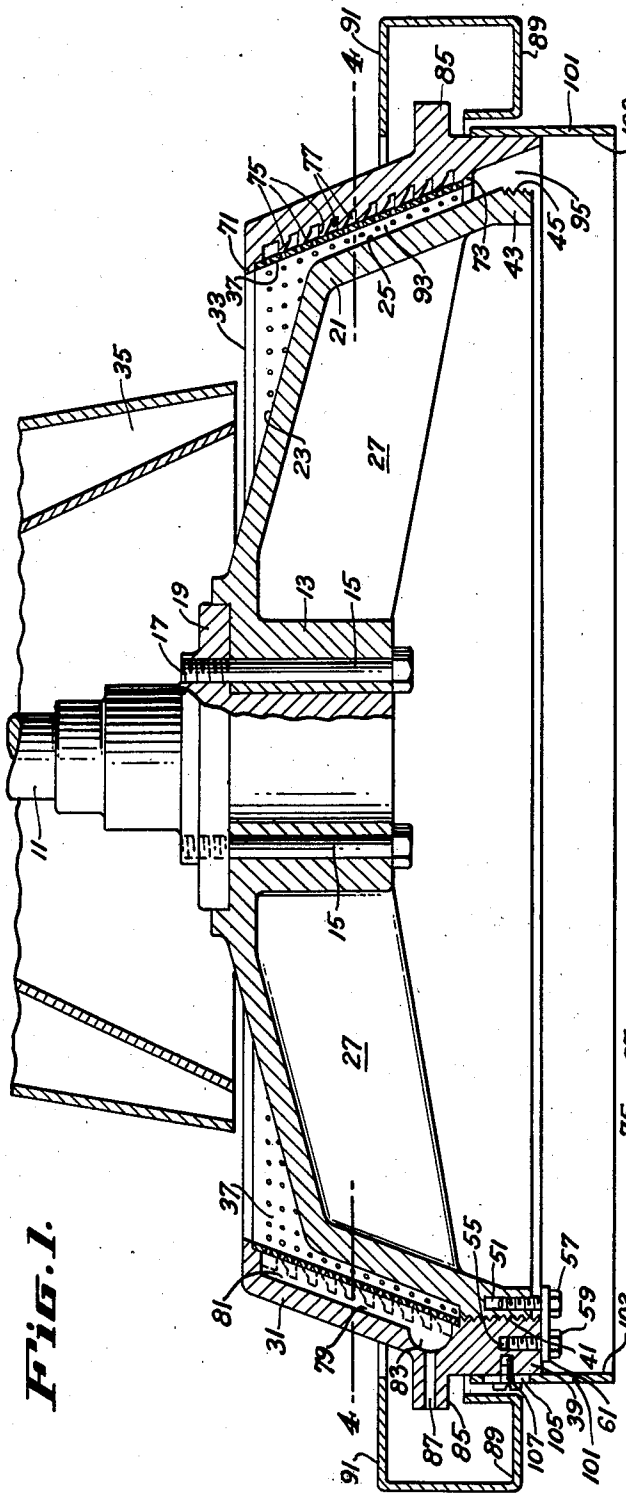


Fig. 1.

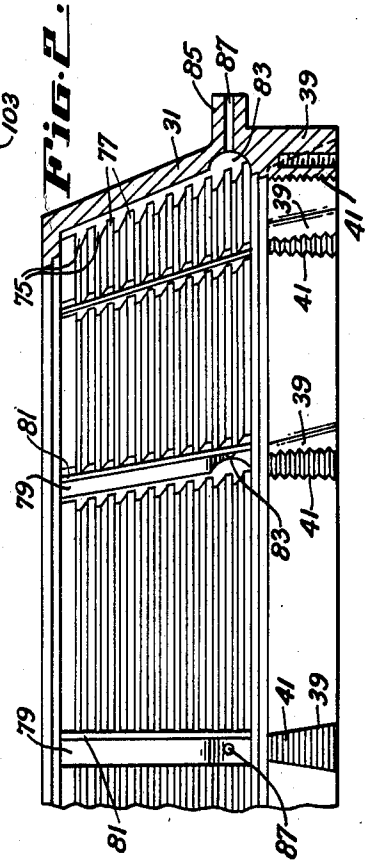


Fig. 2.

