Feb. 17, 1942. W. K. BURGESS 2,273,558

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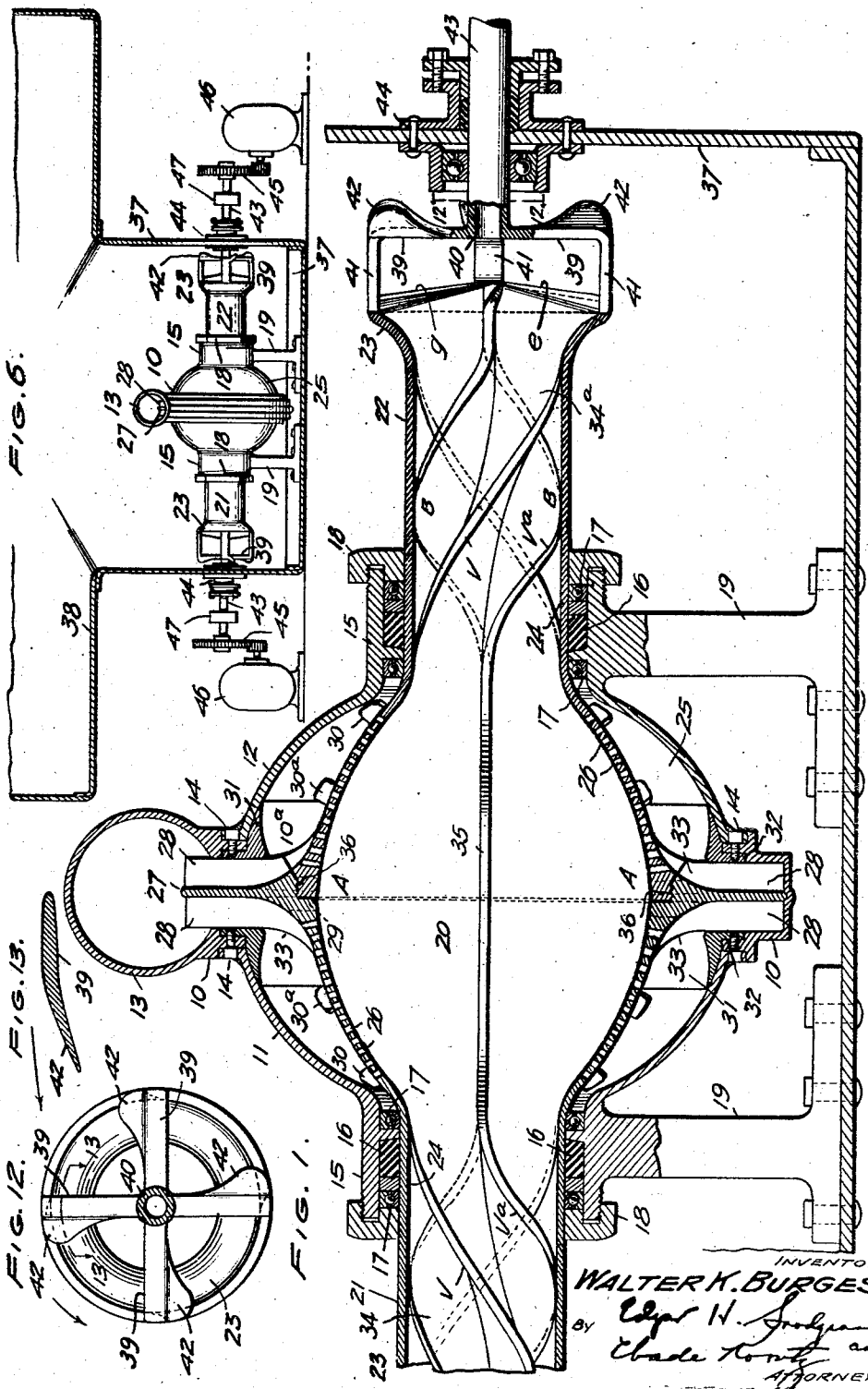


FIG. 6.

FIG. 13.

FIG. 12.

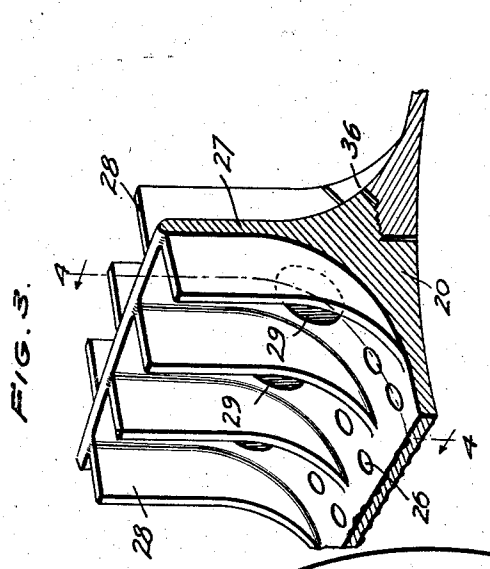
FIG. 1.

