

June 28, 1927.

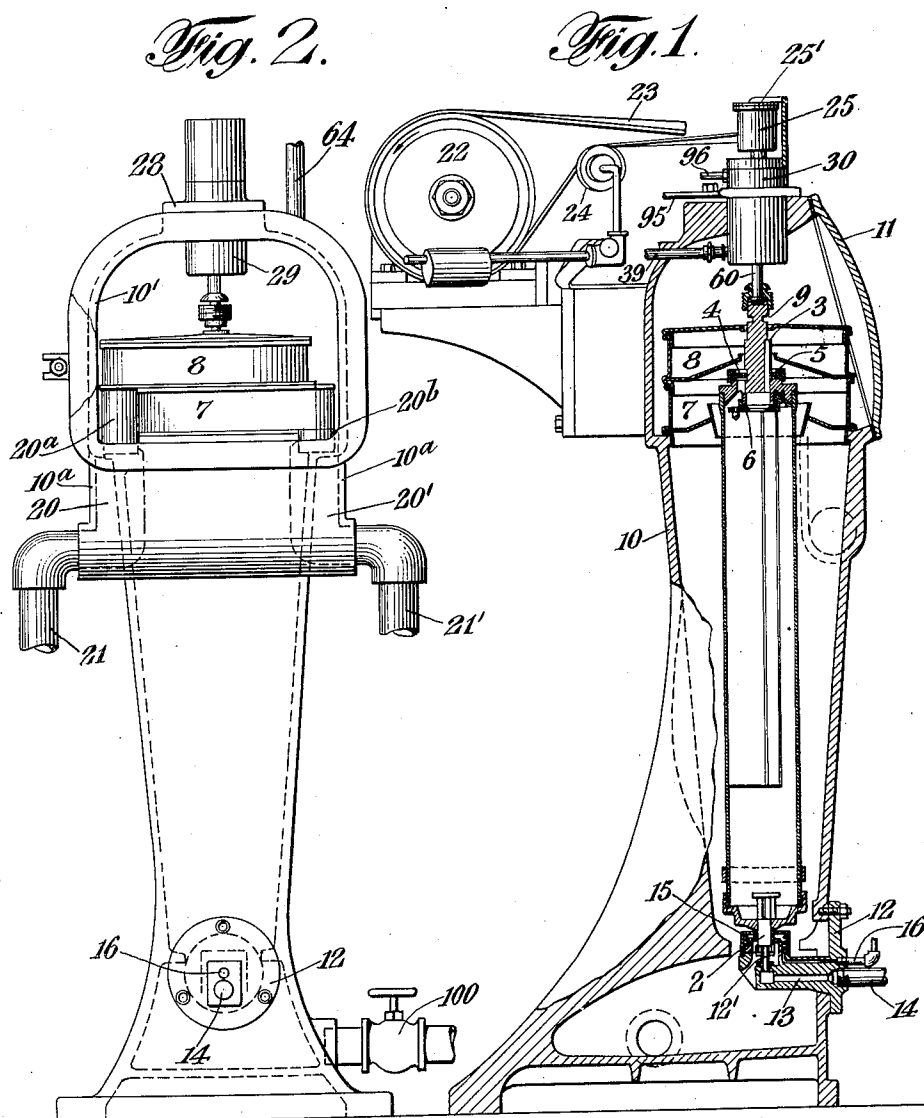
L. D. JONES ET AL

1,634,245

CENTRIFUGAL MACHINE AND PROCESS INVOLVING THE USE OF THE SAME

Original Filed May 1, 1924

4 Sheets-Sheet 1



Inventors
Leo D. Jones
Arthur H. Ayres
By their Attorneys
Kempson & Kempson

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4 Sheets-Sheet 2

Fig. 3.