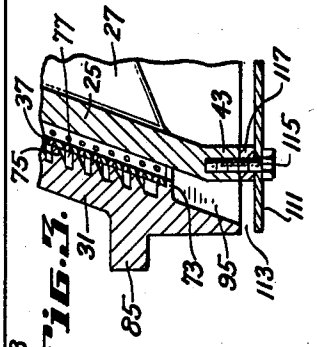


Fig. 3.

INVENTOR.
HENRY G. SCHWARZ
BY Charles M. Fryer
ATTORNEY

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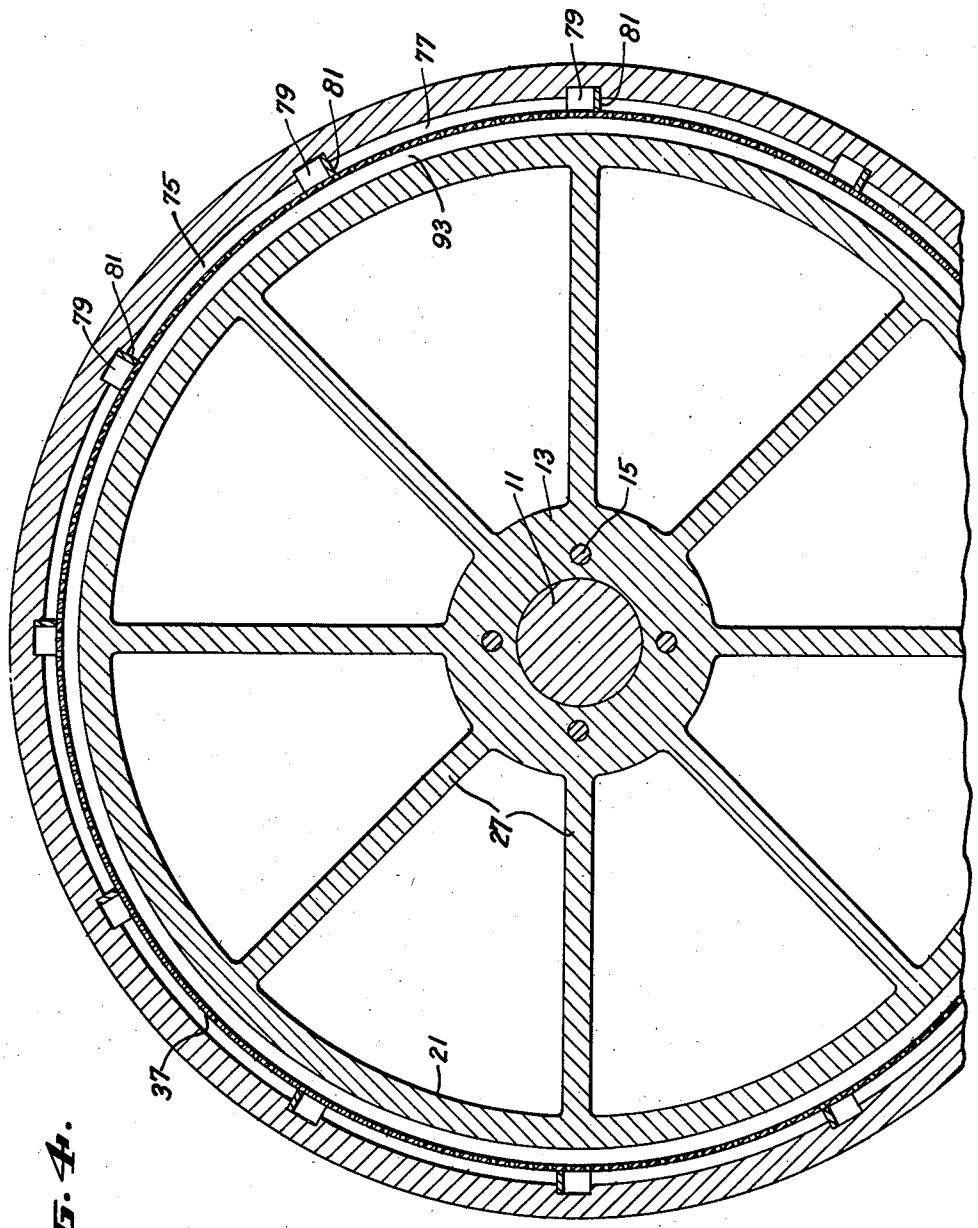


Fig. 4.

