No. 872,361. PATENTED DEC. 3, 1907.

F. MARBURG, Jr.

SCREW PROPELLER PUMP.

APPLICATION FILED AUG. 4, 1903.

3 SHEETS—SHEET 1.

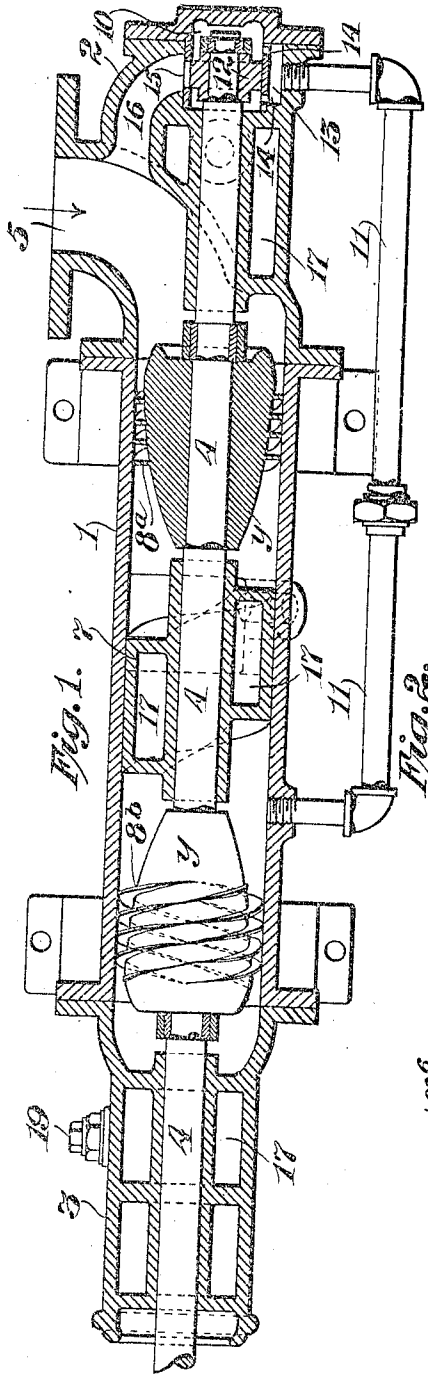


Fig. 1.

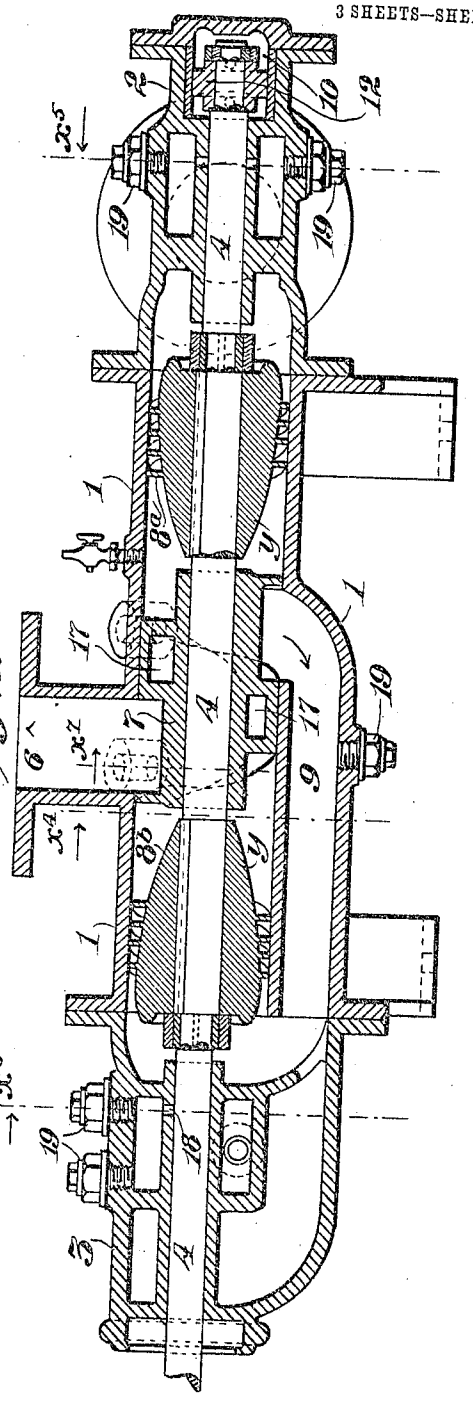


Fig. 2.

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3 SHEETS—SHEET 2.

Fig. 3.