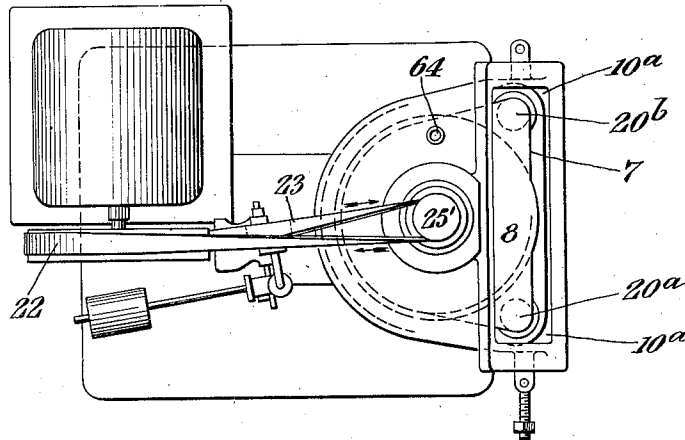
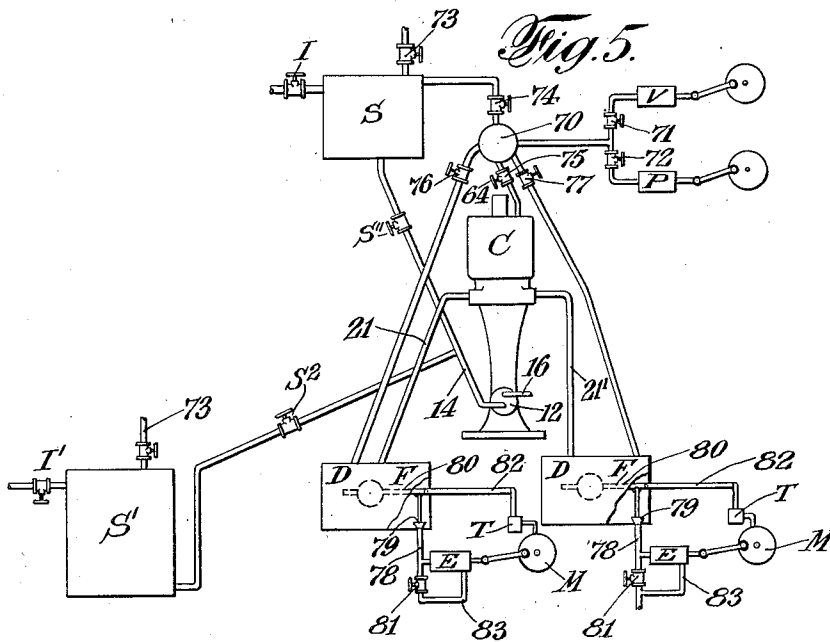


Fig. 5.



Inventore
Leo D. Jones
Arthur H. Ayres
By their Attorneys
Kuyon Kuyon

June 28, 1927.

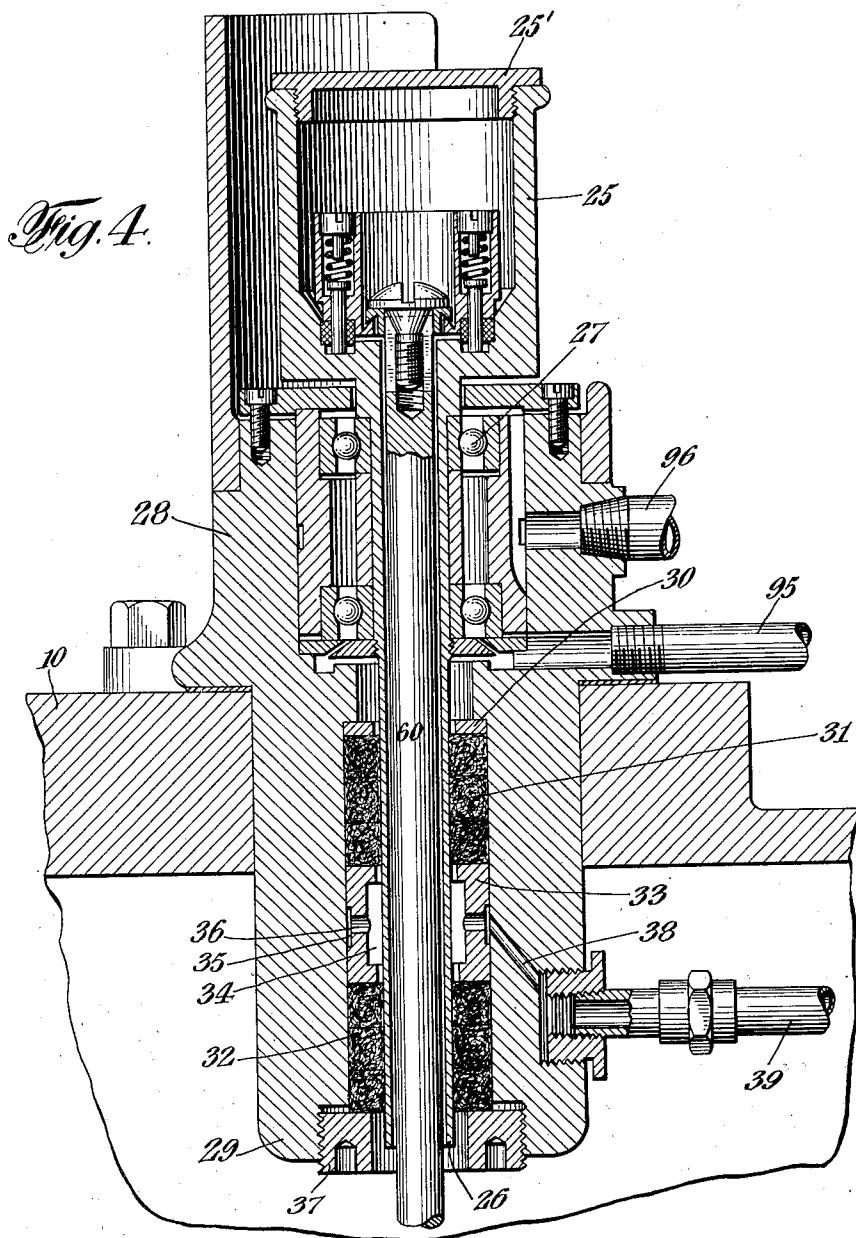
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Inventors
L. D. Jones
Arthur V. Ayres
By their Attorneys
Kearney & Kearney