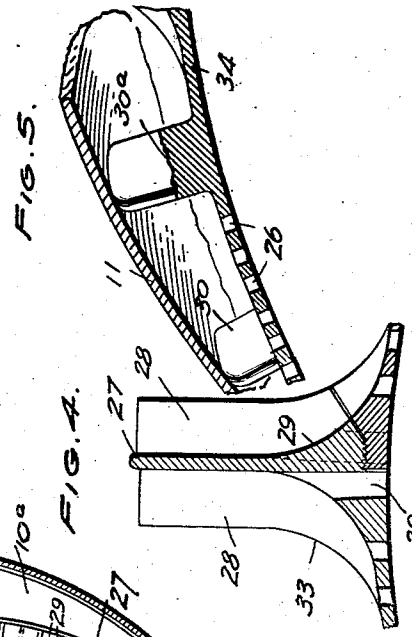
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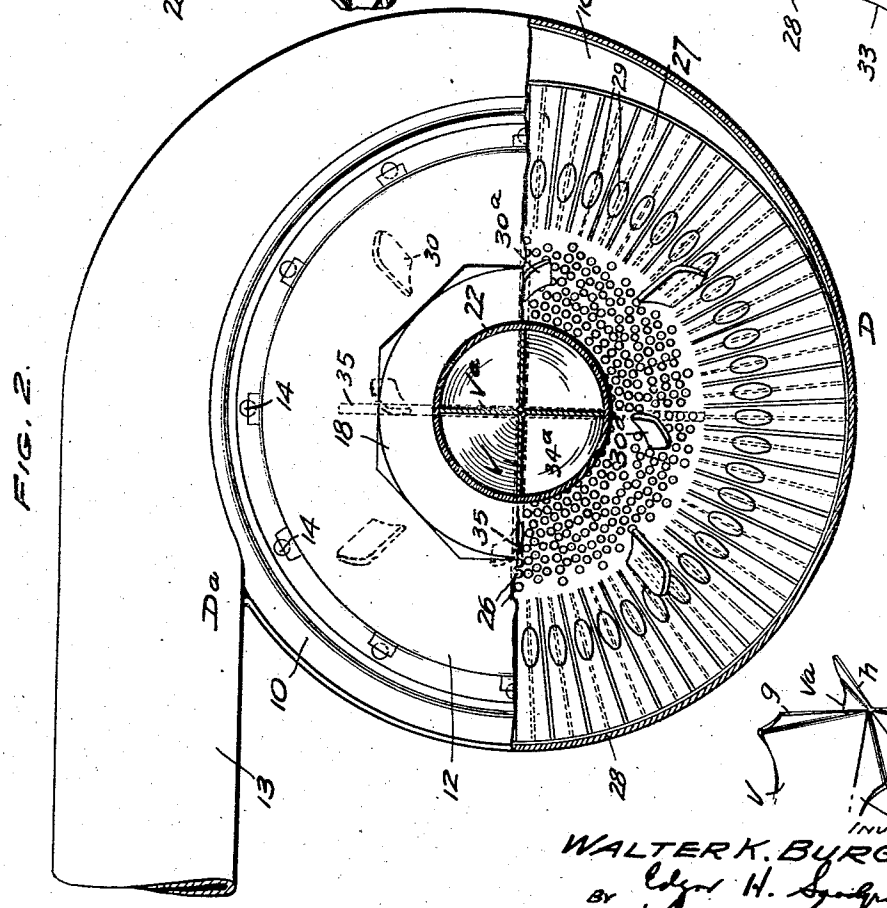
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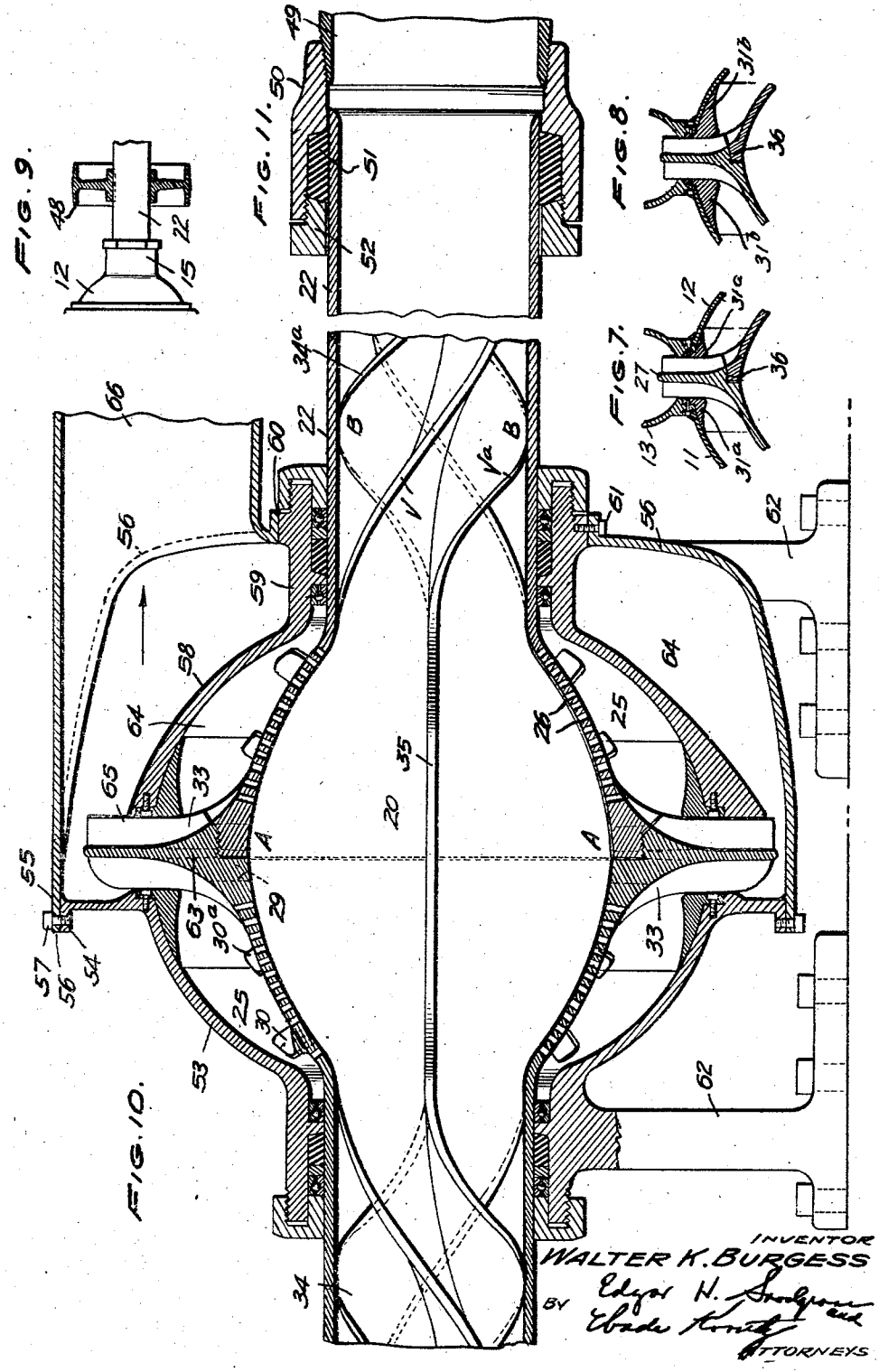