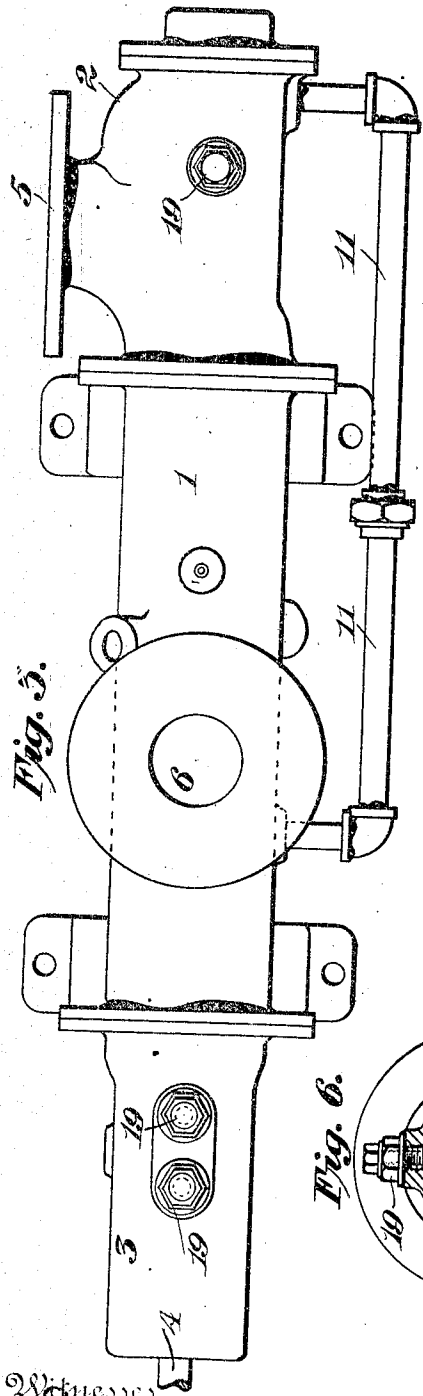


Fig. 4.

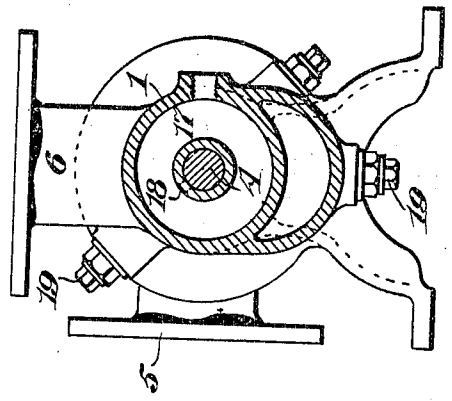


Fig. 5.

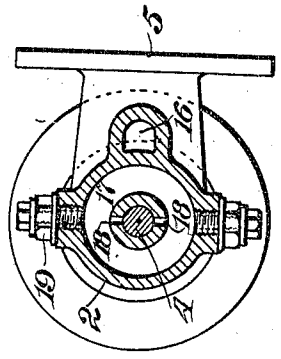


Fig. 6.

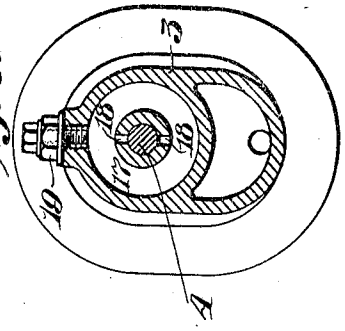
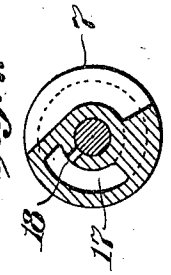


Fig. 7.



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PATENTED DEC. 3, 1907.

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SCREW PROPELLER PUMP.

APPLICATION FILED AUG. 4, 1903.

3 SHEETS—SHEET 3.

Fig. 10.

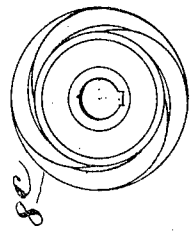


Fig. 9.

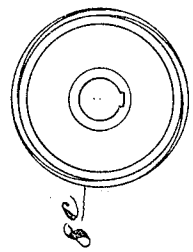
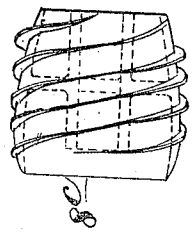


Fig. 8.



Witnesses
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UNITED STATES PATENT OFFICE.

FRANZ MARBURG, JR., OF NEW YORK, N. Y.

SCREW-PROPELLER PUMP.

No. 872,361. Specification of Letters Patent. Patented Dec. 3, 1907.

Application filed August 4, 1903. Serial No. 168,159.

To all whom it may concern:

Be it known that I, FRANZ MARBURG, Jr., residing in the borough of Brooklyn, in the county of Kings and city and State of New York, have invented certain new and useful Improvements in Screw-Propeller Pumps, of which the following is a specification.

This invention relates to the class of pumps wherein the fluid, liquid or aeriform, passing through the same, is acted upon by the spiral blades of a rotatable screw or screws on a shaft extending through the casing; and the object of the invention is, in part, to improve the efficiency of the device and also to produce higher pressure than has heretofore been obtained, so far as known in this class of pumps, by the construction of the screw or screws, as will be hereinafter explained; and in part to improve the means employed for balancing the end-thrust on the shaft.

In the accompanying drawings: Figures 1 and 2 are axial longitudinal sections of a pump embodying the invention, the former being a horizontal and the latter a vertical section. Fig. 3 is a plan of the same. Figs. 4, 5 and 6 are transverse sections taken respectively at lines x^4, x^5, and x^6 in Fig. 2. Fig. 7 is a transverse section of the diaphragm-director, detached, the plane of the section being at line x^7 in Fig. 2. Figs. 8, 9 and 10 illustrate a slightly modified form of the screw-wheel; the first figure being a side elevation and the last two end views.

In the said drawings, 1 is the main casing or body of the pump, 2 the receiving head, and 3 the opposite head of said casing.

4 is the shaft, which has rotative bearings in the heads.

5 is the inlet for the fluid and 6, the outlet.