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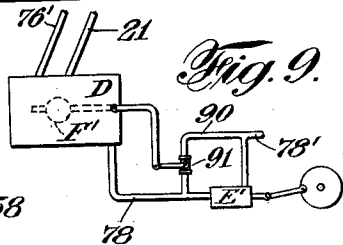
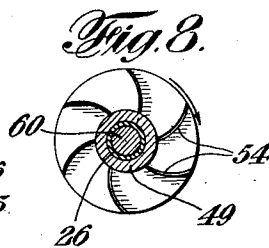
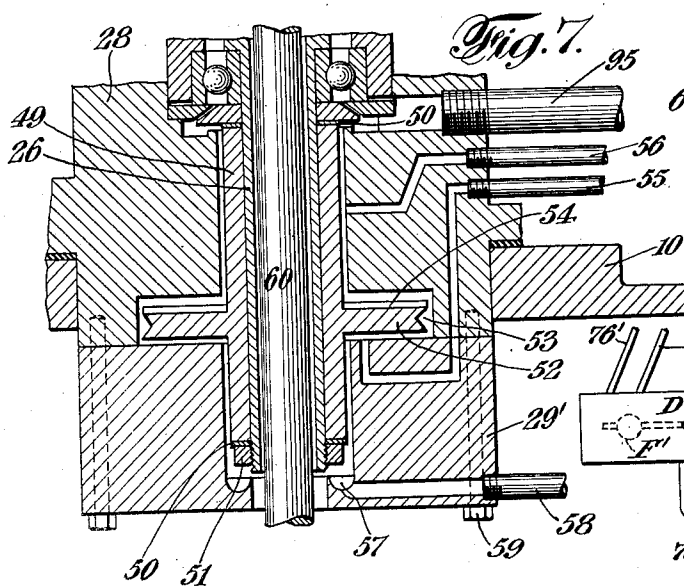
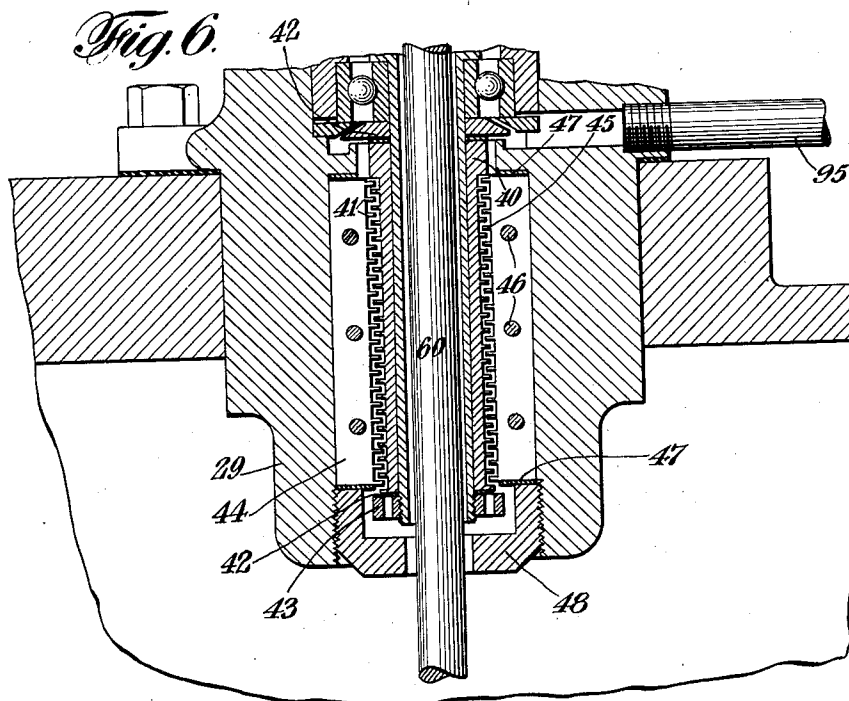
L. D. JONES ET AL

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4 Sheets-Sheet 4



Inventors
 Leo. D. Jones
 Arthur H. Ayres
 By their Attorneys
 Thompson & Thompson

UNITED STATES PATENT OFFICE.

LEO D. JONES AND ARTHUR U. AYRES, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO THE SHARPLES SPECIALTY COMPANY, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF DELAWARE.

CENTRIFUGAL MACHINE AND PROCESS INVOLVING THE USE OF THE SAME.

Original application filed May 1, 1924, Serial No. 710,388, and in Canada April 8, 1925. Divided and this application filed April 13, 1927. Serial No. 183,534.

Our invention relates to centrifugal machines and processes involving the use of the same and particularly to such machines and processes wherein certain conditions and effects resulting from the action of centrifugal force or other forces or conditions may be promoted or prevented or controlled as may be desired.

