May 26, 1925. 1,539,435

J. M. SCHUTZ

CENTRIFUGAL APPARATUS

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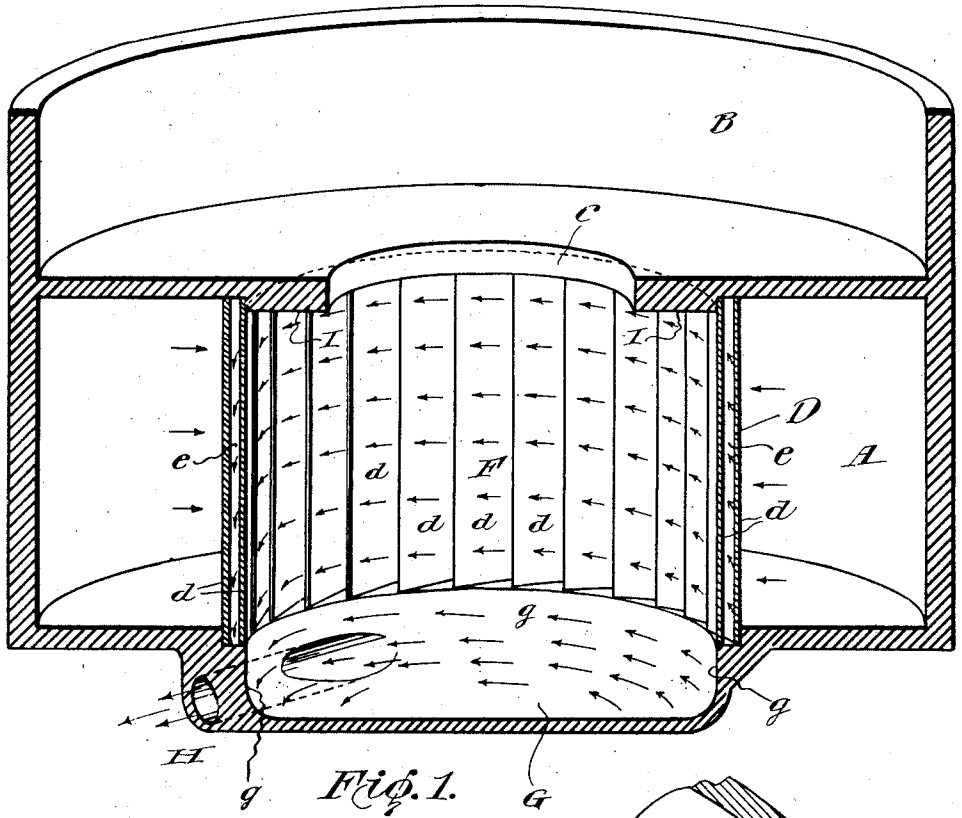

Fig. 1.

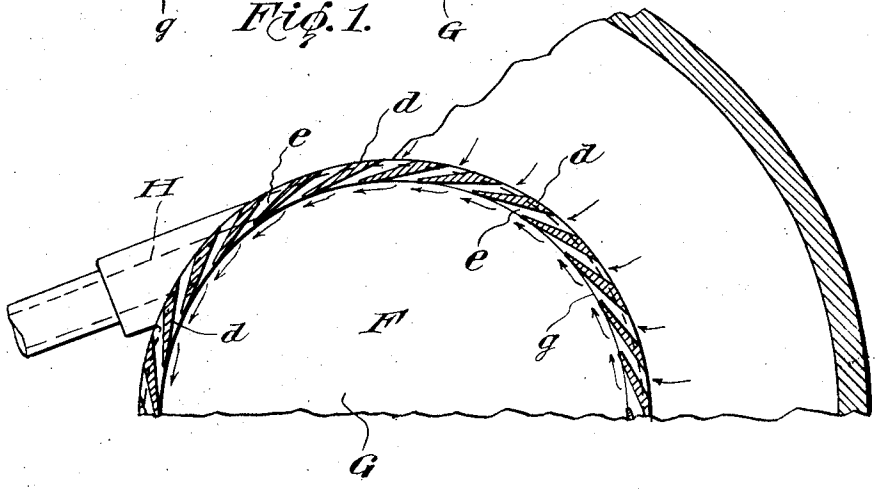

Fig. 2.

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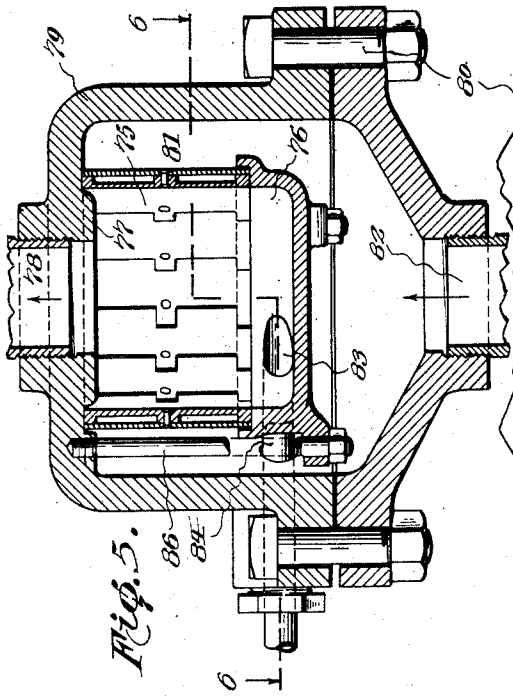

Fig. 5.

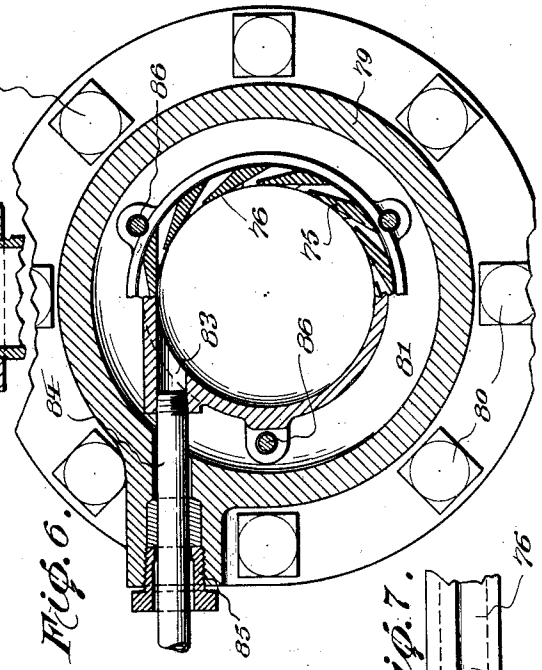

Fig. 6.

Fig. 7.

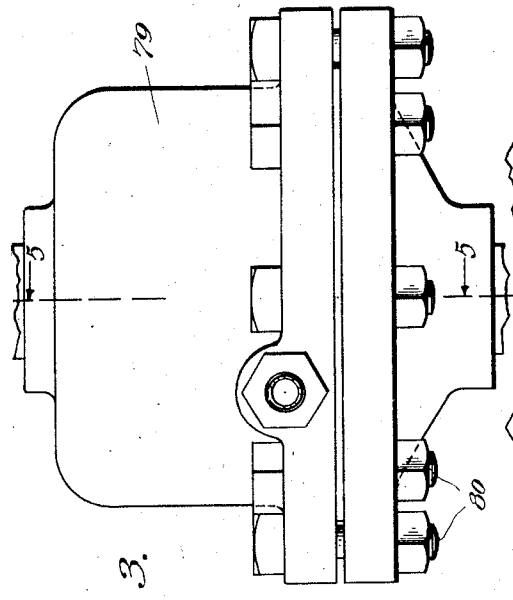

Fig. 3.

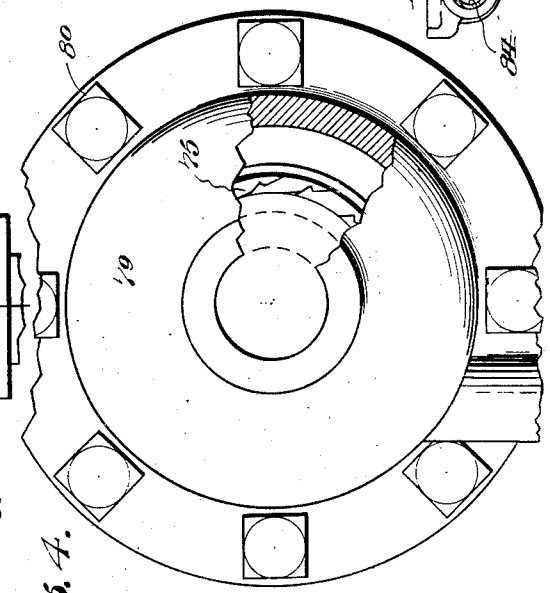

Fig. 4.