In the center of the casing is a fixed diaphragm-director 7, which will be more particularly described hereinafter. The fluid enters the casing at the inlet 5; is driven toward the center of the casing by a screw 8^a on the shaft; impinges on the director 7 and passes through a by-pass 9 to the opposite end of the casing; is taken by another screw 8^b, on the shaft, and driven again toward the center; impinges on the opposite face of the director 7, and passes off thence at the outlet 6. The diaphragm-director 7 is so-called as it is so fixed in the casing 1 as to cut off direct communication between the inlet and outlet, compelling the fluid to pass from the inner end of the screw 8^a to the outer end of the screw 8^b through the by-pass, and its ends or faces are spirally formed, the spiral being opposite to that of the blades of the adjacent screw. As the pressures exerted by the two screws are opposed and act in an axial direction, they theoretically do not produce end-thrust on the shaft; but in practice this result is not wholly accomplished, and to balance the pressure more accurately the device now to be described is employed.

In the head at one end of the casing is formed a cylindrical piston chamber 10, by means of an inserted tube of metal which is concentric with the shaft 4. On the latter is fixed a piston 12 which plays in the chamber. Fluid from the pump-chamber, and under pressure, arrives through a pipe 11 and is admitted to a lateral chamber 13 adjacent to the cylindrical chamber 10, and enters the piston chamber through two ports 14, 14, (Fig. 1) in the tube at the respective ends of the piston-chamber and always open. Opposite to the inlet-ports 14 is an exhaust-port 15; the length of this outlet or exhaust-port is equal to the length of the piston, and it opens into a passage 16 connecting with the pump-inlet. Normally the piston closes this exhaust-port 15, and occupies a position between the inlet-ports 14, so that the pressure on both ends of the piston is equal. If the piston is shifted in either direction, it opens the exhaust-port on the opposite side and thus relieves the pressure on that side of the piston whereby the latter is shifted back again. The movement of the piston—and consequently the endwise movement of the shaft—is of course very slight, and practically the shaft is held by this device against endwise movement.

The screws 8^a and 8^b will be preferably alike, except as to the spiral blades on one having an obliquity opposite to those on the other. It may be preferable that the casing should be internally cylindrical, the outer contour of the screw-wheel being in this case correspondingly cylindrical, which will allow of some endwise play of the screws and of the shaft, which is desirable if the particular balancing arrangement shown herein is to be used in combination with the screw-wheels. As shown herein the casing is cylindrical interiorly, the outer contour of the main portion of the blades being cylindrical; but the core or body of the screw is tapered toward its inner or delivery end, and a portion y of this inner end is naked. Thus as the fluid

flows from the outer to the inner end of the screw it finds more space to fill and moves with less speed in an axial direction. As the speed of the fluid decreases, the speed in an axial direction of the screw blades remaining the same, it will be obvious that the difference of speed between the two will increase and consequently, under known rules, the pressure of the fluid will increase. Thus the fluid enters the screw without a sudden change of pressure and the pressure gradually increases within the screw and is greatest at the screw-outlet.

Pumps of this type have a large amount of unavoidable slip of the fluid under considerable pressure. By underslip is herein understood the relative backflow of the fluid within the screw and in the direction of the spiral blades, in other words, slip is the difference of the theoretical and actual capacity of the screw. In consequence of the slip, the actual capacity of the pump is reduced very much, but the slip within certain limits does not constitute a positive loss in the efficiency of the pump, but affects only the actual capacity of the pump, provided the slip occurs gradually and without shocks and eddy-currents. To accomplish this latter result, is the object of this invention.

From experiments, applicant has found, that in ordinary screw pumps, the fluid under a considerable head moves only at from one-half to one-quarter the axial velocity of the blades, and as a result there is a heavy blow or shock while the fluid is entering the screw, and consequently sudden great peripheral velocity and great whirling of the fluid follows. It is obvious, that after the fluid has attained a high peripheral velocity, the screw blades can exert little or no further pressure on the fluid in a forward direction, and the latter will be simply carried around with the screw peripherally with little or no forward pressure or motion. To prevent this, and to prevent whirling as much as possible, the capacity of the screw herein is made to increase gradually from the screw-inlet toward the screw-outlet; thus the fluid is drawn in at the screw-inlet with an axial velocity equal, or nearly equal, to the axial velocity of the spiral blades at the screw-inlet. The fluid therefor enters the screw without slip, the actual capacity of the present screw being equal to the theoretical capacity of the screw at its inlet end, but being—on account of the slip—less than the theoretical capacity of the screw at its outlet end. The proportion of the theoretical screw-inlet and screw-outlet capacity should increase with the discharge pressure against which the pump operates, and said proportion of the screw-inlet to the screw-outlet should increase with the unavoidable slip. Applicant has found that for different pressures the screw should at the screw outlet have from 2 to 4 times the screw inlet capacity. It is clear that in this manner shocks are greatly reduced at the screw-inlet. By continuing the increase of capacity gradually to the screw-outlet both the unavoidable slip and the fluid pressure increases gradually, thereby the whirling within the screw is kept at a minimum, and a consequent higher efficiency and a higher fluid pressure is attained. In a pump where the screw-outlet capacity is less than the screw-inlet capacity, a former constructor has employed a screw with increased capacity at the middle portion; this is not the construction herein claimed. In the present construction the capacity of the fluid-outlet is greater than that of the fluid-inlet, and this is deemed essential to the proper operation of the pump.