When a substance is treated in a centrifugal machine to effect certain desired results, such, for example, as the separation of constituents of the substance from one another, or the alteration of the substance or one of its constituents by the action of the centrifugal force itself or by the effect of some reagent acting simultaneously with the centrifugal force, it is desirable or necessary to prevent the occurrence of undesired changes or conditions of the substance or its constituents or to promote desired changes or conditions thereof. Thus when liquid soap is being clarified by the action of centrifugal force or when such substances as water solutions of licorice are being treated in a centrifugal machine the treatment should be carried out in such a manner as to prevent foaming of the substance. This can be accomplished by maintaining vacuum upon the substance being treated. And in the clarification of drying or oxidizable oil, e. g. whale oil, or of sour oils before neutralization thereof, and in the treatment of transformer oils, particularly where such oil is drawn from the transformer casing and treated and immediately returned to the casing, the best results are secured when oxidation of the substance being treated is prevented. This can be accomplished by maintaining a reduced pressure upon the substance being treated or by replacing the air that would ordinarily come in contact with the substance being treated by an inert gas. And in treating materials used in the so-called "dry cleaning" process to purify those materials, in dewaxing oils that have been diluted with naphtha, and in treating a volatile substance, loss by evaporation or volatilization or the spreading of injurious or dangerous fumes may be avoided in most cases by enclosing the substance during centrifugal treatment thereof and may in some cases be more effectively avoided by maintaining a pressure

different from atmospheric pressure upon the substance being centrifugally treated. Evaporation of a substance being treated or of a constituent thereof may be promoted by maintaining upon the substance or constituent a pressure, above or below atmospheric pressure, but below that at which evaporation would be prevented at the existing temperature, sub-atmospheric pressure being maintained if evaporation does not proceed rapidly under atmospheric pressure at such temperature. The escape of dissolved gases from a substance being treated can be prevented by maintaining the substance under pressure during treatment, as in the clarification of beer or wine, or the removal of such gas can be effected by maintaining the substance under vacuum during treatment. A substance, or a constituent thereof, is in such a very finely divided state as it is discharged from the rotating member of the centrifugal machine that any result sought by the existence of pressure or vacuum or the presence of an inert or an active gas or vapor is efficiently and readily attained.

From the few instances that are above given, merely as examples, and of which many others will be apparent, it is clear that while a substance is under centrifugal treatment, changes or conditions therein that are undesirable may be prevented and changes and conditions that are desirable may be effected or promoted by maintaining pressure or vacuum upon the substance or by maintaining an inert or an active gas in contact therewith, as may be desired.

Our invention has for its object the provision of a centrifugal machine possessing features and advantages that may be employed in centrifugal machines adapted for general purposes and also features and advantages whereby conditions or changes such, for example, as those above referred to may be maintained or effected or prevented or controlled as may be desired, a further object being the provision of a process involving the employment of a centrifugal machine and whereby changes in or conditions of substances being treated may be promoted, effected, prevented or controlled, as may be desired.

Other objects and advantages of our invention will be apparent from the following

description of our process and of apparatus containing one embodiment of our invention and from the description of the mode of operation of such apparatus.

5 In the drawings,

Fig. 1 is a vertical elevation, with parts in section, of a centrifugal machine embodying and suitable for the practice of our invention;

10 Fig. 2 is an elevation taken from the right side of the construction shown in Fig. 1;

Fig. 3 is a top view of the construction shown in Fig. 1;

Fig. 4 is a sectional detail view;

15 Fig. 5 is a diagrammatic view showing the manner of feeding and withdrawing material from the construction shown in Fig. 1;

Fig. 6 is a sectional view of a modified form of seal for the power shaft;

Fig. 7 is a sectional view of another modification of the seal;

Fig. 8 is a sectional view on line 8—8 of Fig. 7;

25 Fig. 9 shows a modification of means for evacuating a discharge tank.

It being understood that the construction herein described is merely an example of apparatus that embodies our invention and whereby it may be practiced, it will be seen upon reference to Fig. 1 that the centrifugal bowl 1, which may be of any form and as shown is a bowl of the separator type, is provided with an inlet opening 2 which may be, as shown, at the bottom of the bowl and with outlets 3 and 4 which may be, as shown, at the upper end of the bowl. As is customary, each outlet is controlled by a weir in order that the proper hydrostatic balance may be maintained within the bowl. In the construction shown the circular dam 5 controls the outlet 4 and the circular dam 6 controls the outlet 3. Of course if mere clarification, wherein one constituent of a mixture is to be retained within the bowl, is to be carried out, discharge from one or the other outlet may be prevented by adjustment of its controlling dam. Whatever is discharged from the outlet 4 is collected in the compartment 7 and whatever is discharged from the outlet 3 is collected in the compartment 8. The bowl is supported through the stem 9 as hereinafter described.

30 Completely enclosing the separator bowl and its collecting compartments is a substantially closed casing 10 that is provided with a hand hole 10' normally closed by the cover 11 in order that parts may be introduced into the casing and removed therefrom and adjustments made therein. Extending through the side of the casing and attached thereto is an inlet member 12, called the drag assembly, into the passage 13 of which leads the supply pipe 14. The nozzle 12' of the inlet member directs the substance to be

70 treated into the opening 2 of the bowl. The inlet member 12 carries centering means indicated at 15 that may be of any known construction and that cooperates with the lower end of the bowl to center the bowl as it rotates. A lubricant is introduced through the pipe 16 to the centering mechanism at 15.