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Patented Feb. 17, 1942 2,273,558

UNITED STATES PATENT OFFICE

2,273,558

PUMP

Walter K. Burgess, Riverside, Calif.

Application October 18, 1940, Serial No. 361,745

17 Claims. (Cl. 103—88)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government for governmental purposes, without the payment to me of any royalty thereon.

This invention relates to improvements in pumps and an object of the improvements is to provide a four stage rotary screw and centrifugal pump designed for maximum volume and pressure in restricted areas, as in an airplane fuel tank, with special adaptability for use in tubes, housings, or capsule units.

Another object of the invention is to provide a multi-stage pump using but a single rotor and yet having an efficiency similar to that of a triple or quadruple stage centrifugal pump of the multiple impeller type; the rotor being designed to occupy substantially the normal space of a single impeller.

Another object of the invention is to provide a multi-stage rotary screw and centrifugal pump of limited overall dimension and large capacity with opposed intakes.

Another object is to provide, in such a pump, means of varying both the volume and the pressure within wide limits.

A further object is to provide a pump of simple, sturdy, design and requiring little or no attention through long periods of operation.

Briefly, the invention embodies two oppositely disposed screws feeding into a rotary central common chamber from which the fluid or liquid fuel is discharged by centrifugal force through apertures into an outer chamber from which it passes through the outlet port; the flow of the fuel being assisted by propeller blades on the rotary central chamber.

In the drawings—

Figure 1 is a vertical longitudinal sectional view of a pump constructed in accordance with the invention and having a tangential outlet;

Figure 2 is a side view, partly in elevation and partly in section, of the pump shown in Figure 1;

Figure 3 is a detail view, in perspective and on an enlarged scale, of a fragment of the pump rotor showing the radial buckets;

Figure 4 is a section on line 4—4 of Figure 3;

Figure 5 is a detail view of a section of the stator chamber and showing the propeller-like blades of the rotor;

Figure 6 is a view, on a reduced scale, of a section of a fuel tank with the pump stalled in the sump thereon;

Figures 7 and 8 are detail views illustrating the use of different sizes of rings for varying the pump pressure and volume;

Figure 9 is a detail view illustrating the provision of a pulley on the pump as a means for driving the latter;

Figure 10 is a longitudinal section view of the pump as modified to have a lateral instead of a tangential outlet;

Figure 11 is a detail sectional view of an intake and feed pipe connection;

Figure 12 is a section on line 12—12 of Figure 1;

Figure 13 is a section on line 13—13 of Figure 12; and

Figure 14 is a detail view, in perspective, of the terminal construction of the Archimedean screw.