The annular chamber of gradually increasing capacity formed about the naked portion *y* of the screw-body, between the point where the blades of the screw terminate and the fixed director, gradually reduces the unavoidably high peripheral velocity of the fluid after leaving the screw. Thus by a gradual reduction of the velocity of the fluid, the pressure of the fluid will be increased and power thereby saved. The director, formed on the face of the diaphragm 7, is a spiral face having an obliquity opposite to that of the blades of the adjacent screw, and it serves to further reduce the circumferential velocity of the fluid and to gradually deflect it toward the outlet of the pump.

Instead of the means shown herein for gradually decreasing the velocity of the fluid adjacent to the screw outlet, a fixed director of the same construction as the one shown in my co-pending U. S. application Ser. No. 163,560 filed June 29, 1903, can be used. In that case a screw of a similar shape as the one shown in Figs. 8, 9 and 10 can be employed.

The spiral blades of the screw, as shown in the principal drawings, and more clearly in Figs. 8, 9 and 10, gradually increase to their full radial width from the ends of the screw toward its main middle portion. The object of this is to further reduce the shock and whirling of the fluid. The expression "main middle portion" or "main portion" of the screw, or of the screw-blade, as used herein, is to signify that part or portion of the screw, or of the blade, which at its outer contour, is in close proximity to the cylinder wall. In this construction, the main portion or the main middle portion of the screw has blades, which increase gradually and throughout in full radial width, in the direction toward the discharge end of the screw. Thus by increasing the full radial width of the blade, the capacity of the screw is made to increase in the direction from the screw-inlet toward the screw-outlet. Wherever the expression "full radial width" of the screw blade is used

it is to signify the radial width of the blade at the main portion or at the main middle portion only, of the screw.

For purposes of lubrication of the shaft-bearings, oil-chambers 17 are formed in the heads of the casing about the shaft and also in the diaphragm 7; and oil-holes 18 are provided to allow the oil in the chambers to reach the shaft. Oil is admitted to the chambers through suitable holes closed by screw-plugs 19. An oiling arrangement, as for example, the one shown in my pending patent application Ser. No. 163,560, filed June 29, 1903, if desired, may be applied to the present pump.

The receiving ends of the screw-bodies, which are also naked for a short distance, are also tapered, as clearly shown in the principal views, thus providing an easy approach of the fluid to the annular inlet of the screw.

Figs. 8, 9 and 10 show a somewhat larger rate of increase of the full radial width of the spiral blades from the screw-inlet toward the screw-outlet. The naked end of the screw wheel or body is omitted at the outlet end in this construction. The screw blades preferably commence, in a screw-wheel of cylindrical outer contour, at the point of the greatest diameter of the screw body and extend toward a point of the body of less diameter. Figs. 8, 9 and 10 also show more clearly than the principal figures the gradual increase of the radial width of the screw blades, until they attain their full radial width, that is, the gradual increase of the blades to their full radial width, from each end toward the main portion or main middle portion of the screw. The drawings show four substantially spiral blades on each screw, but this invention is not limited in this respect and it is evident that one or more blades can be used. For greater screw-diameters and for high fluid pressure, a plurality of screw-blades is preferable.

The pressure or head against which the pump herein described can operate, is proportional to the square of the peripheral velocity of the screw-blades or any portions thereof. It follows, that the inner portion or section of the blades, that is the portions nearest to the pump-axis, must travel at a sufficient velocity to maintain the required pressure. However in that case the outer portions of the blades travel at a greater velocity than necessary to maintain the required pressure, whereby losses of energy of a different nature are caused. Through careful experiments which applicant has made he has found that the energy consumed in operating this pump, is about proportional to the cube of the peripheral velocity of the screw-blades, or any portions thereof. It follows, that if the radial width of said blades is too large, in proportion to the screw-diameter, the pump is very inefficient, either through back flow at the inner portion of the screw-blades, or through great waste of energy at the outer portions of the screw-blades. It has been found by me in pumps as embodied in this invention, that the radial width of the screw-blades should be less than one-sixth part of the corresponding diameter of the outer contour of the propeller-blade, to give good results. Whenever the expression "corresponding diameter of the outer contour of the screw" is used, it signifies the diameter of the outer contour of the screw axis at the point at which the radial width of the blade is taken. It is clear that the diameter of the outer contour might vary considerably at different points of the screw, or at different vertical planes through the screw-axis. It is of special importance in a pump of a greater screw-outlet capacity than screw-inlet capacity, as shown herein, that the full radial width of the blades should be within the above stated limits, as the capacity of this particular pump at a given number of revolutions per minute is about constant against different pressures, within certain limits, the slip not varying to a large degree under different pressures as in ordinary screw-pumps. This fact of a nearly constant capacity of the pump at a given number of revolutions per minute at different pressures or heads within certain limits, constitutes a vital difference between this and ordinary screw-pumps, inasmuch as under increasing or decreasing pressures at the pump-outlet, in ordinary screw-pumps—under similar conditions—the volume of the fluid pumped decreases or increases very largely in consequence of greatly varying slip. As the present screw is constructed with a certain proportion of inlet and outlet capacity, or in other words, as the screw has a given and practically constant slip, it is necessary in order to attain the best results—to run the blade or each portion thereof while operating against a certain fluid pressure as nearly as possible at a certain velocity, so that the "given" or practically constant slip is not more nor less, than the equivalent of the unavoidable slip under the given pressure at that velocity. In consequence of the "given" or constant slip of this screw, its capacity at relatively low pressure but at high velocity of the spiral blades, might be reduced by more, than the unavoidable slip would amount to in an ordinary screw under similar conditions, while the amount of energy consumed by this screw, or by any sections of the spiral blades, as stated hereinbefore, is proportional to the cube of the velocity of the spiral blades, and is practically independent of the pressure at the pump outlet. The slip being practically constant within this propeller, there is furthermore at all different velocities of the screw-blade and at all pressures or