The casing is formed with extensions 10^a respectively having passages 20 and 20' to which are respectively connected discharge pipes 21 and 21'. The compartments for collecting substances discharged from the bowl have outlet spouts 20^a and 20^b respectively leading to the passages 20 and 20'. The atmosphere within the casing 10 will vary as to temperature, pressure, moisture, and chemical activity according to the effect that is sought to be made upon the substance undergoing treatment therein and for these reasons it is desirable to have the motor that drives the centrifuge located outside of the casing and such an arrangement is also desirable because the motor requires ventilation. Any spark produced in the motor would be dangerous if inflammable substances were being treated, and motor lubrication might contaminate substances passing through the centrifugal. And, in order to transmit power to the bowl, account must be taken of the desire to maintain various pressures within the casing and of the fact that the bowl and parts directly connected to it are subject to vibration by reason of the rotation of the bowl that may be in the neighborhood of 15,000 R. P. M. The motor driven pulley 22 has running over it the belt 23 tightened by the belt tightening idler 24. The belt passes around the pulley 25 that is provided with an extended hub or quill or hollow shaft 26. The power shaft 26 is supported by a bearing such as the ball bearing 27 that is carried by the bearing support 28 that is mounted in and forms a part of the casing 10. Between the hollow shaft 26 and the casing a seal is provided to prevent or control the escape of gas or air around the shaft 26. In the construction shown the bearing support 28 has a downward extension 29 and a seal is provided between the shaft 26 and the inner surface of the downward extension 29. This seal may be constructed in various ways. In Fig. 4 the space between the shaft 26 and the downward extension 29 provides a gland having at its inner end a washer 30 that supports an inner packing member 31. An outer packing member 32 is spaced from the inner packing member 31 by a ring 33 that is spaced from the shaft 26 to provide the chamber 34 and is provided with an outer groove 35 that communicates with the chamber 34 through the passages 36. The gland nut 37 compresses the packing members 31 to any desired degree. A passage 38 through the extension 29 communicates with

the groove 35 and has connected to it the pipe 39 whereby the pressure in the chamber 34 may be regulated or the chamber may be supplied with fluid. If pressure is to be maintained within the casing 10 an equal or slightly greater pressure in the chamber 34 will prevent any leakage around the shaft 26; and a pressure in the chamber 34 that is only slightly less than the pressure within the casing 10 will so reduce the differential of pressures in the casing 10 and the chamber 34 that leakage around the shaft 26 will be prevented or negligible. In either case any leakage around the packing member 31 would be only leakage of whatever gas is supplied to the chamber 34 through the pipe 39. Liquid introduced into or under pressure within the chamber 34 will assist in effecting a seal around the shaft 26. Or a vacuum may be maintained in the chamber 34. It can be readily determined whether it is most desirable to have pressure or vacuum or a liquid in the chamber 34 but, in any event, leakage around the shaft 26 will be prevented or drawn off and loss or atmospheric pollution prevented.

In Fig. 6 a seal of the labyrinth type is shown for prevention of leakage between the shaft 26 and the casing 10. A cylindrical member 40 provided with many circumferential ridges 41 and having gaskets 42 at the upper and lower ends thereof is held on to the shaft 26 by a nut 43. Gas or liquid may be maintained between member 40 and a corresponding member 44 that has on its inner face circumferential ridges 45 that extend between the ridges 41, and is positioned within the downward extension 29 of the bearing support 28. The member 44 is made in two parts connected together by dowels or screws 46 or both in order that the members 40 and 44 may be assembled. The circuitous or labyrinth path between the outer surface of the member 40 and the inner surface of the member 44 will retard or prevent leakage between the shaft 26 and the casing 10. The outer member 44 has gaskets 47 at its upper and lower ends and is held in place by the nut 48.

The seal between the shaft 26 and the casing 10 may be in the form of a liquid seal and in Fig. 7 we have shown one embodiment of such a construction. The sleeve 49 is held between gaskets 50 on the shaft 26 by means of a nut 51. Carried upon the sleeve 49 is a disk 52 that is positioned within the annular chamber 53 of the downward extension 29' of the bearing support 28. Liquid is maintained in the chamber 53 as more fully hereinafter described and the disk 52 carries impeller vanes, for example, the curved vanes 54 that are so formed and positioned upon the disk that they impel fluid within the chamber 53 in a direction opposite to the direction in which the pres-