INVENTOR.
HENRY G. SCHWARZ
BY Charles M. Fryer
ATTORNEY

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Filed Feb. 28, 1941 3 Sheets-Sheet 3

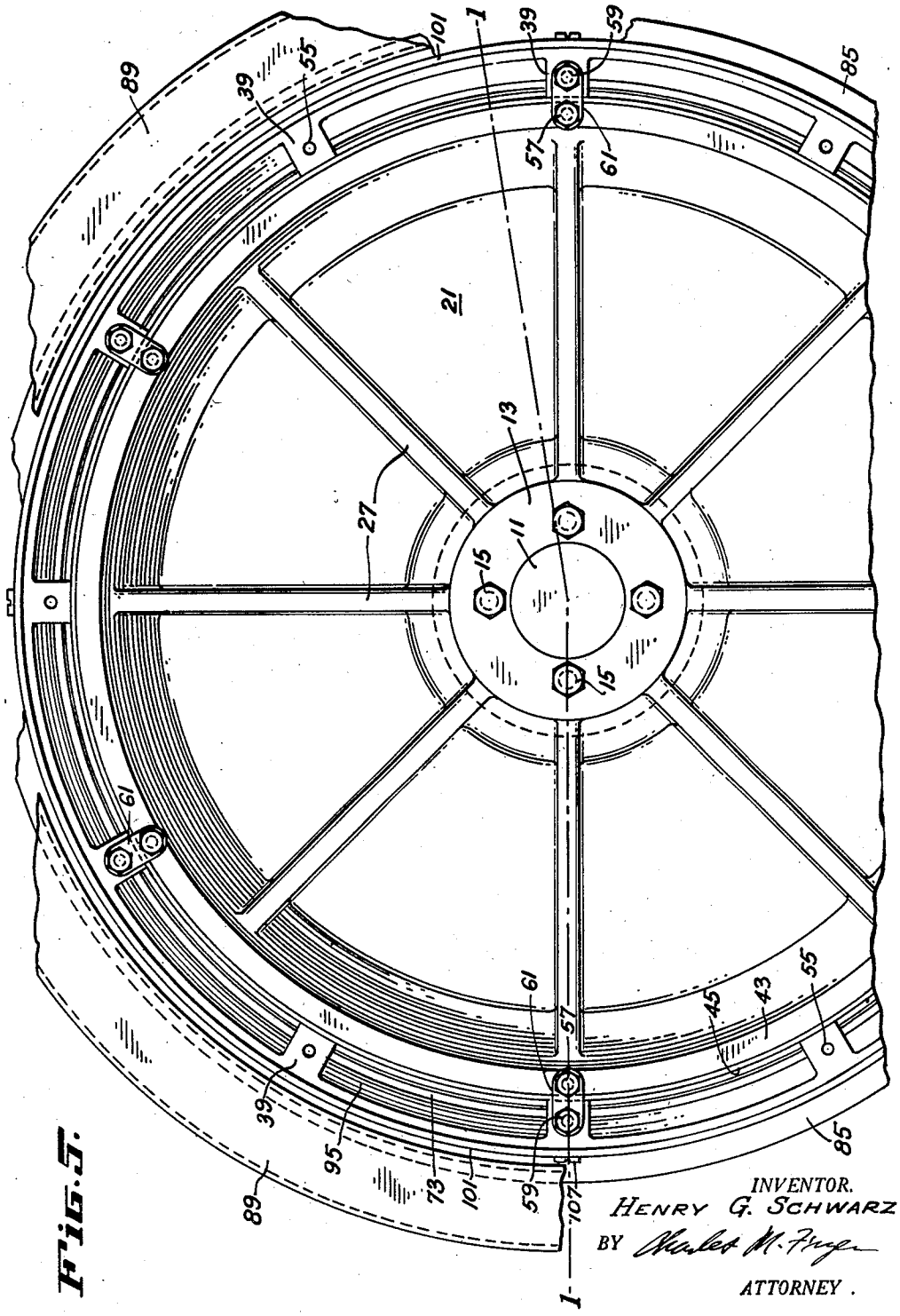


Fig. 5.