heads, an unavoidable high peripheral velocity of the fluid at the screw-outlet, which velocity should be gradually and without shock reduced and the useful pressure thereby increased. It is however clear, that this latter result can only be effectively attained, and without any undue eddy-currents, if the fluid emerges from the screw-outlet with an approximately uniform velocity, which in turn is only possible when the proportions of the radial width of the screw-blade is within the above limits. Unless, therefore, the radial width of the screw-blades, or spiral blades, is within the above limits, the losses through the "given" or constant slip for which the pump has been specially constructed, and which slip in ordinary screw-pumps only takes place under a certain pressure at a certain velocity of the spiral blade, may become a disadvantage instead of an advantage. However, if the pump is run at the proper velocity for the pressure required, and if the radial width of the blades is within the proper proportions, and if fixed directors of a proper shape or other means are employed at the screw-outlet, as shown in this application, to gradually reduce the unavoidable high peripheral velocity of the fluid at the screw-outlet, in that case this pump will operate with a very high efficiency.

The herein stated rules have never before been explained and none of the other manufacturers of this class of pumps, have at present applied them. The stated proportions of the radial width of the spiral propeller blades of this screw, as compared with the corresponding diameter of the outer contour of the spiral blades, and which is absolutely necessary in applicant's construction, for the successful and efficient operation against moderate and particularly against high pressure or head, is also an entirely new feature.

A pump of this type, where the radial width of the blade may be constant from the screw-inlet toward the screw-outlet, but having increasing capacity from the screw-inlet toward the screw-outlet, and having a greater screw-outlet capacity than screw-inlet capacity, is shown and claimed in my co-pending U. S. application Serial No. 246,275, filed February 18th, 1905.

It should also be stated, that whenever the expression "spiral blade" or "screw-blade" occurs in this application it is to signify broadly a blade of oblique shape and gradually carved from the screw-inlet toward the screw-outlet. The expression "screw" is to signify broadly, a body or core having one or more spiral blades, which blades extend in the direction from the screw-inlet toward the screw-outlet, in a peripheral and partly axial direction. A "screw-wheel" may be a screw without or with a rotating outer ring, the latter being shown in my co-pending application Serial No. 246,276, filed February 18th, 1905.

I do not limit myself to the use of the exact means as shown herein, for gradually reducing the velocity of the fluid adjacent to the screw-outlet, as a fixed director similar to the one shown in my co-pending U. S. application Ser. No. 163,560 filed June 29, 1903, might instead be used with good advantage in combination with a screw as herein shown.

This mechanism can be used equally well for pumping elastic and incompressible fluids, the fluid-inlet and fluid-outlet remaining the same, and the invention is not limited in this respect.

I herein broadly claim some of the characteristics of the pump shown while some other characteristics are claimed broadly in my co-pending U. S. applications, namely: Serial No. 163,560 filed June 29, 1903; Serial No. 174,249 filed September 23rd, 1903; Serial No. 246,275, filed February 18, 1905; and Serial No. 246,276 filed February 18, 1905.

Having thus described my invention, I claim—

1. A mechanism for the purpose specified, having a casing, a shaft rotatable in said casing, an inlet and an outlet for the fluid, and a screw on said shaft and rotative in the casing, the said screw having its core tapered or coned toward its delivery end and its diameter at the periphery of its blades uniform, whereby the capacity increases from the receiving end of the screw, substantially as and for the purpose set forth.

2. A mechanism for the purpose specified, having a casing with an inlet and an outlet for a fluid, a shaft rotatable in said casing, and a screw on said shaft and rotative in the casing, said screw having a substantially spiral blade, the radial width of which increases toward the delivery end of the screw, thus effecting an increase in the capacity from the receiving to the delivery end of the screw.

3. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade and the capacity of the screw increasing from the screw-inlet toward the screw-outlet.

4. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a screw-wheel fitted in and mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade and the capacity of the screw increasing from the screw-inlet toward the screw-outlet.

5. In a device for the purpose set forth, a

casing with a fluid-inlet and fluid-outlet, a screw-wheel fitted in and mounted rotatively within said casing between said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade and the capacity of the screw increasing throughout the screw from its inlet.

6. In a device for the purpose set forth, an internally cylindrical casing with a fluid-inlet and fluid-outlet, a screw-wheel with its main portion of cylindrical outer contour, fitted in and mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade and the capacity of the screw increasing from the screw-inlet toward the screw-outlet.

7. In a device for the purpose set forth, an internally cylindrical casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing throughout the screw from its inlet.

8. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and means for gradually reducing the velocity of the fluid adjacent to the screw-outlet.

9. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between the fluid-inlet and fluid-outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing throughout the screw from its inlet, and means for gradually reducing the velocity of the fluid adjacent to the screw-outlet.