The stator casing of the pump shown in Figures 1 and 2 consists of a central or peripheral channel section 10 and opposite side bellied sections 11 and 12 defining a rotor chamber which is of elliptical section in the direction of the rotor axis but of substantially circular cross section in a direction perpendicular to the axis. Section 10 is so dimensioned that the channel formed thereby increases in capacity from point D to D*a*, in a counter-clockwise direction as viewed in Figure 2. This provides a circumferential chamber 10*a* of large capacity to receive the discharge from the rotor. This chamber has its outlet through a pipe or conduit 13 tangent to the circular portion of the peripheral section 10. Hence chamber 10*a* and conduit 13 form a tangential outlet which tapers two ways to the peripheral section 10 with which they are integral. For reasons of manufacture and convenience in assembly, etc., the several sections of the casing may be separately formed flanged units detachably fastened together at their flanged extremities by cap screws or other suitable means, as shown at 14 with weld spots for the heads of the cap screws. As an alternate method, the peripheral section may be cast integral with either side section, the other side section being detachable. Each side section has a journal box 15 with suitable packing 16 and inner and outer ball races 17 to support the journals of the rotor; the box being externally screw threaded to receive the packing nut 18. The inner bearing race is lubricated by the liquid of the pump; the outer by lubricant through cup or other conventional means. Each side section is provided with a pedestal 19 for mounting the pump in a sump or another support. Obviously, other types of mounting may be used, conforming to the particular use and location of the pump.

The rotor of the pump comprises an impeller core inclosed within a covering shell which it is

sweated or otherwise secured to turn as a unit therewith. The shell is formed with a central chamber 20 which is elliptical in the direction of the axis but circular in a direction perpendicular to the axis. Tubular extensions 21 and 22 at opposite sides of the central chamber and concentric with the axis of the chamber provide inlets for the chamber and are flared at their outer open ends 23 to admit the fuel or liquid to be pumped. For reasons hereinafter explained, the diameter A—A of chamber 20 is preferably twice the diameter B—B of either inlet tube 21 or 22. Hence, chamber 20 has a capacity which is four times the capacity of one inlet or double the capacity of two inlets. The rotor shell is inclosed within the stator casing with the tubular extensions 21 and 22 extending outwardly through the journal boxes 15, as shown in Figure 1; the journal portions 24 of the extensions being immediately engaged by the packing and ball races of the journal boxes.

The central chamber 20 occupies less than the full space within the stator casing so as to provide a circular-elliptical chamber 25 surrounding the rotor chamber and in communication with the interior of the rotor chamber through a plurality of orifices 26 in the inclosing wall of the latter. The number and size of the orifices 26 preferably are so proportioned that the sum total orifice area presented thereby is greater than the capacity of the pipes or tubes 21 and 22. Chamber 25 is divided into two concentric compartments of Venturi-like cross section by concentric impeller on the rotor. In the disclosed embodiment of the invention, this is shown as comprising a centrally located outstanding concentric flange or ridge 27 on the periphery of the rotor chamber 20. The ridge is fluted, grooved, or otherwise provided, on opposite sides to provide three-sided radial buckets 28, open on their outsides, as shown to advantage in Figures 2 and 3. These buckets extend into the peripheral section 10 of the stator casing and serve to pick up the liquid from the compartments of the stator chamber 25. Each bucket is in direct communication with the interior of the rotor chamber 20 through a bottom opening 29. For reasons of stress and vibration, the radial buckets are staggeredly arranged along their central division.

The flow of liquid from the compartments of the stator chamber 25 into the buckets 28 is accelerated by small propeller-like blades on and perpendicular to the outer surface of the rotor chamber 20. Two groups of such blades are provided in each compartment, each group preferably consisting of four equi-spaced blades; the blades of one group being staggered with respect to the blades of the other group. The outermost group of blades 30 is set low on the outer circular periphery of the elliptical rotor shell and the innermost group of blades 30*a* is set high, as seen in Figures 1 and 5. On each side of the ridge 27 is a dural ring 31 of the cross-sectional design shown and concentric with the rotor axis. These rings bridge the open sides of the buckets 28 and fit closely against the inner top surfaces of the side sections 11 and 12 of the stator casing adjacent their connections with the peripheral section 10. Each ring has an integrally formed annular attaching flange 32 extending into the peripheral section to be engaged by the fastening members 14. These rings are designed to reduce the cross sectional areas of the passages through which liquid flows into the buckets 28 from the compartments of the stator chamber 25, and provide, in effect, an annular series of Venturi-like apertures or passages 33 on opposite sides of and adjacent the base or root of the concentric impeller 27. Differently sized and interchangeable sets or pairs of such rings are provided for selective use whereby the pressure and volume of the pump may be carried within the limits. Figures 7 and 8 illustrate, on a reduced scale, the use of differently sized rings, the rings 31*a* of Figure 7 proportionately being of smaller size than the rings 31 of Figure 1 while the rings 31*b* of Figure 8 are proportionately larger.