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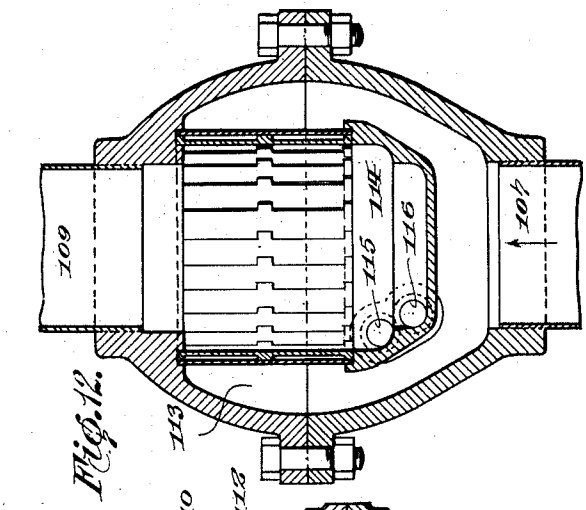

Fig. 12.

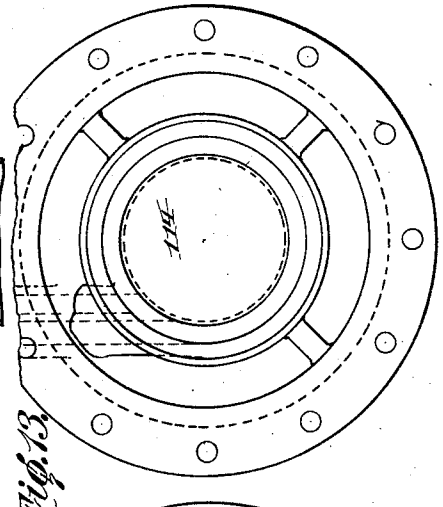

Fig. 13.

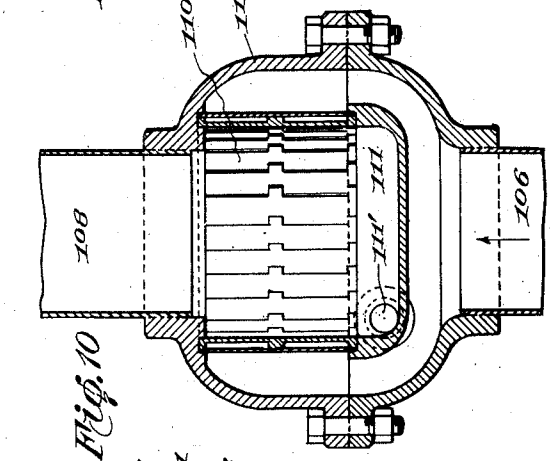

Fig. 10

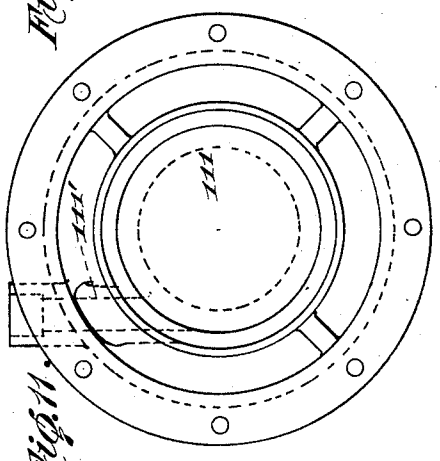

Fig. 11.

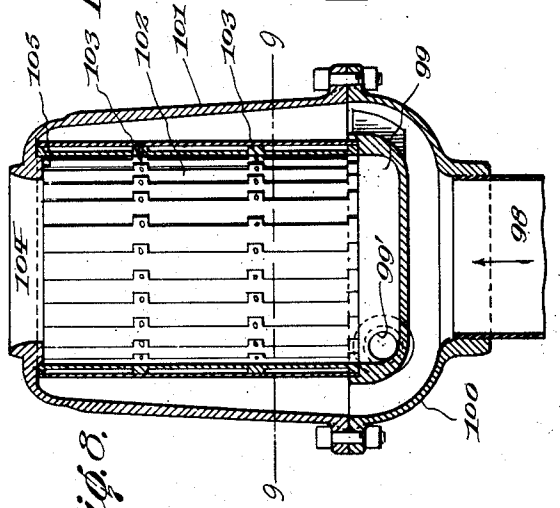

Fig. 8.

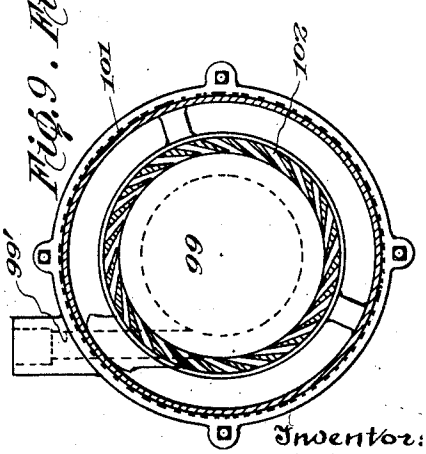

Fig. 9.

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CENTRIFUGAL APPARATUS

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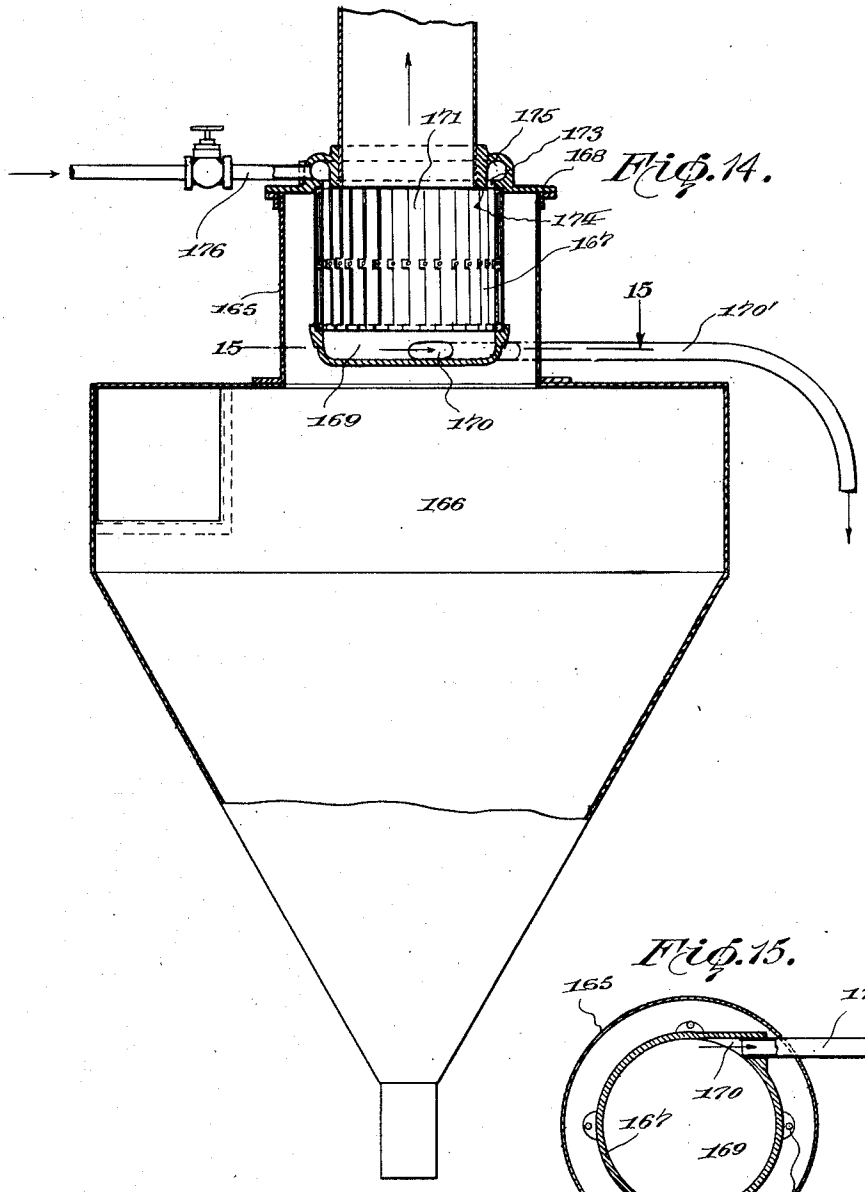

Fig. 14.