10. In a device for the purpose set forth, an internally cylindrical casing with a fluid-inlet and fluid-outlet, a screw-wheel with its main portion of cylindrical outer contour, fitted in and mounted rotatively within said casing between said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and means for gradually reducing the velocity of the fluid adjacent to the screw-outlet.

11. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a screw-wheel fitted in and mounted rotatively within said casing between said fluid inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing throughout the screw from its inlet, and means for gradually reducing the velocity of the fluid adjacent to the screw-outlet.

12. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between the fluid-inlet and fluid-outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet a fixed director.

13. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, and the capacity increasing from the screw-inlet toward the screw-outlet, the said spiral blade gradually increasing to its full radial width from its inlet end toward the main portion of the screw.

14. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and the said spiral blade gradually increasing to its full radial width from its inlet end toward the main portion of the screw.

15. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and the said spiral blade gradually increasing to its full radial width from each end toward the main middle portion of the screw.

16. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and the said spiral blade gradually increasing to its full radial width from each end toward the main middle portion of the screw.

17. A mechanism for the purpose specified, having a casing provided with an inlet and outlet for the fluid, a screw-wheel fitted in and mounted rotatively within said casing between the said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the

screw-inlet toward the screw-outlet, and said screw-wheel having a naked end-portion, the annular space in the casing about said naked end-portion being gradually enlarged in capacity toward the extremity of said end-portion.

18. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel fitted in and mounted rotatively within said casing between the said fluid inlet and outlet, said screw-wheel having a substantially spiral blade and said blade being limited to the middle portion of the screw-wheel, the capacity of the screw increasing from its inlet towards its outlet, the screw-body having naked end-portions and annular spaces in the casing about said naked end-portions, said annular spaces being gradually enlarged toward the respective extremities of the end-portions.

19. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

20. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, with the capacity of the screw increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

21. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

22. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel, mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director.

23. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-inlet, and a fixed director.

24. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said spiral blade increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director.

25. A mechanism for the purpose set forth, having a casing with a fluid inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade and said blade gradually increasing to its full radial width from its inlet end toward the main portion of the screw and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director.

26. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and said blade gradually increasing to its full radial width from its inlet end toward the main portion of the screw, and adjacent to the screw-outlet, an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director.

27. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade the full radial width of said blade increasing from the screw-inlet toward the screw-outlet and said blade increasing gradually to its full radial width from its inlet end toward the main portion of the screw, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director.

28. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, adjacent to the screw-inlet an annular inlet space which gradually decreases toward the screw-inlet, and adjacent to the screw-outlet an annular outlet

space which gradually increases from the screw-outlet.

29. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-inlet an annular inlet space which gradually decreases toward the screw-inlet, and adjacent to the screw-outlet an annular outlet space which gradually increases from the screw-outlet.

30. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-inlet an annular inlet-space which gradually decreases toward the screw-inlet, and adjacent to the screw-outlet, an annular outlet space which gradually increases from the screw-outlet.

31. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, adjacent to the screw-inlet, an annular inlet space which gradually decreases in capacity toward the screw-inlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director adjacent to the outlet end of the screw-wheel.

32. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-inlet an annular inlet space which gradually decreases in capacity toward the screw-inlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director adjacent to the outlet end of the screw-wheel.

33. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a screw-wheel mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said spiral blade increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-inlet an annular inlet space which gradually decreases in capacity toward the screw-inlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director adjacent to the outlet end of the screw-wheel.

34. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, and the capacity increasing from the screw-inlet toward the screw-outlet, the said spiral blade gradually increasing to its full radial width from one end toward the main portion of the screw.

35. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and the said spiral blade gradually increasing to its full radial width from one end toward the main portion of the screw.

36. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and the said spiral blade gradually increasing to its full radial width from each end toward the main middle portion of the screw.

37. A mechanism for the purpose set forth, having a casing with a fluid-inlet and outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between the fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and the said spiral blade gradually increasing to its full radial width from each end toward the main middle portion of the screw.

38. A mechanism for the purpose specified, having a casing, provided with an inlet and outlet for the fluid, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between the said fluid-inlet and fluid-outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and said screw-wheel having a naked end-portion, the annular

space in the casing about said naked end-portion being gradually enlarged in capacity toward the extremity of said end-portion.

39. A mechanism for the purpose specified, having a casing provided with an inlet and outlet, a shaft mounted rotatively in said casing, and a screw on said shaft within the casing between said inlet and outlet, said screw being at its main portion cylindrical, and having increasing capacity from the receiving end of the screw, and having a naked taper extremity *y* at its delivery end, substantially as and for the purpose set forth.

40. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between the said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade and said blade being limited to the main middle portion of the screw-wheel, the capacity of the screw increasing from its inlet toward its outlet, the screw-body having naked end-portions and annular spaces in the casing about said naked end-portions, and said annular space being gradually enlarged toward the respective extremities of the end-portions.

41. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

42. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, with the capacity of the screw increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

43. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

44. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director.

45. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said fluid-inlet and outlet, said screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director.

46. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel having at its main portion a substantially cylindrical outer contour, fitted in and mounted rotatively within said casing between said inlet and outlet, said screw-wheel having a substantially spiral blade, the full radial width of said spiral blade increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet, and a fixed director.

47. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a plurality of screw-wheels fitted in and mounted rotatively and in series within said casing between the fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, and the full radial width of said blade increasing from the screw-inlet toward the screw-outlet.

48. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a plurality of rotating screw-wheels mounted in series within said casing between said fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet and each screw-wheel having a greater screw-outlet capacity than screw-inlet capacity.

49. In a device for the purpose set forth, a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between the fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet,

each screw having a greater screw-outlet than screw-inlet capacity, and means for gradually reducing the velocity of the fluid adjacent to the screw-outlet.

50. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said blade and the capacity of the screw-increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet a fixed director, having a substantially spiral shape.

51. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and the said blade gradually increasing to its full radial width from each end toward the main middle portion of the screw.

52. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and the spiral blade gradually increasing to its full radial width from its inlet end toward the main portion of the screw.

53. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between the fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and the said blade also gradually increasing to its full radial width from its inlet end toward the main portion of the screw.

54. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade and a naked end-portion, and the annular space in the casing about said naked end-portion being gradually enlarged in capacity toward the extremity of said end-portion.

55. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet.

56. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet.

57. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said spiral blade increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet.

58. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between the fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, adjacent to the screw-inlet an annular inlet space which gradually decreases in capacity toward the screw-inlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

59. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and fluid outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-inlet an annular inlet space which gradually decreases in capacity toward the screw-inlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

60. A mechanism for the purpose specified, having a casing provided with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-inlet an annular inlet space which gradually decreases in capacity toward the screw-inlet, and ad-

jacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

61. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels, mounted rotatively and in series within said casing between the fluid-inlet and outlet thereof, each screw-wheel having a substantially spiral blade, said spiral blade gradually increasing to its full radial width from one end toward the main portion of the screw, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

62. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels, mounted rotatively and in series within said casing between said fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, said spiral blade gradually increasing to its full radial width from one end toward the main portion of the screw, the capacity increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

63. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, said spiral blade gradually increasing to its full radial width from one end toward the main portion of the screw, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, and adjacent to the screw-outlet an annular outlet space which gradually increases in capacity from the screw-outlet.

64. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels fitted in and mounted rotatively and in series within said casing between said fluid-inlet and outlet, each screw-wheel having a substantially spiral blade, said spiral blade gradually increasing to its full radial width from each end towards the main middle portion of the screw, and adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw.

65. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade which gradually increases to its full radial width from each end toward the main middle portion of the screw, the capacity increasing from the screw-inlet toward the screw-outlet, and adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw.

66. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between its fluid-inlet and outlet, each screw-wheel having a substantially spiral blade which gradually increases to its full radial width from each end toward the main middle portion of the screw, the full radial width of the blade increasing from the screw-inlet toward the screw-outlet, and adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw.

67. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director adjacent to the outlet end of the screw-wheel.

68. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director adjacent to the outlet end of the screw-wheel.

69. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing, between said inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of the blade increasing from the screw-inlet toward the screw-outlet, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director adjacent to the outlet end of the screw-wheel.

70. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade which gradually increases to its full radial width from one end toward the main portion of the screw, adjacent to the screw-outlet an annular outlet space which gradually

increases in capacity in the direction from the screw-outlet, and a fixed director adjacent to the screw-wheel outlet.

71. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, said blade gradually increasing to its full radial width from one end toward the main portion of the screw, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director adjacent to the screw-wheel outlet.

72. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within the casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, said spiral blade gradually increasing to its full radial width from one end toward the main portion of the screw, adjacent to the screw-outlet an annular outlet space which gradually increases in capacity in the direction from the screw-outlet, and a fixed director adjacent to the screw-wheel outlet.

73. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade which gradually increases to its full radial width from each end toward the main middle portion of the screw, adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw, and a fixed director adjacent to the outlet end of the screw-wheel.

74. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, said blade gradually increasing to its full radial width from each end toward the main middle portion of the screw, adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw, and a fixed director adjacent to the outlet end of the screw-wheel.

75. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a plurality of screw-wheels mounted rotatively and in series within said casing between said inlet and outlet, each screw-wheel having a substantially spiral blade which gradually increases to its full radial width from each end toward the main middle portion of the screw and the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw, and a fixed director adjacent to the outlet end of the screw-wheel.

76. A mechanism for the purpose specified, having a casing with an inlet and outlet and divided into compartments, a shaft rotatively mounted in said casing and extending through said compartments, screws of opposite pitch on said shaft and in the respective compartments, said screws each having a substantially spiral blade, and its capacity increasing from the receiving toward the delivery end of the screw, and a conduit which compels the fluid to pass in series through the screw-wheels but in opposite directions, substantially as set forth.

77. A mechanism for the purpose specified, comprising an elongated casing having a fluid-inlet and fluid-outlet, and being divided into two separate compartments, a shaft rotatively mounted in said casing and extending through said compartments, a plurality of screw-wheels secured on said shaft and mounted rotatively and in series within the compartments between the fluid-inlet and outlet of the casing, each screw-wheel having a substantially spiral blade and its capacity increasing from the screw-inlet toward the screw-outlet, but the several screw-wheels being respectively of reverse pitch within the respective compartments, means compelling fluid to pass in opposite directions and in series through the two compartments and the screw-wheels located therein.