The impeller core of the rotor comprises a number of centrifugal impeller blades or vanes arranged within and dividing the rotor chamber 20 radially along its axis into compartments, and a feed screw or helical conveyor within and coextensive in length with each tubular extension or inlet. The screws are oppositely pitched to feed into the compartments of the chamber 20 during the pumping action of the rotor. In the construction illustrated, the impeller core consists of two Archimedean double spirals or co-axial screws 34 and 34*a* right and left hand pitch, respectively, each screw providing four separate paths or channels for the liquid flow. These screws are spaced apart at their inner opposing terminals by a four-bladed centrifugal impeller 35. The centrifugal impeller may be formed as an integral part of the double spirals 34 and 34*a* by enlarging and straightening the double spiral vanes V and V*a* of the impeller core so as to cause them to bisect each other at right angles along the axis of the screws. Hence, the central rotor chamber 20 is divided into four equal quadrants, and each tubular extension 21 and 22 is divided into four spiral liquid conduits as shown in Figure 2. Each quadrant receives the discharge from one of the conduits of the left hand screw and also from the corresponding spiral conduit of the right hand screw. Obviously, the impeller core may be constructed to provide any other desired number of central chamber compartments and spiral conduits. These compartments prevent any slippage of fluid on the inner periphery of the chamber during rotation of the rotor whereby the motion of the fluid discharged thereinto from the Archimedean spirals is effectively changed from a helical path to one of rotation in a plane at right angles to that of the axis of rotation. At the outwardly flared ends 23 of the tubular extensions the vanes V and V*a* of the impeller screws extend in planes bisecting each other at right angles along the axis of the screw, as shown in Figure 14. These straight or flattened sections of the vanes are provided at their outer edges with blades or deflectors *e*, *f*, *g* and *h*, angularly inclined and pitched in the manner illustrated to impel the liquid into the flared ends of the tubes during the rotation of the latter. By the action of centrifugal force, the fluid is forced outwardly from each compartment through the multiple orifices in the surface of chamber 20. For reasons of manufacture, the impeller core is in two parts, threadably joined at 36.

Various methods and means, suitable to a particular location and mounting of the pump, may be used to transmit power to the pump for turning the rotor. In Figures 1 and 2, the pump is shown mounted in the sump 37 of a fuel tank 38. Each inlet 21 and 22 of the rotor is disposed wholly within the sump and has a driving spider

operatively associated therewith. This spider, as shown in Figures 1 and 12, preferably consists of four equidistant members or arms 39 radiating in a common plane from a hub 40 and having right angle extensions 41. These extensions are welded or otherwise secured to the flared end 23 of inlet and are of a length to space the hub and arms of the spider outwardly from the inlet to minimize interference with the flow of liquid to the inlet. Each arm of the spider is beveled in cross section to function as an impeller for casting the liquid inward, that is, toward the inlet, and in addition is provided on its leading edge with a feathered scooping lip or vane 42. A hollow shaft 43 is rotatably supported in a packed bearing 44 in a side wall of the sump with its inner end secured to the hub of the spider and its outer end connected by gearing 45 with the drive shaft of a motor 46. Suitable clutches 47 are included in the power transmission for securing or breaking rotative continuity between the rotor and the driving devices. One driving device is sufficient to operate the pump but two may be provided so that if one device fails, the other may be set in operation. In the event that a belt or pulley drive is desired, either or both extensions of the rotor may be provided with a pulley 48 as illustrated in Figure 9.

A means of connecting the outer ends of the rotating intakes 21 and 22 of the rotor to stationary supply or feed pipes is shown in Figure 11, wherein adjacent ends of an intake and a feed pipe are indicated at 22 and 49, respectively. A stuffing gland 50 is threadedly engaged with the pipe end 49 and provides a bearing for the rotating intake 22 over and around which it extends as illustrated. The gland is provided with the packing 51 and a packing nut 52.