Fig. 15.

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CENTRIFUGAL APPARATUS

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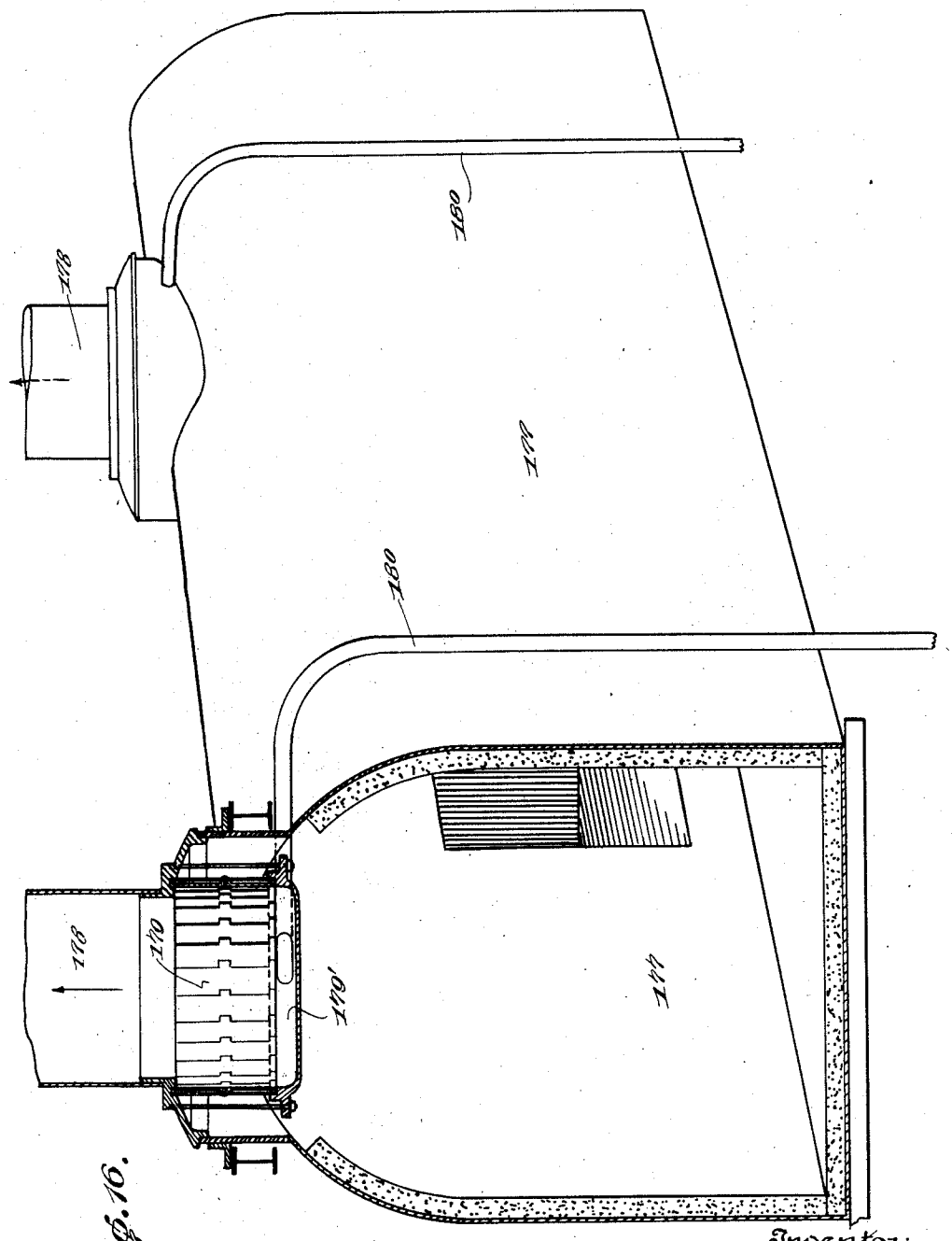

Fig. 16.

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Fig. 17.

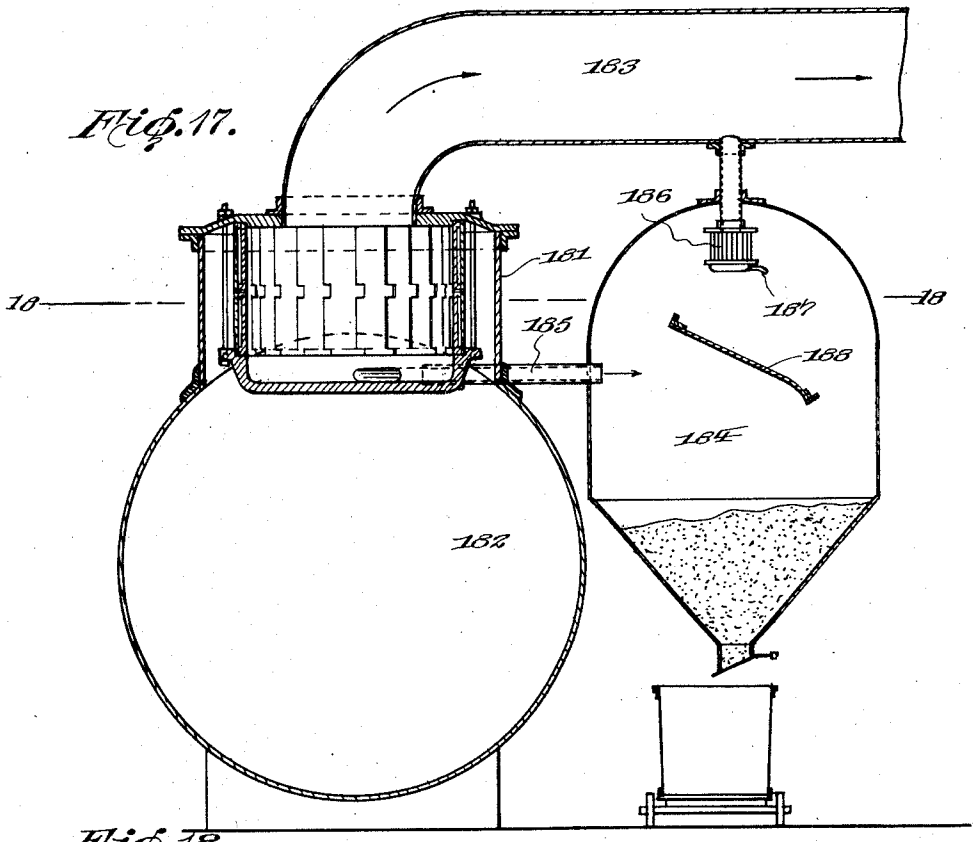
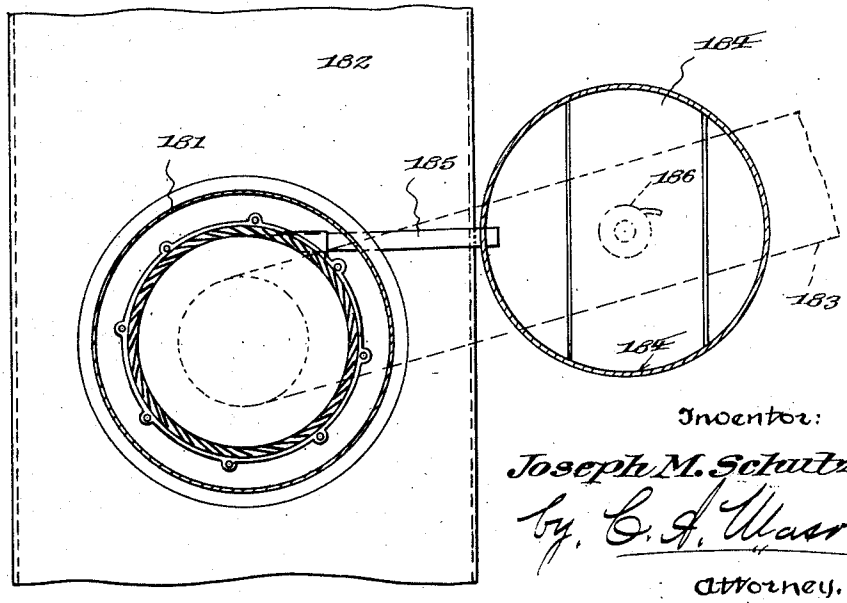


Fig. 18.