INVENTOR.
HENRY G. SCHWARZ
BY Charles M. Fryer
ATTORNEY.

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UNITED STATES PATENT OFFICE

2,342,973

CENTRIFUGAL EXTRACTOR

Henry G. Schwarz, San Carlos, Calif., assignor to The Schwarz Engineering Company, Inc., San Francisco, Calif., a corporation of Nevada

Application February 28, 1941, Serial No. 380,978

8 Claims. (Cl. 210—68)

This invention relates to centrifugal machines for separating liquids from solids in a mixture thereof.

Objects of this invention are to provide centrifugal separators which can operate on the continuous principle according to which the mixture of liquids and solids can be fed continuously to the separator and from which the separated liquids and solids will be discharged separately and continuously as long as the separator contains material to be separated by it, without any necessity for stopping the operation to remove residual solids; and which have high operating efficiency both as to the degree and speed of separation; to provide means to cause the material being treated to move continuously as a sheet past a separating screen; to provide means to adjust and control the thickness of such moving sheet; to provide means to adjust the speed with which such sheet moves past such screen; to provide means to vary and control the period of time that the machine acts on any and all portions of the material; and other objects will be apparent after reading this specification in connection with the accompanying drawings which form a part hereof.

The preferred exemplification of the invention is illustrated on the drawings, on which

Fig. 1 is a vertical section of the machine along the line 1—1 on Fig. 5;

Fig. 2 is a vertical section of the casing;

Fig. 3 is a vertical section of of part of the machine showing a modification;

Fig. 4 is a cross section on the line 4—4 on Fig. 1; and

Fig. 5 is a bottom plan view of the machine.

A vertical shaft 11 having a suitable support and bearings (not shown) to permit of rotation, supports a collar 13 made fast to the shaft in any suitable manner, preferably by means of bolts 15 extending through the collar with the threaded ends 17 thereof in correspondingly threaded openings in a flange 19 which is fixed to or a part of the shaft 11.

A bell-like or umbrella-like and preferably imperforate guide member 21 is carried by the collar 13, being preferably cast integral therewith. It comprises upright truncated-cone-like parts 23, 25, the upper and outer surfaces of which are oblique and at different angles, sloping downwardly and outwardly, that of the part 25 having a greater slope and being nearer the vertical than that of the part 23, as shown on Fig. 1. Reinforcements are provided to maintain the guide member rigid, preferably radiating arms or webs 27 preferably cast integral with the collar 13 and the parts 23, 25 of the guide member 21.

A casing 31 surrounds the guide member 21. It has a feed opening 33 in the top thereof, and over such opening is a feed hopper 35 which is preferably but not necessarily annular and which supplies the machine with the material which is to be separated into its component liquid and solid parts. The casing 31 carries an upright conical screen 37 in fixed relation thereto which is preferably parallel or substantially parallel to the guide member part 25. The casing and screen extend upwardly beyond the guide member part 25 to a level high enough to prevent material from being thrown or spilled out of the machine. The level of the highest part of the guide member part 23 is often sufficient, but due to the rate at which material is fed into the machine and to other operating conditions, it may become desired to increase this height or less than the indicated height may suffice.

The various parts so far referred to, except the feed hopper 35, all rotate together with the guide member in fixed but adjustable relationship to the screen. A means is provided to adjust and to control the width of the passage between the guide part 25 and the screen, this preferably being means to adjust the casing and screen higher or lower with respect to the guide part 25. With this in view, the lower part of the casing is provided at intervals with enlargements or lugs 39 spaced peripherally or angularly about the axis thereof, the inner faces of which are vertical and provided with screw threads 41 (Fig. 2). Depending from the lower end of the guide member 25 is an annular skirt 43 (Fig. 1), the outer face of which is vertical and is provided with screw threads 45. With the screw threads 45 and 41 in register with each other, the casing 31 and the screen 37 may be adjusted by rotation thereof to be closer to or further away from the guide member 25, to make the space between them smaller or larger as may be desired.