sure would normally tend to move the fluid in chamber 53. Thus assuming that there is a pressure in the casing 10, fluid will be supplied through the inlet 55 and be conducted to the chamber 53 below the disk 52 and be thrown outward in the chamber 53 by reason of the rotation of the disk 52 so that gas passing upward between the sleeve 49 and the inner face of the downward extension 29' will be prevented from escaping from the casing 10. In order to assist in maintaining a sufficiently large body of liquid in the chamber 53 and in contact with the rotating disk 52, the vanes 54 are placed on the upper side of the disk 52 and as they tend to throw the liquid outward they tend to move the liquid in the direction opposite to the direction in which a pressure within the casing is tending to move it. Any excess liquid may be discharged through the pipe 56, or the pipe 95 that carries away oil that is fed to the bearings through the pipe 96. If there is a vacuum within the casing, flow would ordinarily be downward between the sleeve 49 and the inner face of the extension 29' so the impeller vanes 54 would be located on the under side of the disk 52 and fluid would be introduced through the pipe 56 and any excess liquid would collect in the annular channel 57 and be conducted to some desired point within or outside of the casing by means of the pipe 58. The parts of the extension 29' are held together by bolts 59.

The head of the bowl 1 is, as is usual, provided with a stem 9 that is connected with a spindle 60 in a well known manner and the upper end of the spindle is connected to the driving pulley or other prime mover 25. The particular construction of the bearing by which the shaft 26 is supported and the connection between the spindle 60 and the pulley 25 form no part of our present invention and they are more particularly described in the application of Arthur U. Ayres filed April 6, 1925, Serial No. 20,961. But it is to be noted that while the centrifugal bowl is entirely enclosed, power from a source outside of the enclosure is transmitted to the bowl through mechanism, a part of which, e. g. shaft 26, is firmly supported from the bearing while another part, e. g. the spindle 60 is free to partake of such vibration and flexure as may result from the rapid rotation of the bowl. The seal that prevents leakage where the transmitting mechanism passes through the casing is located between the casing and a part of the power transmitting mechanism, e. g. shaft 26, that is relatively free of vibration. The upper end of the pulley is closed by a cap 25'.

It will thus be apparent that while by placing the motor outside of the casing we have avoided the many difficulties that would

arise if the motor were placed within the casing, we have nevertheless provided a seal for the transmitting mechanism that extends into the casing and we have avoided the difficulties that would arise if it were attempted to seal a part of the transmitting mechanism that partakes of the vibration and flexure due to the rapid rotation of the bowl. The valved pipe 100 is provided for draining the casing 10.

In Fig. 5 we have shown diagrammatically certain connections and devices whereby the feeding and discharging of substances to and from the casing may be effected while the pressure or vacuum therein is maintained or controlled as desired. A chamber or header 70 is connected to a vacuum pump V or a pressure pump P. When the valve 71 is opened and the valve 72 closed a vacuum will be created in the chamber 70 and when the valve 72 is opened and the valve 71 is closed pressure will be created in the chamber 70. A supply tank S having an inlet controlled by the valve I and a vent controlled by the valve 73 is connected to the chamber 70 by a pipe controlled by the valve 74. The pipe 64 leading from the casing to the chamber 70 is controlled by the valve 75. The discharge pipes 21 and 21' lead from the casing to discharge tanks D, D. Vent pipes leading from the discharge tanks to the chamber 70 are controlled by the valves 76 and 77. Each discharge tank D has an outlet 78 that may lead to any desired point. Flow from each tank D through its outlet 78 is controlled as by a valve 79, the opening and closing of which is dependent upon the level of liquid in the tank D. For example, valve 79 may be controlled by a float F operating the lever 80. An alternate method of emptying a tank D, that is used particularly when there is a vacuum within the tank D, consists in closing the valve 81 and permitting an extension 82 of the float operated lever 80 to actuate a controlling device T of a prime mover M that in turn actuates an exhausting pump E. The pipe 39 leading to the space between the packing members 31 and 32 may be connected in any manner to the vacuum pump V or the pressure pump P or to a source of liquid supply as may be desired. The pipe 16 conducting lubricant to the guiding mechanism 15 may be supplied and controlled in any known manner.

If the centrifugal treatment is to be carried out with pressure, above that of the atmosphere, in the casing C the supply tank is closed by the closing of the valves I and 73 and pressure is created in the chamber 70. The valve 75 is opened to permit pressure to accumulate in the casing C and in the discharge tanks D and the valves 74, 76 and 77 are opened in order to equalize the pressures in the tanks S and D and the casing C. The

supply to the centrifugal machine is controlled by the valve S' and constituents of the substance treated pass through the discharge pipes 21 and 21' into the discharge tanks until the level therein is sufficiently high to raise the valve 79 and permit flow through the outlets 78, the valves 81 of which are open. If the centrifugal treatment is to be carried out with a vacuum existing in the casing C the valves 81 of the outlets 78 are closed and a vacuum is created in the chamber 70 by means of the pump V. As the level rises in the discharge tanks D the floats F will raise the valves 79 and actuate the control devices T in such a way as to cause the pumps E to withdraw liquid from the tanks D and discharge it through the pipes 83 into the outlet 78. Under certain conditions it may be desirable to have atmospheric pressure in the tank S when there is a vacuum in the casing C and then the valve 74 is closed and the valve 73 opened. If the centrifugal treatment is to be carried out under atmospheric pressure but still while the casing C is closed off from the surrounding atmosphere there will be neither pressure nor vacuum in the chamber 70 but the various vent pipes will permit of the desired flow. The supply may be from a point below the level of the casing C such as the tank S' that has an inlet valve I' and a valve 73' corresponding to the valves I and 73 of the tank S. Flow from tank S' to the casing is controlled by the valve S². If it is desired to carry out the centrifugal treatment in the presence of an inert or other gas such a gas may be supplied by pump P at either atmospheric pressure or some greater pressure or after the system is filled with such a gas the pressure thereof may be reduced.