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CENTRIFUGAL APPARATUS

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Fig. 19.

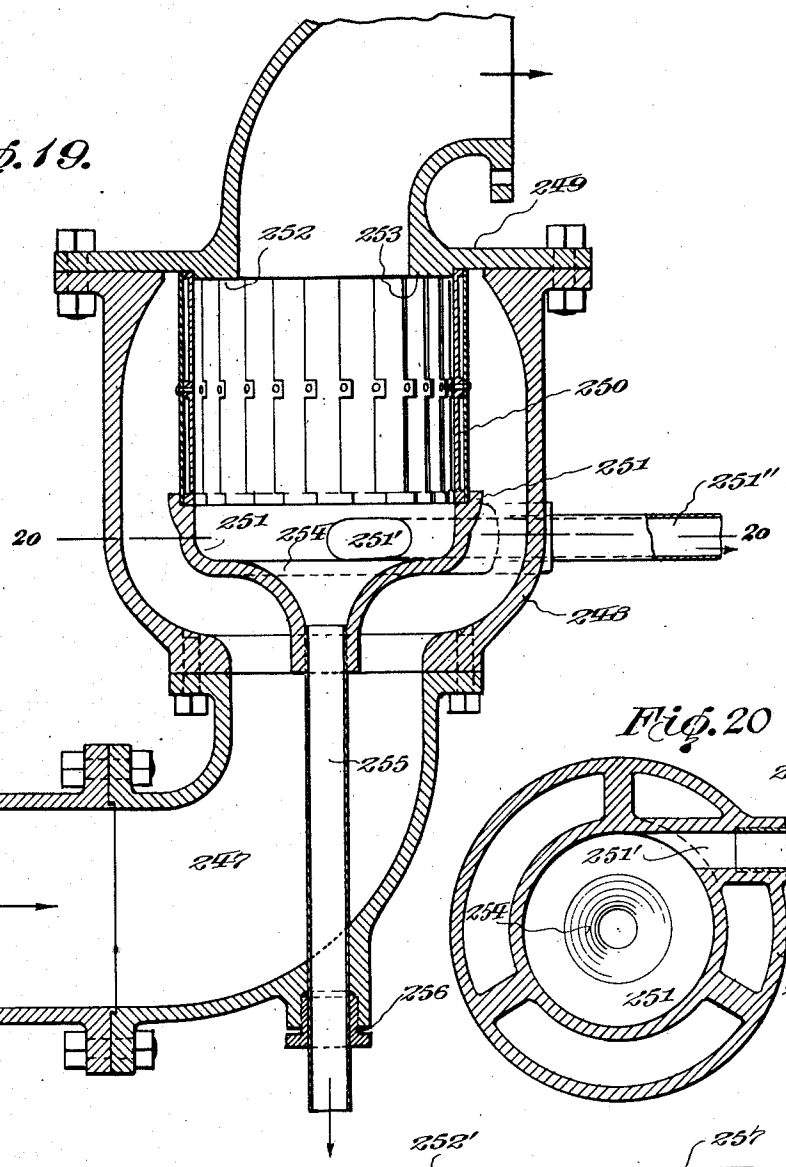
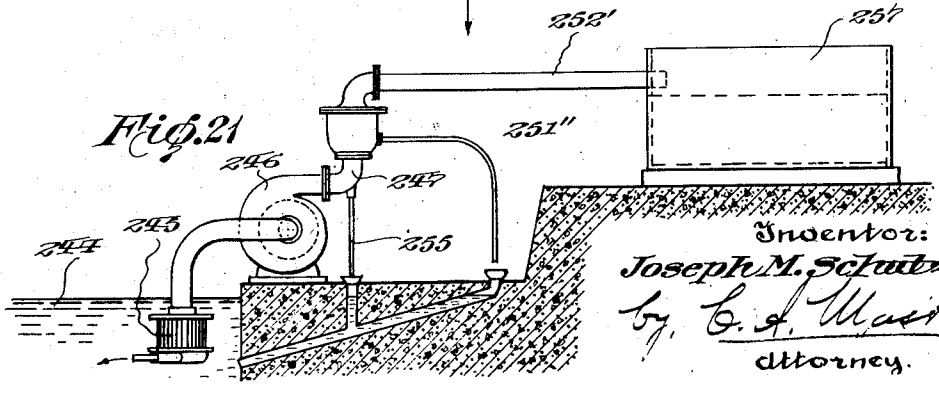


Fig. 20

Fig. 21



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CENTRIFUGAL APPARATUS

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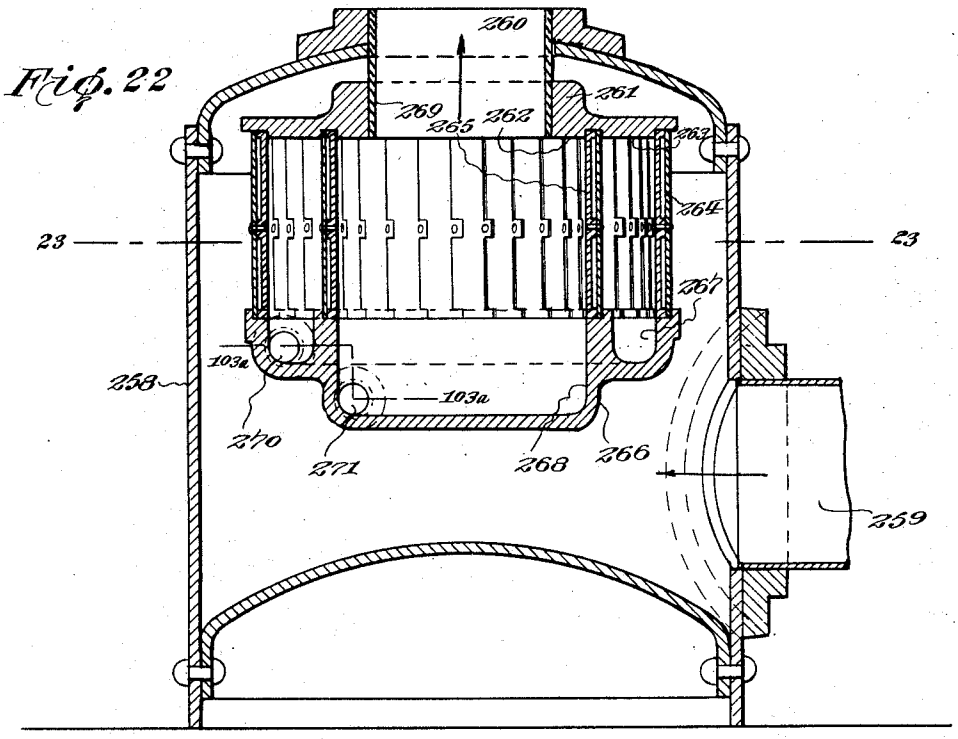
Fig. 22



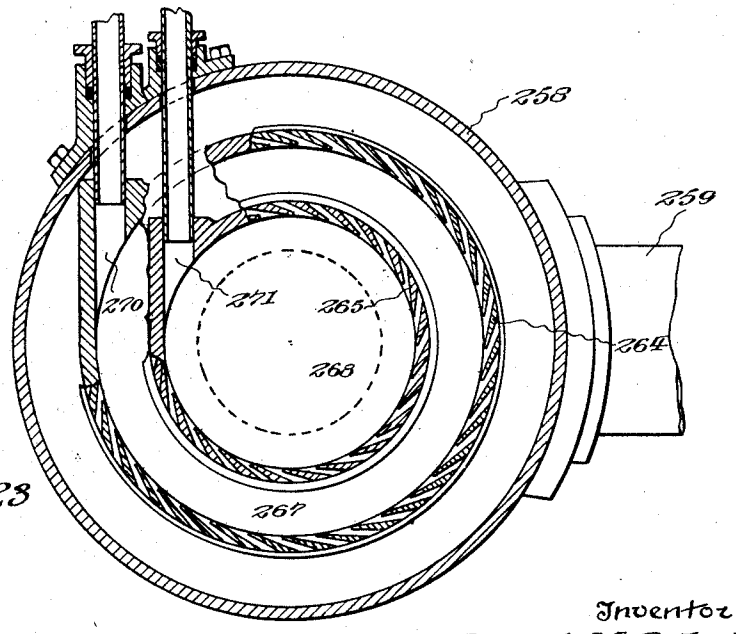


Fig. 23

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May 26, 1925. 1,539,435

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CENTRIFUGAL APPARATUS

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Fig. 24.

