No. 787,039. PATENTED APR. 11, 1905.

E. G. HARRIS.

CENTRIFUGAL PUMP.

APPLICATION FILED SEPT. 29, 1903.

4 SHEETS—SHEET 1.

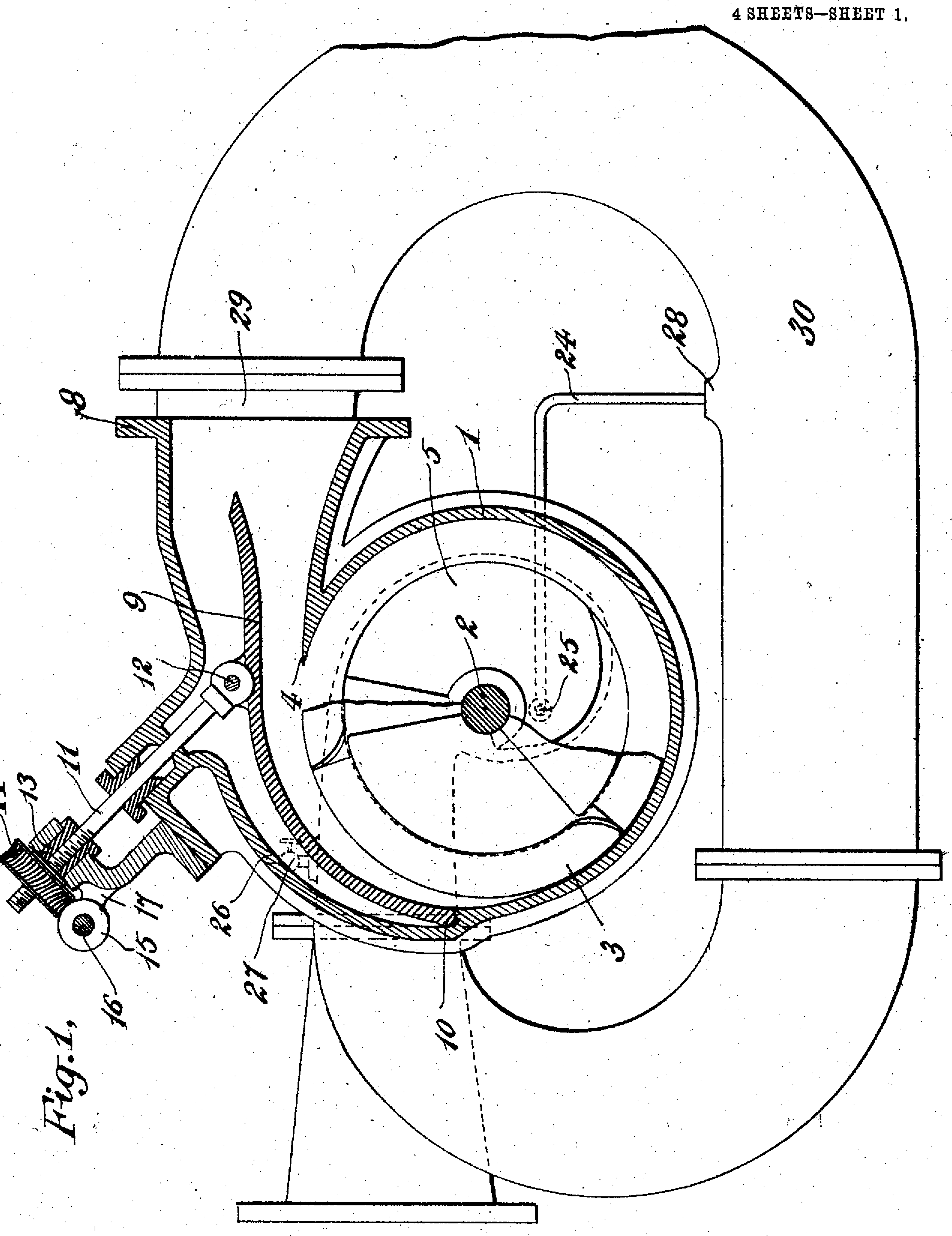


Fig. 1.