For mounting in a tube or capsule, where the maximum capacity within a minimum overall diameter is desired, a casing exit variation type of pump is provided, as illustrated in Figure 10. In this type, one side section 53 of the stator casing is provided with a flanged extension 54 to which the larger flanged end 55 of the peripheral section 56 is connected by suitable means 57. The peripheral section extends completely around and incloses the other side section 58 of the stator casing; the journal box 59 of said section 58 having a snug fit in the flanged orifice 60 at the smaller end of the peripheral section. The stator casing side section 58 is thus supported by the peripheral section to which it is connected as shown at 61. One unit of the pump mounting, such as the pedestal 62, is provided on the stator casing side section 53; the other unit is integral with the peripheral section 56. Between its connections with the stator casing side sections, the peripheral section is spaced outwardly from the concentric impeller 63 and from the rotor casing side section 58 to provide a large capacity outlet chamber 64 to receive the discharge from the impeller buckets 65. Chamber 64 has its outlet through a pipe or conduit 66 extending laterally of the chamber in the axial direction of the rotor. The conduit 66 is formed as an integral part of the peripheral section 56 and, together with the chamber 64 is located almost wholly within the circumferential dimensions of the concentric impeller 63. In other words, as compared with the tangential exit type of pump illustrated in Figures 1 and 2, the lateral exit type of pump shown in Figure 10 is of smaller total overall diameter. Aside from the specific distinguishing features already pointed out and described, the pump shown in Figure 10 is structurally similar to the pump shown in Figure 1 and both types of pump function in like manner.

In the operation of the pump, the fluid is impelled into the flared inlet ends of the tubular extensions of the rotor by the action of the casting impellers 38 and the deflectors *e*, *f*, *g* and *h* at the respective inlets of the extensions. The liquid is then acted upon by the screws 34 and 34*a* and forcibly fed into the separate compartments of the rotor central chamber 20. This is the first stage of the pumping operation. The separated bodies of fluid in the compartments are acted upon by centrifugal force in proportion to the increase of the central chamber diameter A—A over the inlet diameter B—B and fly quickly to the circular periphery of the chamber 20 and exit through its perforated colander-like surface. This is the second stage. The diameter A—A provides for more than twice the capacity provided by the diameter B—B. Therefore, there is created in the central chamber 20 in proportion to the centrifugal force a partial vacuum which tends to accelerate the feed of the fluid from the inlet and increase the efficiency of the first stage. The fluid exiting from the revolving chamber 20 enters the outer stationary chamber 25 and passes through the Venturi passages 33. In this, the third stage, the propeller blades 30—30*a* on the periphery of the rotor asset in evacuating chamber 25 by forcing the fluid from both sides towards the central outlets 33. In the fourth and last stage, the fluid passing through the Venturi-like passage 33 is picked up by the buckets of the concentric impeller and discharged in large volume at maximum force into the outlet chamber of the stator casing peripheral section. Fluid also passes directly from the rotor chamber 20 to each bucket of the concentric impeller through the opening in the root or bottom of the bucket. From the outlet chamber, the fluid passes under pressure through the pump outlet for conveyance in any suitable manner to the point or points of delivery.

It is understood that although the pump structures herein described and illustrated embody certain specific designs, the ideas and principles disclosed are by no means limited to these same, but are applicable to and may be used with any number of other suitable designs and variations as conditions may indicate.

Having thus disclosed the invention, what is claimed as new and patentable is:

1. A multi-stage fluid pump having, in combination, a feed screw, a centrifugal impeller having a center intake at the fluid-exit end of the screw, a chamber enclosing the centrifugal impeller for receiving the fluid-discharge of the centrifugal impeller and having an annular Venturi-like fluid exit passage, an evacuating propeller in the chamber for boosting the fluid flow toward the Venturi-like fluid exit passage of the chamber, an annular outlet chamber in communication with the Venturi-like fluid exit passage of the chamber, and a centrifugal impeller operatively associated with the first-mentioned centrifugal impeller to be rotated therewith and disposed between the fluid receiving chamber and the outlet chamber to receive the discharge from the fluid receiving chamber and to deliver it to the outlet chamber.

2. A multi-stage fluid pump having, in combination, a feed screw, a centrifugal impeller hav-

ing a center intake at the fluid-exit end of the screw, a fluid receiving chamber operatively associated with the centrifugal impeller for receiving the fluid discharged therefrom and having an annular Venturi-like outlet orifice, an outlet chamber extending circumferentially of the fluid receiving chamber and in communication with the outlet orifice of the fluid receiving chamber, an evacuating propeller in the fluid receiving chamber for boosting the fluid flow toward the outlet of the said chamber, and a centrifugal impeller having circumferential buckets operatively associated with the said chambers to receive the discharge from the fluid receiving chamber outlet and to deliver it to the outlet chamber.

3. In a pump, a power-driven rotary tube having an enlarged bulbous middle portion provided with multiple orifices in its periphery, spiral conduits in the ends of the tube and discharging into the bulbous portion, radial vanes in said bulbous portion forming compartments having outlet through the said multiple orifices, a centrifugal impeller on the periphery of the bulbous portion of the tube and including an annular series of buckets extending radially outward in a common plane perpendicular to the axis of the tube and substantially equidistant from the ends of the tube, each of said buckets being open at its side and outer end, a stationary chamber inclosing the said bulbous portion of the tube and being of reduced cross sectional area at the open sides of the buckets to provide an annular Venturi orifice on each side of the impeller, propellers on said bulbous portion and operating in the stationary chamber to assist in the evacuation thereof, and an outlet chamber in communication with the outer ends of the impeller buckets.