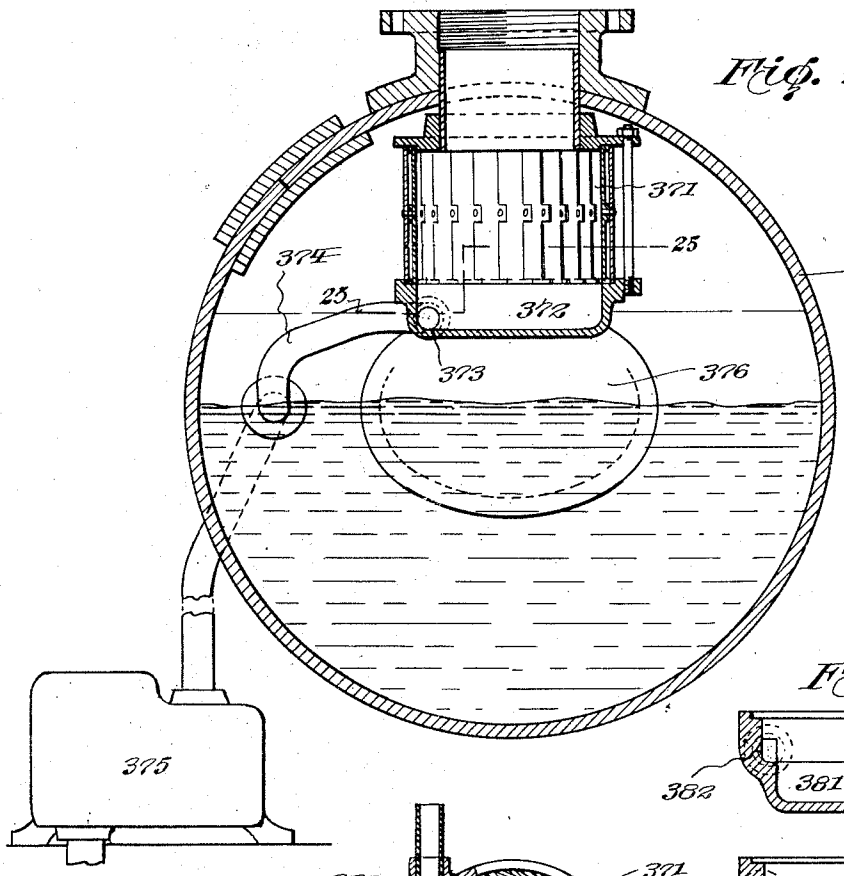


Fig. 28

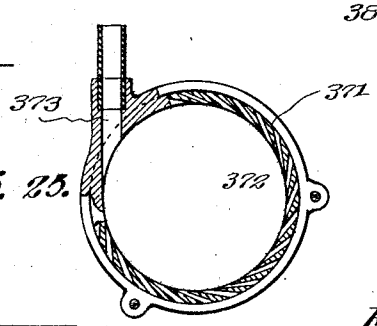


Fig. 25.

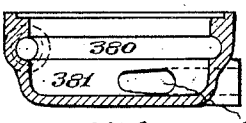
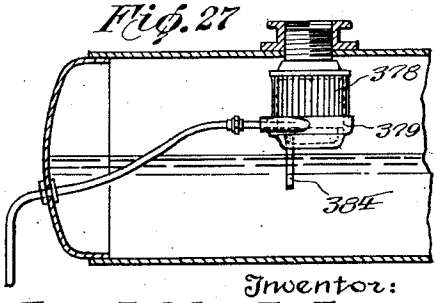


Fig. 29

Fig. 27



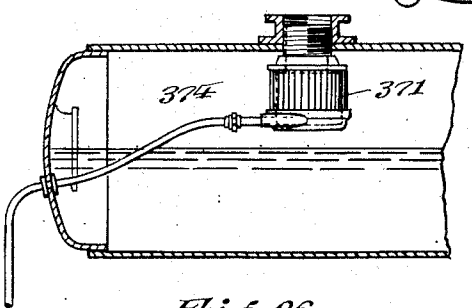


Fig. 26

Inventor:
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by C. F. Mason
Attorney.

Patented May 26, 1925. 1,539,435

UNITED STATES PATENT OFFICE.

JOSEPH MARTIN SCHUTZ, OF CHICAGO, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO CENTRIFIX CORPORATION, OF CLEVELAND, OHIO, A CORPORATION OF DELAWARE.

CENTRIFUGAL APPARATUS.

Application filed February 5, 1924. Serial No. 690,861.

To all whom it may concern:

Be it known that I, JOSEPH MARTIN SCHUTZ, a citizen of the United States, residing at Chicago, Cook County, Illinois, U. S. A., assignor to Centrifix Corporation, of Cleveland, Ohio, a corporation of Delaware, have invented the new and useful Improvements which are described and claimed in the following specification, entitled Centrifugal Apparatus.

The invention provides for the centrifugal treatment of substances without resort to rotating parts, and is intended for variously clarifying, filtering, separating, classifying, grading, concentrating, condensing, heating and distilling various liquids, vapors and gases and the substances therein contained. With these purposes, the invention comprehends novel apparatus or devices operating upon a clearly apprehended principle and having a novel generic basis; whereby all such purposes and many important results and products may be accomplished and obtained easily, quickly and safely and by remarkably small expenditures of time, money, labor and space.

Briefly, the invention consists in means employing the pressure or energy of a body or stream of liquid, vapor or gas to set up at a defined point therein a whirling action which assists in collecting and then expels the substances (gaseous, liquid or solid) that it may be desirable to separate and remove therefrom. Coincidently the body or stream to be acted upon is first finely subdivided into a large number of thin streams, layers or films. These are caused to tangentially unite at the periphery of the whirling body and both form and maintain the whirling action referred to. Each such film or layer in the course of its first action is immediately deflected, and the heavier and the lighter substances making up the film are thus separated by centrifugal force.

The many films or streams are projected tangentially against suitable surfaces and a free axial outlet being provided for the main stream, the described whirling action is organized and is steadily maintained. In consequence, the divided or separated substances can not again join together, being held in a sufficiently divided state by centrifugal force.

In the case of heavier substances within the small streams or films, immediately upon entrance they are projected or impacted upon the nearest deflecting surface and thus are collected and retained upon the periphery of the main whirling body. From that peripheral position, the separated substances are continuously worked or moved axially and pass across an imperforate surface, thence to be separately discharged under the strong whirling and centrifugal impulsion of the main body or stream within the region of the whirling action. The main stream formed by the reunitement of the subdivided and purified films at the axis of the whirl, moves onward and away through an outlet at one or the other or both ends of the region or restricted space in which the whirling action takes place.

In most forms of the invention the imperforate surface above mentioned is provided in the form of a centrifugal bowl. That bowl is stationary. The main body to which rotation is imparted serves to keep in rotation the contents of the bowl; and, under the centrifugal force developed and continuously maintained therein, the separated substances are discharged through one or more openings at or near the periphery of the bowl.

Obviously the movement of the main body or stream may be caused by either external pressure or by suction. Only a slight difference of pressure is required between the point of entrance and the point of exit; the same yielding, within the confines of the whirling action, a velocity and a suddenness of deflection sufficient to accomplish the centrifugal separation of the several substances. The greater the difference of pressure, the greater the rotative velocity of the substances within the region of the whirling action; and, given a certain velocity of movement, the smaller the radius of the whirling action the greater will be the centrifugal force developed.

As should now be apparent, this invention in its several aspects is most fortunately harmonized with all the laws of centrifugal force. The conveniently small units embodying the invention separately and by multiplication lend themselves to the performances of the smallest and of the largest tasks; and, it will be found both objectionable and unnecessary to make or use these units in large, cumbersome or expensive sizes.

The invention will be readily understood on reference to the accompanying drawings. The practical scope of the invention is so extensive that it is not possible to present all forms, varying details and employments thereof but it is believed that those shown will enable persons who are skilled in the several arts to fully understand and utilize the invention.