It will be apparent that because of the very high speeds encountered in connection with centrifugal treatment of substances and the proportionately great pressures and forces incident thereto that certain conditions that arise by reason of forces, speeds, or possible agitation may either be utilized in effecting a desired change or may interfere with the attainment of the desired result and that it is therefore desirable to control such conditions, for example, the tendency of a substance to foam. And when a substance or constituent of a substance is discharged at very high speed from the rotating bowl it is discharged in such an extremely finely divided form that outside influences act upon the substance very readily. For example, the presence of air may oxidize a substance, e. g. whale oil, or transformer oils, or sour oils, or the presence of another gas may readily effect a desired change and in accordance with our invention we intend that the finely divided state of the discharged substance or constituent

may be taken advantage of in effecting a treatment of that substance or constituent by a gas or in order to effect evaporation, such evaporation being effected by maintaining in the space where the substance exists in dispersed form a pressure, above or below atmospheric pressure, at which evaporation will occur at the existing temperature.

The fact that the casing C is closed except for controlled openings therein makes it possible to carry out centrifugal treatment without any chance that vapors or gases will be lost or will pollute the surrounding atmosphere. And such closed condition of the casing makes it possible to carry out the centrifugal treatment under pressure or vacuum or in the presence of a gas of desired characteristics in accordance with the principles and for the attainment of the results above described.

While we have described certain arrangements for controlling the pressure within the casing C under certain conditions of feeding and discharging, such control being effected by the maintenance of pressure or vacuum or atmospheric pressure in the supply tanks and discharge tanks, it will be apparent that other arrangements of vents and other setting of valves are possible so that there is such equalization of pressures within the various tanks and the casing as will permit of the desired flow of the substance being treated.

From the foregoing it will be apparent that we have disclosed apparatus and a process whereby the various alterations and conditions above set out, and others that will be apparent, of the substance being treated, or the constituents thereof, may be effected or prevented or controlled as desired. And while we have described such apparatus and process in considerable detail, we do not intend to be limited to such details but we intend that our invention shall be susceptible of such variations and modifications as fall within the hereunto appended claims. It will also be apparent that we have provided a process and apparatus whereby the condition of a substance being centrifugally treated is maintained constant or preserved or altered, e. g. foaming, oxidation and loss of dissolved gases are prevented and evaporation or chemical change is furthered or prevented, by controlling or regulating the condition, e. g. pressure, moisture, chemical activity or inactivity, etc., of the atmosphere within which the centrifugal treatment takes place. While we have shown several types of devices for sealing the power transmitting mechanism where it passes into the casing, such devices are described for the purpose of illustrating the principles of our invention whereby such seals may be formed and made effective but we do not intend to be limited to the construction shown. A pos-

sible modification of means for evacuating the discharge tank D is shown in Fig. 9 wherein the tank D is supplied with fluid through the pipe 21 and is vented by the pipe 76' and fluid is withdrawn from the tank by the pump E'. Fluid will be withdrawn from the tank D through the pipe 78 and leaves the pump E' through pipe 78', but in order to prevent the pump from drawing air when the tank D is empty a by-pass 90 extends around the pump E' from pipe 78 to pipe 78' and the float F' opens the valve 91 in the by-pass 90 when the liquid level in tank D drops so that liquid will pass from the pipe 78' back to the pipe 78 and prevent the pump from entirely emptying the tank D regardless of whether fluid is flowing into the tank D or not. It is apparent that regardless of what, if any, change or separation is effected by the action of centrifugal force the pressure of the atmosphere within which the substance is discharged in finely divided state may be controlled to effect the objects of our invention as by maintaining sub-atmospheric pressure in the covers or receptacles within which the substance or substances so discharged are collected. Thus in accordance with that species of our invention claimed herein sub-atmospheric pressure may be maintained within the separator bowl and also within the collecting covers or only within the collecting covers. The nature of the control of the atmospheric conditions will depend upon the change that is sought to be promoted or prevented and will vary under the circumstances existing in each case. To this end the chemical activity or inactivity of the controlled atmosphere with respect to the substance and the solubility or insolubility and the pressure and temperature of the controlled atmosphere with respect to the particular substance will be taken into consideration.