4. A multi-stage fluid pump having, in combination, a rotating tube having an elliptical bulbous section, said section having multiple orifices in the periphery, a spiral inclosed in an open end of the tube and connected with the latter to rotate therewith for delivering fluid into said section, means in said section for changing the fluid motion from a helical path to one of rotation in a plane at right angles to the axis of rotation whereby the fluid is expelled centrifugally through the peripheral orifices, a stationary annular chamber concentrically about the bulbous section for receiving the fluid expelled from the said section, said chamber having a concentric annular Venturi-like outlet opening, a circular group of fluid impelling members within the stationary chamber and integral with the periphery of the bulbous section to rotate therewith about the axis of the chamber to force the fluid in the chamber toward the outlet opening, a centrifugal impeller concentric with and connected to said rotating tube to turn therewith and having radially disposed buckets bridging the said Venturi outlet opening to receive its fluid discharged therethrough and a peripheral outlet chamber in communication with the outlets of the buckets.

5. A multi-stage pump having, in combination, first stage means including an induction screw, second stage means including a centrifugal impeller at the eduction end of the screw and of larger diameter than the screw, third stage means including a stationary Venturi chamber of double Venturi-like cross section concentric with and embracing the second stage centrifugal impeller and evacuating propellers within the chamber concentric with and operatively connected with the said centrifugal impeller to turn therewith, and fourth stage means including a centrifugal impeller of larger diameter than the second stage centrifugal impeller and having a ring of radial discharge buckets at the eduction throat of the Venturi chamber to receive the output of the said chamber.

6. A multi-stage pump having, in combination, first stage means including a rotary power driven eduction screw, second stage means including a centrifugal impeller operatively connected with the screw at the eduction end of the latter to turn therewith and being of larger diameter than the screw to boost the output thereof, third stage means including a stationary Venturi chamber of double Venturi-like cross section concentric with and embracing the centrifugal impeller and evacuating propellers within the chamber and operatively connected with the centrifugal impeller to turn therewith, and fourth stage means including a centrifugal impeller of larger diameter than the second stage centrifugal impeller and having a ring of radial discharge buckets at the eduction throat of the Venturi chamber to receive the output of said chamber, said fourth stage centrifugal impeller being operatively connected with the second stage centrifugal impeller to rotate therewith.

7. A pump having, in combination, a rotary power-driven vane assembly having a colander-like inclosing wall provided with a center inlet opening, a screw operatively associated with the said assembly to rotate therewith for delivering fluid thereto through the said inlet opening, a stationary chamber around said assembly for receiving the fluid discharged through the multiple orifices in the said colander-like wall, said chamber having a Venturi outlet, and multiple propellers in said stationary chamber and operatively connected with the vane assembly to rotate therewith for propelling the fluid of the stationary chamber toward and through the said Venturi outlet.

8. A pump having, in combination, a central elliptical rotatable chamber provided with a center inlet and a colander-like discharge surface, said chamber having radial compartments, a screw at the said inlet and operatively associated with the said chamber to rotate therewith for delivering fluid to the chamber, a stationary Venturi chamber around and concentric with said rotatable chamber for receiving the fluid discharged through the multiple orifices in the said colander-like discharge surface of the rotatable chamber, said Venturi chamber being of double-Venturi-like cross section with its annular throat portion opening radially outward in a central plane perpendicular to the axes of the chambers, impeller buckets on the periphery of the rotatable chamber and extending through the throat portion of the Venturi chamber, said buckets being open at their outer sides and ends, and a volute-shaped outlet chamber inclosing the outer ends of the impeller buckets.

9. A fluid pump having, in combination, a power-driven rotary elliptical chamber having co-axial fluid inlet tubes at opposite sides and multiple fluid outlet orifices in its inclosing peripheral wall, the maximum diameter of the chamber being substantially twice the diameter of either inlet tube and the number and sizes of the multiple orifices being such that the sum total orifice area thereof is greater than the orifice area of the inlet tubes, a fluid feed screw-

mounted in each tube to turn therewith and pitched to discharge into the elliptical chamber, radial vanes in said chamber for changing the fluid motion from a helical path to one of rotation in a plane at right angles to the axis of rotation whereby the fluid is expelled from the chamber through the multiple orifices by a direct centrifugal force equal to the radius of the chamber at any point plus the speed of rotation and supplemented by the combined force of the screws and a partial minus pressure within the chamber, a ring of impeller bucket on the periphery of the chamber and in a common central plane at right angles to the axis of rotation of the chamber, an outer stationary elliptical chamber surrounding the rotary elliptical chamber at opposite sides of the impeller buckets and having concentric Venturi-like orifices on each side of the impeller buckets, and an outlet chamber inclosing the buckets at the discharge outlets thereof.