In the drawings, Fig. 1 is a perspective sectional elevation diagrammatically representing the invention; Fig. 2 is a partial horizontal section thereof disclosing how the tuyère ring, though small in diameter, may have many tangential slits, ports or tuyères and may be of preferably relatively great length; Fig. 3 is a side view of a centrifugal unit embodying this invention and of a heavy closed type adapted for employment with high pressure steam or other high pressure fluid; Fig. 4 is a plan view, with the top broken away to show the interlocked formation of the top of the centrifugal ring; Fig. 5 is a longitudinal section, on the line 5—5 of Fig. 3; Fig. 6 is a transverse section on the line 6—6 of Fig. 5; Fig. 7 is an external detail, better showing the outlet of the centrifugal bowl; Fig. 8 is a vertical section of an exhaust steam outlet or head embodying the invention; Fig. 9 is a horizontal section on line 9—9 of Fig. 8; Fig. 10 is a longitudinal section of a closed type centrifugal unit embodying the invention in a modified form; Fig. 11 is a face view of the lower half of the casing of Fig. 10; Fig. 12 is a vertical section of a further modified form of the closed type unit illustrating a plural separation centrifugal bowl; Fig. 13 is a plan view of the lower half of the casing of Fig. 12; Fig. 14 is a vertical section of a so called centrifugal dust collector equipped with a final dust collecting unit embodying this invention; Fig. 15 is a horizontal section on the line 15—15 of Fig. 14; Fig. 16 is a sectional perspective view of a furnace breeching with several stacks rising therefrom, each equipped with a centrifugal unit embodying the invention; Fig. 17 is a vertical section of a blast furnace gas duct or main equipped with a gas purifying apparatus embodying the present invention; Fig. 18 is a horizontal section on the line 18—18 of Fig. 17; Fig. 19 discloses the invention in the form of a centrifugal unit that is adapted to filter an upward moving stream of water or the like; Fig. 20 is a horizontal section on the line 20—20 of Fig. 19; Fig. 21 exhibits the use of the invention in filtering water from a stream or basin such as the basin 244; Fig. 22 is a vertical section of a two-stage or ultra type of purifier or classifier embodying this invention, the same being shown within an enclosing casing for a better understanding of its operation; Fig. 23 is a horizontal section on the line 23—23 of Fig. 22; Fig. 24 illustrates the employment of the invention for the purification of the steam leaving a steam boiler or the like; Fig. 25 is a horizontal view on the line 25—25 of Fig. 24; Fig. 26 is a longitudinal section of the steam drum and purifier of Fig. 24, on a reduced scale; Fig. 27 is like unto Fig. 26 but illustrates the employment of a centrifugal unit having a plural or two-stage centrifugal bowl; and, Figs. 28 and 29 are enlarged sectional views of two such plural bowls, of slightly differing forms.

For the simplification of a necessarily extended specification the description of each structure and process shown will generally be restricted to one use thereof, easy comprehension of other uses being expected of those skilled in the several arts.

The principles involved and a desirable form of apparatus will be understood almost at once upon an inspection of Figs. 1 and 2.

The space A represents any source of liquid, vapor or gas. The space B represents any separate space into which the substance from the space A is discharged through any axial opening such as C, but only through the medium or gateway which is provided by the part D, which is a multiple tangential tuyère barrel or ring. This last is coaxial with the outlet opening C and is made up of a number of staves, vanes, or blades, marked *d*. These are arranged circularly and in relatively tangential overlapping positions. They are separated by narrow spaces or slit-like openings, and thus the tangential entrance ports or tuyères *e* are formed. All of these ports or narrow passages have the same direction. The cylindrical space F within the tuyère ring, D, is that region within which the before mentioned whirling action is organized and maintained by the movement of the substance from the space A toward the space B. No rotating or moving parts are involved in originating or maintaining the described whirling action. The portion *g* at the end of, or in other words beyond, the staves *d* and ports *e*, is the annular imperforate surface before referred to across which the separated substances are delivered to their outlet. In this case it is a component part of the centrifugal bowl G; constituting the peripheral portion thereof. Leading from the inner periphery of the bowl G is a discharge opening or duct H. This is preferably tangential to the bowl and has the same direction as the slits or ports *e*; and through this duct the separated substances are discharged from the region (space F) of the whirling action.

The effective internal diameter of the tuyère ring and the diameter of the centrifugal bowl as here shown are substantially the

same. Both are of greater diameter than the axial outlet C. Thus, the annular imperforate portion I remains between the margin of the axial outlet C and the adjacent end of the tuyère ring; that is, the ring end which is opposite to the centrifugal bowl. This portion I will be referred to as the annular abutment portion. As to that portion of the substance which lies close to the inner periphery of the tuyère ring or barrel, the abutment I forms the limit of motion in that direction, whereas the bowl G permits relief and motion in its direction and thence parallel to the axis of rotation, and while that rotation is going on. Such are the relations of the abutment I and the bowl G. How large or how small shall be the width of the annular abutment, I, is determined by the nature of the substance or substances to be treated in the apparatus. For the separation of those which are of nearly the same weight or specific gravity an abutment of considerable width may be employed; whereas, only a very narrow abutment is required for the reliable separation of substances of widely different specific gravities. Thus, in the case of particles of solid matter contained in gases or in liquids, the separation is accomplished with an annular abutment of little greater width than the diameter of such particles of solid matter. This relation will become clearer as the description proceeds.

A definite description of the action of the apparatus in clarifying or filtering a liquid that contains solids in suspension, such as sand or silt, will serve to further exhibit its principles. Thus, water under pressure, admitted through the space A, is subdivided and passed into the ring through the many slot-like tangential tuyères E. Entering in this manner it tends to maintain its motion in the tangential direction (with respect to the ring D and outlet C) in which it is started. But each stream is immediately deflected by the surfaces of the overlapping staves, *d*, and these acting together, restrain and cause the whole body within the tuyère ring to rotate at a peripheral velocity which is substantially equal to the velocity of the movement of the liquid from the space A through the tuyères *e*. Such movement and velocities may be imparted by external pressure, or by suction at the outlet C, and obviously the greater the pressure difference between the spaces A and B, the higher will be the velocity of rotation within the tuyère ring. And the smaller the radius of rotation, the greater the centripetal reaction of the circular series of blades. Thus the solids which enter from the space A and are precipitated upon succeeding staves of the tuyère ring are swept round and round within the ring, with three pronounced effects:—1st, they are thrust against the staves by centrifugal force: 2nd, if of cellular or of flocculent structure, they are considerably disintegrated; and 3rd, by this rotation, the liquid adjacent the encompassing tuyère ring is placed under higher pressure than the liquid nearer the axis.

In consequence of the higher pressure the fluid tends to expand longitudinally. If such expansion were immediately permitted in the direction of the outlet C, not only the purified water but also the periphery separated solids would be discharged through the outlet C. This, however, in the embodiment of the invention being described, is prevented by the annular abutment, I, and being prevented from expansion in that direction the whirling liquid is forced to move in the other direction, and hence into the bowl F. Obviously the whole body which fills the ring and the bowl G is kept in rapid rotation, including the solids collected at the periphery of the bowl. To discharge the collected solids it is only necessary to provide the periphery of the bowl with an opening (such as H) through which the contents may escape. The opening H is made much smaller than the outlet C so that not much of the liquid can escape with the solids. By preference this opening H, as before stated, is tangential to the bowl and through that opening a portion of the liquid, laden with all collected solids, is expelled with such force as to, at all times, empty and ensure the freeing of the bowl from any accumulation of the solids. Meantime the purified water being displaced toward the axis of the centrifugal elements, and reacting against the bottom of the bowl G has its rotative motion converted into longitudinal or axial motion and thus passes off through the outlet C.

The fixed centrifugal apparatus which embodies this invention may be used in any desired position (vertical, horizontal or inclined) provided only that the rotation therein attained is radially restricted and is centrifugally sufficient to hold the separated substances at the periphery of the imperforate annular surfaces described. But wherever possible, it is the better practice to arrange the bowl at the bottom of the centrifugal tuyère ring so that the displacing effect of the opposed top or abutment I shall be harmonized with the force of gravity and permit the heavier substances to slowly and by a helical motion descend into the bowl.

Such rotatively longitudinal action, in whatever manner accomplished, embraces an important time element that ensures the complete centrifugal separation of the heavier from the lighter substances, a matter of vital importance, particularly as the diameters of the centrifugal members are

but little larger than the duct or pipe through which the purified substances is removed. In other words, the apparatus as a whole is at once extremely small in proportion to the volume of the substance that passes through it and nevertheless, is completely effective in the work to which it is devoted.