WITNESSES:

C. F. Carrington

Minnie Pape

INVENTOR

Elmo G. Harris

BY

Chapin Raymond & Marble

his ATTORNEYS

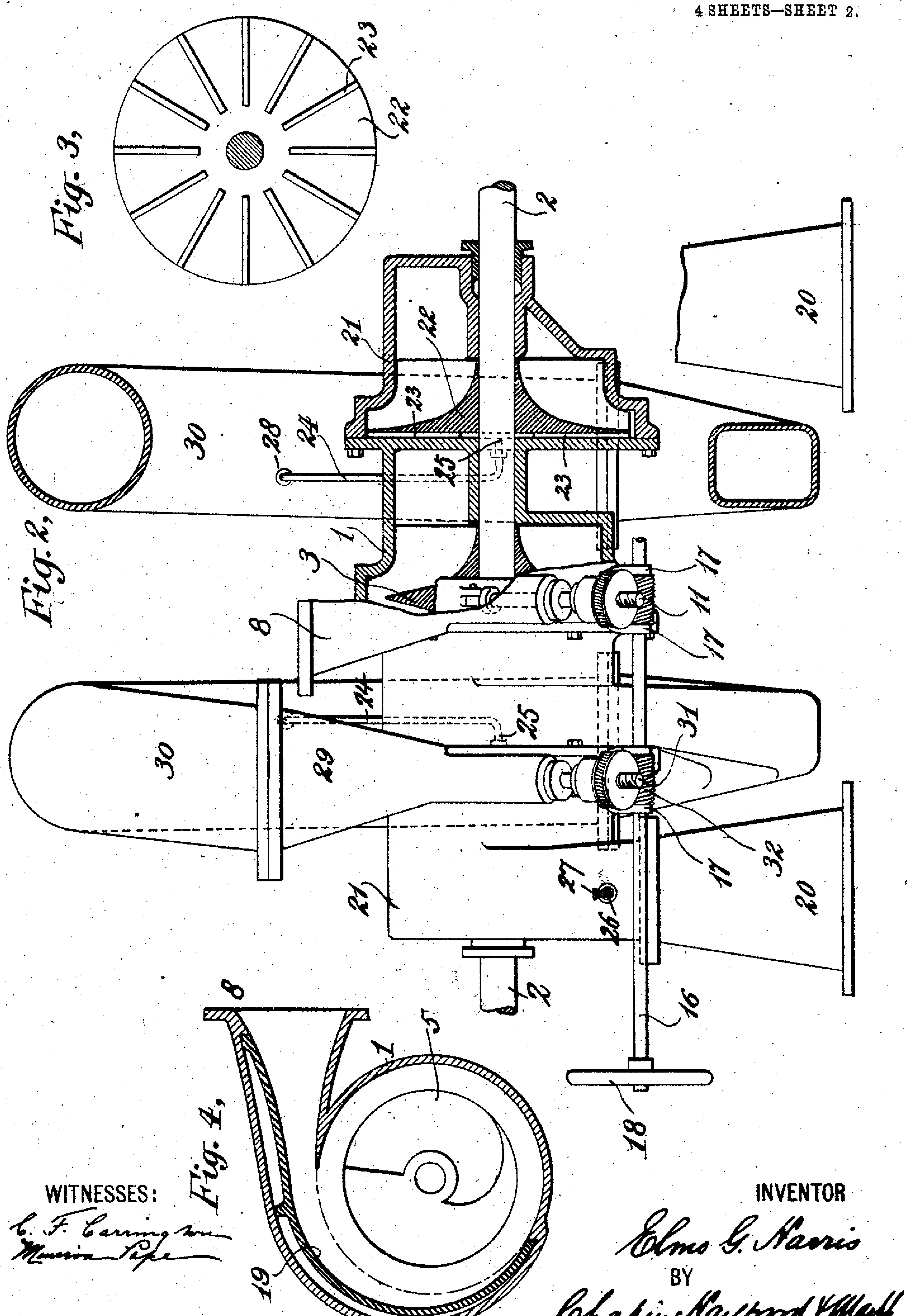
No. 787,039. PATENTED APR. 11, 1905.

E. G. HARRIS.

CENTRIFUGAL PUMP.

APPLICATION FILED SEPT. 29, 1903.

4 SHEETS—SHEET 2.



WITNESSES:

C. F. Carrington

Minnie Pape

INVENTOR

Elmo G. Harris

BY

Chapin Hayward & Mauk

his ATTORNEYS

No. 787,039. PATENTED APR. 11, 1905.