A means is provided to prevent relative rotation of these parts once this spacing has been adjusted to the desired size. Screw threaded holes 51 are provided at spaced intervals in the lower face of the annular skirt 43, the enlargements or lugs 39 being similarly provided with screw threaded holes 55. Bolts 57, 59 pass through perforations in strips 61 which are preferably but not necessarily rigid, the threads on the bolts registering with the threads in the

holes 51 and 55 respectively. This prevents relative rotation of the parts. By proper spacing of the screw-threaded holes 51 and 55, and by providing enough thereof, very fine adjustment of the space between the guide member 25 and the screen 37 is easily possible.

The screen 37 is truncated-cone-shaped similarly to the outer face of the guide member 25, and is held in place on the casing member in any suitable manner, preferably by projections or flanges 71, 73 against which the upper and lower ends of the screen abut. Its outer side rests against a series of projections which hold it away from the inner face of the casing member to make room for the juice after it has passed through the screen to the outer side thereof. Any suitable type of projections may be used and they should be of such a kind, in such number, and so spaced that they will suitbly support the screen while permitting flow of juice after it reaches the outer side of the screen. An embodiment of the projections which is preferred because they are easily machined comprises a series of annular inwardly projecting horizontal ribs 75 extending around the inner face of the casing member. These ribs form spaces 77 between them to receive the liquid which passes through the screen. The ribs are preferably tapered so as to widen the spaces adjacent the screen to facilitate the collection of the liquid in the spaces. The continuity of the ribs is interrupted at intervals to form passages 79 in the casing member extending substantially from adjacent the top to adjacent the bottom of the screen to collect together the liquid in the spaces 77. To prevent the liquid from being whirled out of the passages 79 by the rotation of the machine, deflecting obstructions are placed therein at one side thereof, these being preferably radially extending plates 81 at that side of the passages 79 at which they prevent the liquid from flowing laterally out of the passages and permit the liquid to flow laterally into such passages, depending on the direction of rotation. These passages are enlarged at the lower ends thereof to form spaces 83. An annular flange 85 surrounds and is preferably cast integral with the casing 31 at the level of the enlarged spaces 83, and there are perforations 87 forming outlets connected with such enlarged spaces. Surrounding these outlets is an annular trough 89 open at the side toward the casing, the flange 85 projecting through this open side far enough so that any liquid running or dripping from the outlets will be collected in the trough. A top portion 91 prevents liquid from being splashed out of the trough which preferably does not rotate with the machine and is stationary in order that suitable outlets therefrom (not shown) may be provided as desired.

In the operation of the machine, the guide 21 comprising the parts 23 and 25, the casing 31, and the screen 37 rotate as a unit. Material to be separated into its solid and liquid components is fed from the hopper 35 onto the upper face of the guide part 23 which urges such material outwardly due both to the slope thereof and to centrifugal action. As the material to be separated reaches the outer end of the guide part 23, it enters the truncated-cone-shaped treatment space 93 between the guide part 25 and the screen where the liquid is urged through the screen, the residual solids then passing into the annular space 95. The screen 37 increases in diameter downwardly, and the treatment space 93 preferably does likewise.