10. A pump having, in combination, a centrifugal impeller having a central fluid intake and a radial fluid outlet, a fluid-receiving chamber extending circumferentially of the said impeller for receiving the fluid discharge from the latter, said chamber having a Venturi-like annular fluid exit passage leading radially and centrally outward of the chamber, an annular outlet chamber extending circumferentially of the fluid-receiving chamber and covering the said fluid exit passage of the latter chamber, a centrifugal impeller operatively associated with the said chambers to pick up the fluid at the outlet of the fluid-receiving chamber and to deliver it under centrifugal force to the outlet chamber, and booster impeller in the fluid-receiving chamber for boosting the fluid flow toward and through the Venturi-like fluid exit passage of the said chamber.

11. A pump having, in combination, a rotary centrifugal impeller having a center intake opening and radial discharge openings, a fluid-receiving chamber having its inlet open to the said impeller for receiving the radial discharge from the latter, and having a Venturi-like outlet, an outlet chamber contiguous to and in communication with the Venturi-like outlet of the chamber, and a booster impeller within the fluid-receiving chamber and operatively connected with the centrifugal impeller to be rotated therewith for boosting the fluid flow toward and through the Venturi-like outlet.

12. A pump having, in combination, a power-driven rotor having a fluid-receiving chamber of elliptical bulbous section provided with a fluid inlet aperture in the side and multiple fluid outlet apertures in its periphery, fluid impelling means within and rotating with the chamber for forcing the fluid through the multiple outlet apertures, a stationary fluid-receiving chamber enveloping the said rotor to receive the fluid from the said outlet apertures of the rotor chamber and having a circular fluid-exit passage opening circumferentially and centrally outward thereof, a peripheral outlet chamber contiguous to and in communication with the said fluid-exit passage of the stationary chamber, a centrifugal impeller on the external periphery of the bulbous-like chamber and extending into the fluid-exit passage of the stationary chamber to divide the said chamber into separate axially aligned compartments, and means within each compartment and reducing the cross sectional area of the compartment at the inlet to the said centrifugal impeller to provide a Venturi-like passage through which the fluid of the compartment passes to the said impeller.

13. A pump having, in combination, a rotary centrifugal impeller, a stationary chamber about the periphery of the impeller and having separate non-communicating compartments for receiving the centrifugal discharge from the impeller, said chamber having a central circumferentially extending outlet orifice common to and opening radially outward of the said compartments, means within the chamber and reducing the cross sectional area of the chamber at each side of the outlet orifice to provide in each compartment a Venturi-like passage connecting the compartment of the chamber with the outlet orifice, and a peripheral outlet chamber in communication with the said orifice.

14. A pump having, in combination, a rotary centrifugal impeller, a stationary chamber about the periphery of the impeller for receiving the centrifugal discharge from the impeller and having a central circumferentially extending outlet concentric with and facing radially outward of the impeller, means integral with said impeller and extending into the said chamber and its outlet to partition the chamber into oppositely disposed compartments having separate fluid-outlet passages, said partition means including radially disposed buckets operatively associated with the said fluid-outlet passages to receive the fluid passing therethrough, removable annular members within the chamber and concentric with the partition means, said members collectively being of a configuration producing a reduction in the cross sectional area of the chamber and being relatively arranged adjacent opposite sides of the partition means to provide Venturi-like passages through which the fluid of the compartments passes into the buckets of the partition means, and a peripheral outlet chamber in communication with the said buckets to receive the fluid discharged therefrom.

15. A pump comprising a power-driven hollow rotor of elliptical bulbous contour having oppositely disposed axial inlet openings and multiple outlet apertures in its periphery, induction spirals discharging into said inlet openings, radial compartments in said hollow rotor for receiving the discharge from the said spirals and expelling same through the outlet apertures, a stationary chamber surrounding the rotor and having a peripheral passage concentric with and opening radially and circumferentially outward of and in the equatorial plane of the rotor, impeller means integral with said rotor and including oppositely disposed radial buckets on the periphery of the rotor and extending through the peripheral outlet passage of the stationary chamber, said buckets being open to the chamber on their outer sides and tips and to the interior of the rotor through bottom apertures, said chamber being of reduced cross sectional area in the vicinity of the peripheral outlet to provide on each side of the buckets an annular Venturi-like orifice through which discharge is effective from the chamber into the buckets.

16. A fluid pump having, in combination, a rotatable tube having an inlet and an outlet, a screw mounted in said tube to be rotated therewith, impeller elements on the end of the screw adjacent the inlet of the tube to impel fluid toward the screw, and impeller elements secured to the inlet tube in outwardly spaced relation to the impeller elements of the screw for casting fluid toward the screw impeller elements.

17. A fluid pump having, in combination, a rotatable tube having an inlet and an outlet, a plurality of co-axial screws mounted in said tube to be rotated therewith, said screws terminating adjacent the inlet of the tube in straight vanes extending in planes bisecting each other along the axis of the screws, and blade elements provided at the outer edges of the said vanes and angularly inclined to impel fluid into the inlet of the tube.

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