78. A mechanism for the purpose specified, comprising an elongated casing having a fluid-inlet and fluid-outlet and being divided into two separate compartments, a shaft rotatively mounted in said casing and extending through said compartments, a plurality of screw-wheels secured on said shaft and mounted rotatively and in series within the compartments between the fluid-inlet and outlet of the casing, each screw-wheel having a substantially spiral blade, the full radial width of which increases from the screw-inlet toward the screw-outlet, but the respective screw-wheels being of opposite or reverse pitch within the respective compartments, means compelling fluid to pass in opposite directions and in series through the respective compartments and the screw-wheels located therein.

79. A mechanism for the purpose set forth, comprising an elongated casing having a fluid-inlet and fluid-outlet and being divided into two separate compartments, a shaft ro-

tatively mounted in said casing and extending through said compartments, a plurality of screw-wheels secured on said shaft and mounted rotatively and in series within the compartments between the fluid-inlet and outlet of the casing, the blades of said screw-wheels being of opposite or reverse pitch in the respective compartments, each screw-wheel having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, said spiral blade gradually increasing to its full radial width from each end toward the main middle portion of the screw, adjacent to each screw-end an annular space which gradually increases in capacity in the direction from the screw, adjacent to the screw-wheel outlet a fixed director, and means compelling the fluid to pass in opposite directions through the respective compartments successively, and through the screw-wheels located therein in series.

80. A mechanism for the purpose specified, comprising an elongated casing, having a fluid-inlet and fluid-outlet and being divided into two separate compartments, a plurality of screw-wheels, fitted in and mounted rotatively within the two compartments between the fluid-inlet and fluid-outlet, each screw-wheel having at its main portion a substantially cylindrical outer contour, and having a substantially spiral blade, the capacity increasing from the screw-inlet toward the screw-outlet, the several screw-wheels being connected endwise but being of opposite or reverse pitch within the respective compartments, means compelling the fluid to pass in opposite directions but in series through the two compartments, and in series through the screw-wheels located therein.

81. A mechanism for the purpose specified, comprising an elongated casing, having a fluid-inlet and fluid-outlet and being divided into two separate compartments, a plurality of screw-wheels, fitted in and mounted rotatively within the two compartments between the fluid-inlet and fluid-outlet, each screw-wheel having at its main portion a substantially cylindrical outer contour, and having a substantially spiral blade, the full radial width of said blade increasing from the screw-inlet toward the screw-outlet, the several screw-wheels being connected endwise but being of opposite or reverse pitch within the respective compartments, means compelling the fluid to pass in opposite directions but in series through the two compartments, and in series through the screw-wheels located therein.

82. A mechanism for the purpose specified, having a casing with a fluid-inlet and fluid-outlet, and divided into separate compartments, a plurality of screws, being at their respective main portions of substantially cylindrical outer contour, fitting and mounted rotatively within the respective compartments, but being of opposite or reverse pitch within the respective compartments, each screw having increasing capacity from the receiving end toward the delivery end, the several screw-wheels being connected with each other endwise, a conduit or by-pass which compels the fluid to pass in series but in opposite directions through the several compartments and through the screw-wheels mounted therein.

83. A mechanism for the purpose set forth, having a casing with an inlet and an outlet, a shaft mounted rotatively in said casing and slidable endwise, a cylindrical piston-chamber through which the shaft extends, said piston-chamber having two inlet-ports, one at each side of said piston and an exhaust port at the middle portion of said piston-chamber, a piston on said shaft and controlling said exhaust-port, and means for admitting fluid under pressure to the piston-chamber at both sides of said piston, whereby the endwise movement and thrust of the shaft is controlled.

84. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a shaft mounted rotatively in said casing and slidable endwise, a cylindrical piston-chamber through which the shaft extends, said piston-chamber having a fluid-inlet port near each end, an exhaust port near its middle or center portion, a piston secured on said shaft within the piston-chamber, means for admitting fluid under pressure at said inlet ports, the piston controlling the exhaust port which is normally closed by said piston, said exhaust port being opened at either side of said piston if there is an end-wise movement of the shaft, thus controlling automatically the end-thrust on the shaft by relieving the pressure on said piston in the direction of the end-thrust.

85. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a shaft mounted rotatively in said casing and slidable end-wise, a piston-chamber through which the shaft extends, said piston-chamber having an exhaust port near its middle or center portion, a piston secured on the shaft and fitting peripherally and rotatively within the piston-chamber, means for admitting fluid under pressure to said chamber through separate inlet ports at both sides of said piston, the latter controlling said exhaust-port which is normally covered by the piston, the exhaust-port being opened at one side or the other of said piston if there is an endwise movement of the shaft.

86. A mechanism for the purpose set forth, having a casing with a fluid-inlet and fluid-outlet, a screw-wheel with its main portion having a substantially cylindrical outer contour and being fitted in and mounted rotatively within said casing between the fluid-

inlet and fluid-outlet, a shaft on which the screw-wheel is mounted, and a piston-chamber through which the shaft extends, said piston-chamber having an exhaust-port near its middle or center portion, a piston secured on said shaft and fitting peripherally and rotatively within the piston-chamber, means for admitting fluid under pressure to said chamber through separate inlet ports at both sides of the piston, the latter controlling said exhaust-port which is normally covered by the piston, said exhaust-port being opened at one side or the other of the piston if there is an endwise movement of the shaft.

In witness whereof I have hereunto signed my name this 23d day of July, 1903, in the presence of two subscribing witnesses.

FRANZ MARBURG, Jr.

Witnesses:
HENRY CONNETT,
WILLIAM J. FIRTH.