I provide means to vary and control the length of time that the material being treated remains in the treatment space 93 and undergoes treatment therein, this preferably being adjustable means to impede the flow of the solids or to permit them to flow faster. This may comprise a depending skirt 101 which rotates with the other rotating parts. Material from which liquid has been removed and leaving the annular space 95, moves onto the inner face 103 of the skirt. The tendency for the material to travel along this face against which it is urged by centrifugal action will be lessened by making the wall less oblique and nearer the vertical, or even beyond the vertical so that the diameter below is less than that above. The simplest way to accomplish this effect is to make the skirt 101 vertical with the inner face 103 vertical. Centrifugal force urges the material in the direction of increasing diameter, and lessening the increase of diameter decreases the speed of movement of the material. With this increase equal to zero, that is, with the face 103 vertical, the material thereon is not urged downwardly by centrifugal force, its rate of movement is retarded, and it in turn retards the movement of material through the treatment space 93. With the face 103 in the shape of an inverted truncated cone, the centrifugal force would even urge the material upwardly and thus retard even more the progress of the material through the treatment space. Such retardation or upward urging of the material being treated may at times be useful to build up on the screen a filter bed of adjustable thickness of the solids of the material being treated. Such filter bed will extend upwardly along the screen for a distance which depends on the design and adjustment of the various parts and conditions of operation, and the thickness of the filter bed will depend on similar factors. Not only the position or slope of the wall, but the length thereof also has its effect on the degree of retardation. A very easy control of the retardation effect is by means of the vertical skirt 101 and by mounting it so that its length can be quickly and easily adjusted.

The skirt 101 surrounds the lower part of the casing 31 and preferably has a slot 105 therein through which the shank of a screw 107 passes with the head thereof resting on the material of the skirt, the shank fitting into a screw-threaded hole in the casing. As many slots and screws may be used as are found desirable. With the skirt adjustable as to its length below the casing and below the conical surface formed by extending the screen downwardly, the retarded material at the skirt will hold back and retard the material following it along the screen thus making the period of time it is being treated by the machine variable at will by a mere adjustment of the length of the skirt.

Other means for retarding the flow of material along the screen may be provided. For example, as shown on Fig. 3, means to form and to vary and control the size of an outlet from the machine for the residual solids may be provided. This may comprise a suitable member, for example a plate 111 adjustably mounted at the outlet space 95 to form an outlet mouth 113. This plate is fixed in position preferably by bolts 115, the threaded shanks of which pass through openings in the plate and in washers or spacer mem-

bers 117, and into threaded openings in the skirt 43, the plate being held between these spacer members and the heads of the bolts. This construction forms the outlet mouth 113, the size of which may be adjusted by using more or less or thicker or thinner spacer members or in any other suitable way.

In operation, material to be treated is continuously fed from the hopper 35 to the continuously rotating machine. While the feed hopper is preferably annular in order to feed material to be treated evenly to the machine while it is in operation, it need not be annular but the feed can be at one or more points if an even feed is not desired. The feed hopper is preferably stationary while the machine rotates in operation, but it may, if desired, rotate at the same or a different speed. The material to be treated falls onto the guide member 23 where it is moved by the slope thereof and by centrifugal action outwardly and into the truncated-cone-shaped treatment space 93. By reason of the centrifugal action due to the rotation, the liquid is forced through the screen, while the solids, or at least that part of the solids which cannot go through the screen, remain behind and pass downwardly toward the lower end of the treatment space. The centrifugal effect actually aids in this downward movement because the treatment space has a greater diameter below than above. The residual solid material then passes into the outlet space 95, and in its further downward movement centrifugal force urges it against the inner face 103 of the skirt 101 in the modification illustrated on Fig. 1. Some of the liquid may pass through the screen before entering the space 93, but regardless of this it is generally preferable that the material be denuded of liquid to the greatest possible extent before it enters the space 95. By having less of a slope than the outer face of the guide member 25, this face retards the downward movement of the residual material, this retardation being reflected back into the treatment space 93. The degree of retardation is controlled by the length of the skirt and may be varied by the easy and quick adjustment of the skirt up or down as the case may be. The easily and quickly adjustable outlet mouth 113 of the modification illustrated on Fig. 3 likewise causes controlled retardation of the movement of the material through the treatment space 93. The solid residue may drop into or onto any suitable means (not shown) to collect or convey it, from the lower end of the skirt 101 (Fig. 1) or from the outlet 113 (Fig. 3).