The described appliances are capable of many other uses and of assembly in many other combinations of parts and, also as in the case of every newly discovered tool or facility, they lead forward and embrace many new methods, effects and results never before possible of attainment at reasonable expense.

Referring to Figs. 3 to 7, the centrifugal tuyère ring 75 and centrifugal bowl 76 are preferably of the now familiar construction; likewise the annular abutment portion 77 surrounding the outlet 78. The whole is enclosed by the heavy casing 79, made in two parts which are packed and fastened together by numerous bolts 80. Thus the centrifugal elements are enclosed within a static pressure space or chamber 81. The fluid enters through the pipe connection 82 and passing inwardly through the tuyère of the ring 75, takes on the described whirling action and is purified before escaping through the outlet pipe 78. The collected heavier substances are discharged through the tangential outlet 83; usually into an automatic discharge trap.

A detail of novelty resides in the arrangement of the discharge pipe 84; it passes through a stuffing box 85 positioned in that part of the casing 79 to which the bowl and the ring are secured by the assembly bolts 86. Disturbing motion between the parts is thus avoided and they are kept tight notwithstanding the forces of expansion and contraction due to variations of temperature.

Figs. 8 to 13 exhibit the device in slightly modified forms that better adapt them to special uses. But neither the centrifugal operations nor the structures are modified in any essential particular. These devices already have been sufficiently described as to their uses, and now their details are obvious.

Figs. 8 and 9 represent an exhaust steam outlet or head which removes the liquids from the steam before permitting it to escape to the atmosphere. The exhaust enters from below, through the pipe 98. The centrifugal bowl 99 is integral with the bottom 100. Above this rises the top casing 101, a very light structure, having the outlet 104 at its top. The top member 101 serves to clamp the centrifugal ring 102 upon the top of the bowl 99.

For this use the centrifugal ring or element 102 is made tall; and therefore affords in the aggregate of its tuyères, a very free outlet for exhaust steam, obviating back pressure in the exhaust pipe 98.

Conveniently the long or tall staves of the ring 102 are provided with bolt or rivet fastenings 103 at two points, to add to their stability. In such cases it will be unnecessary to provide other interlocking means or lugs for the staves.

The centrifugal outlet 99′ of the bowl is clearly shown. The exhaust steam, relieved of its burden of oil and all water of condensation, passes off through the large opening 104 in the top of the member 101. It will be noted that the annular abutment 105 is preserved in this case.

By employing this invention, it is possible to provide an exhaust head of the highest efficiency, of good appearance (such devices are exposed to view), and of a diameter so small as to closely approximate the mere doubled diameter of the exhaust pipe.

The smaller devices of Figs. 10 to 13 have a like close relation to the sizes of their respective inlet pipes 106 and 107 and respective outlet pipes 108 and 109. These are so called "line" separators; that is, they are merely coupled or included in the lines from which certain substances are to be removed. In Fig. 10, the centrifugal ring 110 and the bowl 111 are enclosed by a parted casing 112. The bowl is integral with the bottom member of the casing and has a single centrifugal outlet 111′. In contrast the bowl 114 belonging to the centrifugal ring 113 of Fig. 12 is a "double" bowl, having dissimilarly placed centrifugal outlets 115 and 116, and therefore automatically performing the function of separating or classifying the substances rejected from the main stream flowing through the unit. This novel feature adapts the device of Fig. 12 for employment in removing, first water, and then oils from a flowing stream of gas.

Fig. 14 is a sectional elevation of a so-called centrifugal dust collector equipped with a final dust collecting unit embodying this invention. A cap or dome 165 rises from the top of the main casing 166. In this dome the novel centrifugal unit is suspended as by its top or cover plate 168. The centrifugal bowl 169 has a tangential outlet 170 and 171 represents the now familiar tuyère ring.

The collected dust is discharged externally through an extended duct or pipe 170′. A quantity of water may be poured into the centrifugal element through an annular slot 173 in the abutment portion 174. This slot, or if desired a series of openings, is supplied from the channel 175 in the top casting 168. It receives water from the valved pipe 176. The relatively small volume of water applied in this way takes

on the whirling motion of the outgoing air or gas and completely absorbs the finest of the dust. The water is continuously discharged from the bowl 169 through the outlet 170 along with the collected dust. As compared with other wet washers used with hot gases, this present invention presents the advantage of only slightly cooling the gases. They lose little heat in passing through the comparatively tiny shower of water.

Fig. 16 represents a furnace breeching 177 with several stacks 178 rising therefrom. At the base of each stack is one of the described centrifugal units 179, which will now be fully understood upon mere inspection of the drawing. The parts 180 are the dust discharge pipes leading from the centrifugal bowls 179'. The arrangement here disclosed is of distinct value and importance.

Fig. 17 is a sectional view of a blast furnace gas duct equipped with a dust collecting apparatus embodying this invention. A dome 181 rises above an opening in the top of the large gas duct 182 and as shown contains the centrifugal unit which is characteristic of this invention. Conveniently, the top of the unit forms the top of the dome 188, as in preceding cases. The cleaned gas departs through the pipe 183 toward the stoves or furnaces in which it is to be burned. Alongside the duct 182 is a closed dust pocket 184 into which the collected dust is discharged through the outlet pipe 185. The dust, either wet or dry, settles in the trap and is drawn off into cars from time to time. As well known it is of much intrinsic worth. The excess gas (that which is discharged into the trap by the centrifugal unit) is relieved and sent back to the cleaned gas pipe 183 through the medium of a smaller centrifugal unit 186. The part 188 is a renewable dash plate which may be used to save the walls of the trap 184.

Figs. 19 and 21 show the invention in the form of a centrifugal unit that is adapted to filter an upward moving stream. That use will conveniently serve to exemplify many other uses. Preferably, the water is taken from the stream through an initial filter 245 comprising a centrifugal unit of the open type first herein described. Passing through the pump 246 the water discharges into the intake elbow 247 of the centrifugal unit, here under discussion. This elbow is the means of connection with the casing 248 of the unit, which casing contains the familiar tuyère ring 250 and centrifugal bowl 251. Those parts may be supported from the part 248 by making the bowl 251 integral therein as suggested by Fig. 20. Passing through the centrifugal elements, the clarified liquid is discharged through the top opening 252, centrally positioned within the abutment portion 253. The bowl differs from those previously shown in having a central conical part 254 from which an outlet pipe 255 extends downward, passing through a stuffing box 256 at the bottom of the part 247.

As illustrated, only the clarified water from the outlet pipe 252' is discharged into the reservoir 257. The foul waters from the centrifugal outlet 251' of the bowl and from the central outlet, are in this case returned to the source 244, as shown in Fig. 21. But in many conditions the differing products or filter savings from the pipes 255 and 251'' will be saved. In some cases just such use of the apparatus will be made its chief use, it being obvious that a true classification of the heavier substances is accomplished in the peripheral and central outlets here provided. Furthermore these pipes may contain one or more valves for controlling their outputs. The downgoing stream through the central outlet may also be varied as to quality by varying the spread of the cone 254; and again, the downflow at the center of the bowl serves effectually to destroy any vortex at the bottom of the centrifugal elements, which, if permitted, might conceivably cause the return of very fine impurities to the upgoing main stream discharging through the top outlet 252. The illustrated apparatus is therefore both a clarifier and a classifier of the finest possibilities.

Figs. 22 and 23 diagrammatically and yet fully disclose a staged or ultra-type of filter or classifier embodying this invention. The primary or fundamental device is a plural-ring-and-bowl centrifugal unit. That unit is enclosed by a sheet steel or copper shell 258, having a fluid inlet 259 at the bottom and a clarified fluid outlet 260 at the top. The novel unit comprises the top 162, having the now familiar annular abutments, 262 and 263;—the large tuyère ring, 264 and the small tuyère ring, 265;—the bottom 266, containing the ring-like outer bowl 267 and also the more familiar inner bowl, 268;—and suitable means (not shown) for binding the parts together. The outlet nipple 260, supports the device as a whole. 270 and 271 are the respective tangential outlets of the bowls. These are extended in pipes, which pass through suitable joints or stuffing boxes in the side of the shell 258.

The carrier-fluid, burdened with the substances that are to be removed therefrom, fills the casing under pressure. Passing first through the tuyères of the outer ring 264, an initial whirling action is organized, with the result that the heavier of the foreign substances are forcibly ejected through the tangential outlet 270, as before described.