This application, like our application upon which Letters Patent No. 1,575,061 were granted to us on March 2nd, 1926, constitutes a division of our application Serial No. 710,388, filed May 1st, 1924. In application, Serial No. 710,388, filed May 1st, 1924, we claim broadly the regulation of the condition of the atmosphere that is acting upon a substance in which a change is effected by centrifugal force and also upon a substance or constituent thereof discharged in dispersed form by the same centrifugal force, such regulation being for the purpose of controlling the condition of the substance so treated and discharged. In that same application we claim that species of our invention wherein the chemical properties are regulated of the atmosphere acting on the substance under treatment and on a substance discharged in dispersed form. In our Patent No. 1,575,061 we claim broad-

ly that species of our invention wherein a substance is subjected to centrifugal force to effect a change and to discharge it in dispersed form and the pressure is regulated of the atmosphere within which the substance is treated and within which it is so discharged, such regulation being for the purpose of controlling the condition of the substance; and we claim the regulation of such pressure to a point other than atmospheric pressure, and the causing of evaporation by regulating the pressure acting upon a substance discharged in dispersed form, to a point, above or below atmospheric pressure, that will cause evaporation of the substance at the existing temperature. In that patent we claim specific features of our apparatus, and a method and apparatus whereby a substance is maintained tightly enclosed throughout centrifugal treatment in order that vapors and gases may not escape from substances discharged in dispersed form; and we claim the use of pressures above atmospheric pressure in connection with substances centrifugally treated to effect a desired change and to discharge the substance in dispersed form. Herein we claim the use of sub-atmospheric pressures in connection with substances centrifugally treated to effect a change therein and to discharge them in dispersed form, one effect of such reduced pressure being to cause evaporation of substances that do not evaporate rapidly under atmospheric pressures at the existing temperature.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In the centrifugal treatment of substances the process which comprises subjecting a substance to the action of centrifugal force and thereby effecting a desired change in the substance and discharging the changed substance in dispersed state, and maintaining sub-atmospheric gas pressure upon the substance while it exists in the dispersed state in which it is centrifugally discharged.

2. In the centrifugal treatment of substances the process which comprises subjecting a substance to the action of centrifugal force and thereby effecting a desired change in the substance and discharging the changed substance in dispersed state, and preventing oxidation of the substance by subjecting it to sub-atmospheric pressure while in such dispersed state.

3. In the centrifugal treatment of substances the process which comprises subjecting a substance to the action of centrifugal force and thereby effecting a desired change in the substance and discharging the changed substance in dispersed state, and maintaining sub-atmospheric gas pressure upon the substance during centrifugal treat-

ment thereof and while it exists in the dispersed state in which it is centrifugally discharged to control the condition thereof.

4. In a centrifugal machine, a separator bowl for separating and separately discharging substances under the action of centrifugal force in a dispersed state, means for maintaining at sub-atmospheric pressure the gas contacting the substance while it exists in the dispersed state in which it is discharged.

5. In combination, a centrifugal machine of the type wherein a substance is subjected to the action of centrifugal force to effect a change therein and centrifugally discharged in a dispersed state, and means for maintaining at sub-atmospheric pressure the gas within which the substance is subjected to the action of centrifugal force to effect a change therein and within which the substance is centrifugally discharged in a dispersed state.

6. In a centrifugal machine, a separator bowl for separating and separately discharging substances under the action of centrifugal force in a dispersed state, means substantially enclosing said bowl, means for conducting a substance to said bowl from a point outside of said enclosing means, means for conducting the separated substances out of said enclosing means, and means for maintaining sub-atmospheric pressure within said enclosing means.

7. In the centrifugal treatment of substances the process which comprises subjecting a substance to the action of centrifugal force and thereby effecting a desired change in the substance and discharging the changed substance in dispersed state, and preventing undesirable alteration of the substance while it exists in dispersed form by maintaining gas at sub-atmospheric pressure in contact therewith.

8. In combination, a centrifugal machine having a bowl wherein a substance is subjected to the action of centrifugal force to effect a change therein and centrifugally discharged in a dispersed state, an enclosing casing for the centrifugal bowl, means for conducting the substance into the casing and to the bowl, means for withdrawing the discharged substance from the casing and a vacuum pump operatively connected to said casing.

9. In combination, a centrifugal machine of the type wherein a substance is subjected to the action of centrifugal force to effect a change therein and centrifugally discharged in a dispersed state, a compartment for collecting a substance so discharged, and means for maintaining sub-atmospheric pressure within said compartment.

10. In the centrifugal treatment of substances the process which comprises subjecting a substance to the action of centrifugal

force and thereby effecting a desired change in the substance and discharging the changed substance in dispersed state, and controlling the condition of the substance so discharged by maintaining sub-atmospheric gas pressure upon the substance while it exists in the dispersed state in which it is centrifugally discharged. 15

11. In the centrifugal treatment of substances the process which comprises subjecting a substance to the action of centrifugal force and thereby effecting a desired change 20

in the substance and discharging the changed substance in dispersed state, and so treated by maintaining sub-atmospheric gas pressure upon the substance during centrifugal treatment thereof and while it exists in the dispersed state in which it is centrifugally discharged. 20

In testimony whereof, we have signed our names to this specification.

LEO D. JONES.

ARTHUR U. AYRES.