The thoroughness of removal or separation within the treatment space 93 of liquid present depends on the speed of rotation, the thickness, length and diameter of the moving layer of material being treated, the period of time that the material remains in and undergoes treatment in the space 93, and possibly on other factors. The speed of rotation may be varied and controlled by known means; but it has generally been desired to rotate any centrifugal machine at the highest possible speed consistent with the strength of the machine, and speed increases have not been practicable under such conditions without substituting a new machine or major machine parts, although separation into fluid and solid components of some substances comprising free liquids and solids may be best effected at speeds of rotation below the maximum possible. Variation of the length and of the diameter of the layer of material being treated have likewise not been practicable without substituting a new machine or major machine parts. My above-mentioned control of the thickness of the layer of material being treated affects and controls the rate of flow of the material through the treatment space 93 measured in amount of material per unit of time, but it has very little, if any, effect on the rate of flow measured in distance traversed in the treatment space per unit of time. For a fixed length of treatment space 93, and with a constant speed of rotation, the rate of travel of the material measured in distance per unit of time has heretofore determined the period of time that the material underwent treatment in a continuously operating machine. Variation of this period of treatment has been a simple matter with centrifugal machines operating on the batch principle, because a batch of material can be placed within the machine, the machine can then be run for any desired or required length of time, and then stopped, whereupon the remaining material may be removed and a new batch placed within the machine for the same treatment.

This invention thus provides, without substitution of major parts of the machine, for varying and controlling the period of time that the material is being treated and the amount of material treated within such period, within a machine operating on the continuous principle wherein material may be continuously fed to the machine which treats and expels it continuously, and thus for easily and quickly controlling the completeness of separation. The invention is generally useful for obtaining complete separation, or as complete a separation as may be desired, of liquids from solids, especially where the solids are in the form of an aggregate mass of many pieces or particles. It is also particularly adapted for the separation of juices of various mashed or comminuted vegetables and fruits of many different types, such for example, as apples, pears, peaches, apricots, tomatoes, carrots, beets, celery, and the like. It is also useful for the final and more complete separation of the liquids from the solids which have been denuded of liquid as far as possible in other machines to which the machine of this invention may be directly or indirectly connected and from which it may be fed either with or without the elimination of the feed hopper 35. It may be used, for example, as an additional separation stage in connection with the machine of my application Serial No. 54,795, filed December 17, 1935, for "Centrifugal extractors," now Patent No. 2,267,048, dated December 23, 1941, should a more complete separation be found desirable because so much frictional heat can be developed in the material being treated by the comminution means of the machine of that application that it is often desirable in using it to leave more of the liquid with the solids as a lubricant at least until the material has passed the last comminution stage thereof than would easily be separated in a short stationary screen. This invention is also useful in connection with any machine or method when, due to operating conditions or for any reason, the separation has not been complete.

While the present invention is particularly well adapted for continuous principle operation, yet it may be used for batch operation if desired. Should it be found desirable to do so, the retarding effect of the retarding elements on the travel of material through the machine may be made equal to the effect of the forwarding factors. The same

machine can thus be made to operate on either the continuous or the batch principle and also on a combination thereof.

Even removal of denuded solids from the machine is provided by making the outlet space 95 substantially annular as shown on Fig. 5. In the modification shown on Figs. 1 and 5 this outlet space is interrupted at intervals by the lugs 39 only to a small degree which may be increased as desired for greater retarding effect on the flow of solids. The outlet space is not interrupted at all in the modification shown on Fig. 3.

The present invention has many advantages. The centrifugal effect increases as the material becomes denuded of liquid. The material may be treated as a thin sheet whereby it is more thoroughly denuded. Different kinds of materials may require different thicknesses of the material being treated, and adjustments with this in view are easily made. Different kinds of materials may be best denuded with different applied back pressures, and adjustments for this are easily made. The machine is simple in operation and material is easily fed into the machine, passes easily therethrough, and out of the machine without stopping it to remove residual solids. No part of the machine need be below the residual solids as they leave the machine so that means to receive such solids are easily accommodated and soiling of the shaft or other machine parts is avoided as is soiling of a workman making the above-mentioned adjustments. Practically all of the removed fluid is collected in the annular trough and without waste or soilage by splashing or dripping. There are other advantages as well.

While I have referred to various details of construction for the purpose of explaining the invention, yet many of them may be varied without departing from the spirit thereof.