The carrier-fluid, which is displaced centripetally, next enters (without material loss of pressure) the inner tuyère ring 265, wherein a second whirling action is organized. This second action is rotatively much more vigorous than the first by reason of the smaller radius, with the result that the finest or the lightest of the foreign substances are collected and discharged through the outlet 271; leaving only the unburdened or clarified fluid to escape through the main outlet 260.

The drying or cleaning of steam at the outlets of steam boilers has hitherto presented problems of such difficulty as to be solved, if at all, only by resort to extensive and expensive apparatus of relatively great size. The whole problem is here solved by the mere combination of the described centrifugal units with such steam outlets and thereby all globules of moisture and all particles of solid matter entrained in the steam of boilers may be successfully and reliably separated or removed, leaving only the rectified or purified steam to pass out through the boiler nozzles in truly dried condition. While certain details of construction may require further explanation it should now be obvious that these centrifugal units, so used as steam dryers, may have variously constructed bottoms or bowls for the ejection of the collected moisture and solids; and, that by such means such substances may be returned directly to the boiler, or, as is clearly the better practice, may be discharged to the atmosphere by suitable pipes leading through the boiler shell. And further it should be obvious that the collected substances, by means of the classifying bowls hereinbefore described (see Figs. 12, 27, 28, and 29) may be made to externally eject the solids with very little of the water, while at the same time returning the major part of the water to the boiler. This last task would seem to be difficult were it not for the facts that the externally discharged portion is expelled under boiler pressure and the centrifugal force of the whirling mass is sufficient to discharge the purified remainder of the collected liquid back into the steam space or if a down pipe be provided, directly back into the underlying boiler water.

If the boiler water were clean there would be no objection to discharging the offal of the centrifugal unit directly back into the same as next above described. But the boiler water is never clean for it contains many solids in suspension and ofttimes other injurious substances. The effect of moisture and solids that are carried over into superheaters and engines is well known, but it is not so well known, that water which is distilled at less than 150 pounds boiler pressure is not even pure when condensed because many of the soluble elements in water are not precipitated at boiler temperatures of less than 360 degrees. These figures and statements are approximate and are merely set forth as guides, for it is to be recognized that boiler feed waters from different localities vary widely in their make-up. In a practical sense it may be said that every steam boiler throws off such moisture and many entrained solids with the steam. For these reasons it is objectionable to return the water and solids collected by the centrifugal unit to the boiler without at least first clarifying the return water; for to do so, would merely add to the concentration of objectionable scale-forming matter in the boiler water. Rather should the effort be made to constantly reduce and virtually dissipate the proportion of scale-forming materials in the boiler; and presently attention will be directed to further sheets of these drawings in which that object is specifically pursued.

For the moment, attention is limited to Figs. 24, 25 and 26 in which the exhibited centrifugal unit 371 includes a now familiar centrifugal bowl 372 having a tangential outlet 373 through which the foul collected water is discharged externally, as through the medium of the pipe 374 and the automatic discharge trap 375. The latter is of well known construction and does not require explanation. Traps of both the intermittent and continuous discharge types are readily obtainable.

Fig. 24 discloses the usual manhole 376 in the end of the steam drum 377. The readily dismemberable centrifugal unit may easily be introduced and removed through the manhole. There are no complications concerned in its installation. Here again appears a marked advantage flowing from the ability to make the centrifugal rings and associated parts of so nearly the same diameter as the outlet that is served.

Plural bowls such as shown in Figs. 27, 28 and 29 are characterized by two centrifugal outlets, one above the other, with the lower one preferably nearer the axis of the bowl. The upper bowl in each case is marked 380 and the lower bowl 381. As suggested in Fig. 29, the upper bowl need be no more than a skimming groove. In operation the heavier solids thrown down by the centrifugal unit are the first to be caught in the upper bowl. Its tangential or other peripheral outlet 382 being restricted by an external trap, such as 375, prevent the escape of all of the collected water through the outlet 382. The remainder, in obviously clarified condition, is delivered to the bottom bowl 381. The clarified water may likewise be externally discharged through a trap, but as it has been cleared of objectional foreign sub-

stances at boiler temperature, it is most acceptably returned direct to the body of water in the boiler through the outlet 383 or down pipe 384.

Thus at one and the same time, by this simple appliance the outgoing steam is effectively dried and the condition of the boiler is improved by the described removal of a quantity of objectionable scale forming solids.

Having thus described my invention, I claim:

1. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising a ring containing a circumferential series of longitudinal inwardly directed and operatively overlapping slit-like tangential tuyères, in combination with an end closure presenting an annular inner surface edgewise to said tuyères and perpendicular to the axis of said ring, a second closure of a bowl-like shape providing a longitudinal extension for the other end of said ring and containing a peripheral outlet for the heavier constituents of the fluid, and, one of said closures having a central outlet, smaller than said ring, for the lighter constituents of the fluid.

2. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising a ring containing a circumferential series of longitudinal inwardly directed and operatively overlapping slit-like tangential tuyères, in combination with an end closure presenting an annular inner surface edgewise to said tuyères and perpendicular to the axis of said ring, a second closure of a bowl-like shape providing a longitudinal extension for the other end of said ring and containing a peripheral outlet for the heavier constituents of the fluid and the first mentioned closure having a central outlet, smaller than said ring, for the lighter constituents of the fluid.

3. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising a ring containing a circumferential series of longitudinal inwardly directed and operatively overlapping slit-like tangential tuyères, in combination with an end closure presenting an annular inner surface edgewise to said tuyères and perpendicular to the axis of said ring, a second closure of a bowl-like shape providing a longitudinal extension for the other end of said ring and containing a peripheral outlet for the heavier constituents of the fluid, and, each said closure having a central outlet, smaller than said ring, for the lighter constituents of the fluid.

4. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising a ring containing a circumferential series of longitudinal inwardly directed and operatively overlapping slit-like tangential tuyères, in combination with an end closure presenting an annular inner surface edgewise to said tuyères and perpendicular to the axis of said ring, a closure for the other end of said ring constructed and arranged to permit the discharge of the heavier constituents of the fluid, and, the first mentioned closure having a central outlet, smaller than said ring, for the lighter constituents of the fluid.

5. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising a ring containing a circumferential series of longitudinal inwardly directed and operatively overlapping slit-like tangential tuyères, in combination with an end closure presenting an annular inner surface edgewise to said tuyères and perpendicular to the axis of said ring, a closure for the other end of said ring constructed and arranged to permit the discharge of the heavier constituents of the fluid at the periphery of that end, and, the first mentioned closure having a central outlet, smaller than said ring, for the lighter constituents of the fluid.

6. The herein described improvement for the centrifugal purification of fluids without resort to rotating parts, comprising a circular collecting bowl having a substantially flat fluid reaction bottom provided with a peripheral outlet for the heavier substances, in combination with a purified fluid outlet coaxial with the bowl but of less diameter and above said bottom, and a circular series of operatively overlapping tangential fluid admission tuyères between said outlet and said bowl, serving to whirlingly direct the fluid into said bowl and downward against said bottom; whereby the heavier substances are collected and discharged at said bottom while the lighter fluid reacting against the bottom is whirlingly discharged upward along the axis of the bowl and outlet and outward through the latter.

7. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising, in combination, a circular bowl of greater diameter than depth and having a substantially flat fluid reaction bottom, a heavy substance outlet at the periphery of said bottom, a top member containing a purified-fluid outlet that is coaxial with but smaller than said bowl, and a circular series of overlapping tangential fluid admission tuyères between said bowl and outlet; whereby the fluid is whirled in said bowl, relieved of heavy substances at the bottom thereof and caused to react and whirl upwardly through said outlet.

8. The herein described improvement for the centrifugal treatment of fluids without resort to rotating parts, comprising a ring containing a circumferential series of longitudinal inwardly directed and operatively overlapping slit-like tangential tuyères, in combination with an end closure presenting an annular inner surface edgewise to said tuyères and perpendicular to the axis of said ring, a second closure of bowl-like shape providing a longitudinal extension for the other end of said ring and containing a peripheral outlet for the heavier constituents of the fluid, one of said closures having a central outlet, smaller than said ring, for the lighter constituents of the fluid, a larger tuyère ring surrounding and spaced from the first-mentioned ring and through which the fluid must pass to reach said first mentioned ring, and means for discharging at the bottom of the space between the two rings the heavy constituents of the fluid intercepted by the outer ring.

In testimony whereof I have hereunto set my hand this 31st day of January, 1924.

JOSEPH MARTIN SCHUTZ.