I claim:

1. A centrifugal extractor comprising a rotatable member having a conical surface, a conical screen about and spaced from such surface to provide an annular conical-like treatment space having an annular discharge opening, means mounting the screen for rotation with the member including parts which are relatively adjustable to vary the spacing between the surface and the screen, and additional adjustable means adjacent the discharge opening for controlling back pressure on material passing therethrough.

2. A centrifugal extractor comprising a rotatable member having a conical surface; a conical screen about and spaced from such surface to provide an annular conical-like treatment space; and supporting means for the screen; the member and the screen supporting means being connected by a circumferentially extending screw threaded connection therebetween which is adjustable in an axial direction with reference to the axis of the member to support the screen for rotation with the member, and to provide for varying of the space between the surface and the screen.

3. A centrifugal extractor comprising a rotatable member having an upright conical surface; an upright conical screen about and spaced from such surface to provide an annular upright conical-like treatment space having a lower annular discharge opening; and a casing about and supporting the screen; the member and the lower part of the casing being connected by a circumferentially extending screw threaded connection therebetween which is adjustable in an axial direction with reference to the axis of the member to support the casing and the screen for rotation with the member, and to provide for varying of the space between the surface and the screen; the casing having means for receiving and discharging fluid which flows through the screen.

4. A centrifugal extractor comprising a plurality of parts rotatable about the same axis; an inner one of such parts having a conical surface; a conical screen supported by an outer one of such parts; the screen being about and spaced from the surface to provide an annular conical-like treatment space having an annular discharge opening; and an adjustable screw threaded connection between such parts adjacent the discharge opening for supporting such parts and the screen for rotation together as a unit, and to provide for varying of the space between the surface and the screen, said connection including lugs on one of the parts having circumferentially extending screw threads engaging similarly extending screw threads on the other of said parts and being peripherally spaced to allow passage of material through the spaces therebetween.

5. A centrifugal extractor comprising an inner member having an upright-cone-like outer surface, an upright-cone-like screen spaced from and surrounding said member, said screen and inner member forming an annular upright-cone-like treatment path for material to be denuded of liquid whereby the centrifugal effect on said material increases as said material passes through said path from above to below, a casing member about said screen, closely adjacent horizontal ribs on the inner face of said casing member forming grooves therebetween to receive liquid passing through said screen, said ribs being interrupted to form a passage connecting said grooves, an obstruction at said passage to cause collection of liquid passing through said screen, and means for receiving the collected liquid, said screen contacting said ribs which afford a sufficiently firm support to prevent damage to said screen at a higher speed of rotation than would be possible without said firm support, whereby the increasing centrifugal effect due to the upright-cone-like treatment passage may be further increased by rotation at a speed higher than would otherwise cause damage to said screen, and means to rotate said inner member, said screen and said backing in unison at said higher speed.

6. A centrifugal extractor comprising a rotatable member having an upright-cone-like outer surface, an upright-cone-like screen about and spaced from such surface to provide an annular upright-cone-like treatment path having a lower annular discharge opening, a casing fixedly supporting said screen and having means for receiving fluid which passes through said screen, means mounting said casing for rotation with said member, means for varying the thickness of said treatment path, and additional means for creating and controlling back pressure on material passing through said path.

7. A centrifugal extractor comprising a rotatable member having an upright-cone-like outer surface, an upright-cone-like screen about and spaced from such surface to provide an annular upright-cone-like treatment path having a lower annular discharge opening, a casing fixedly supporting said screen and having means for re-

ceiving fluid which passes through said screen, means mounting the casing for rotation with said member, means for varying the thickness of said treatment path, and additional means to vary the size of said discharge opening.

8. A centrifugal extractor comprising a rotatable member having an upright-cone-like outer surface, an upright-cone-like screen about and spaced from such surface to provide an annular upright-cone-like treatment path having a lower annular discharge opening, a casing fixedly supporting said screen and having means for receiving fluid which passes through said screen, means mounting said casing for rotation with said member, means for varying the thickness of said treatment path, a skirt in the path of said material and beyond said treatment space attached to said casing and rotatable therewith to create back pressure on material passing through said path, and means to vary the effective length of said skirt.

HENRY G. SCHWARZ.