E. G. HARRIS.

CENTRIFUGAL PUMP.

APPLICATION FILED SEPT. 29, 1903.

4 SHEETS—SHEET 3.

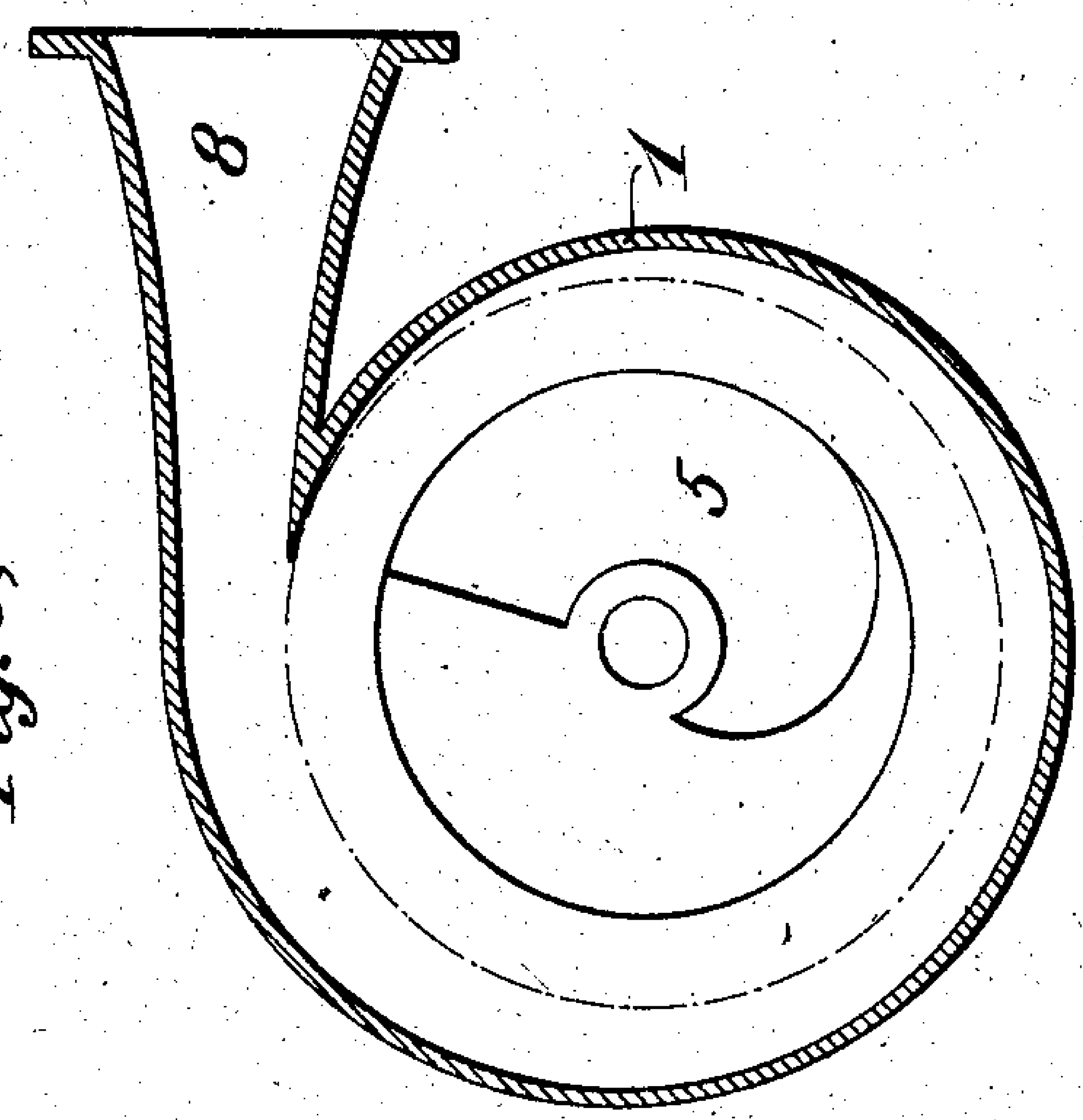


Fig. 5,

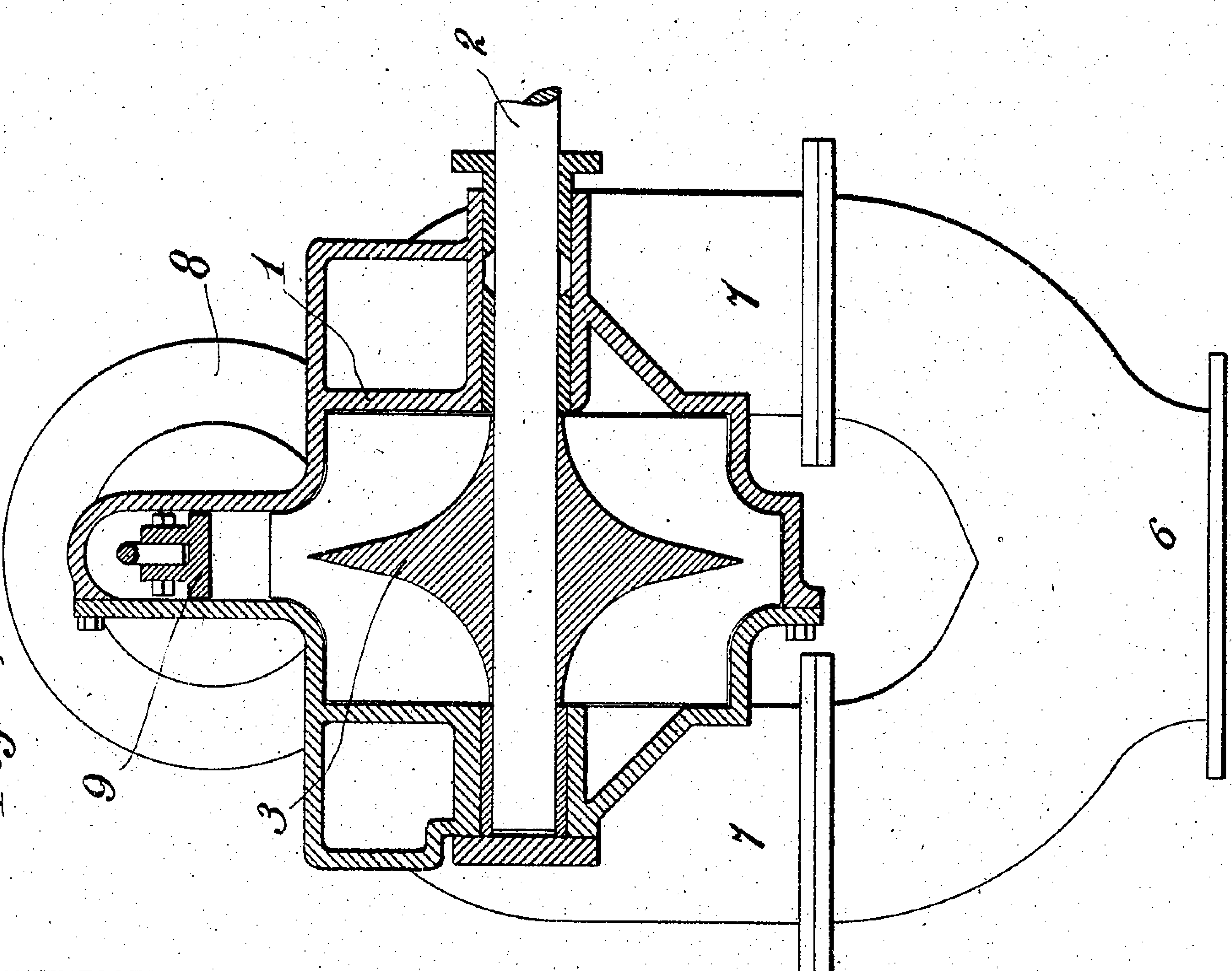


Fig. 6,

WITNESSES:

C. F. Carrington

Minerva Pape.

INVENTOR

Elmo G. Harris

BY

Chapin Raymond & Marble

his ATTORNEYS

No. 787,039. PATENTED APR. 11, 1905.

E. G. HARRIS.

CENTRIFUGAL PUMP.

APPLICATION FILED SEPT. 29, 1903.

4 SHEETS—SHEET 4.

Fig. 8.

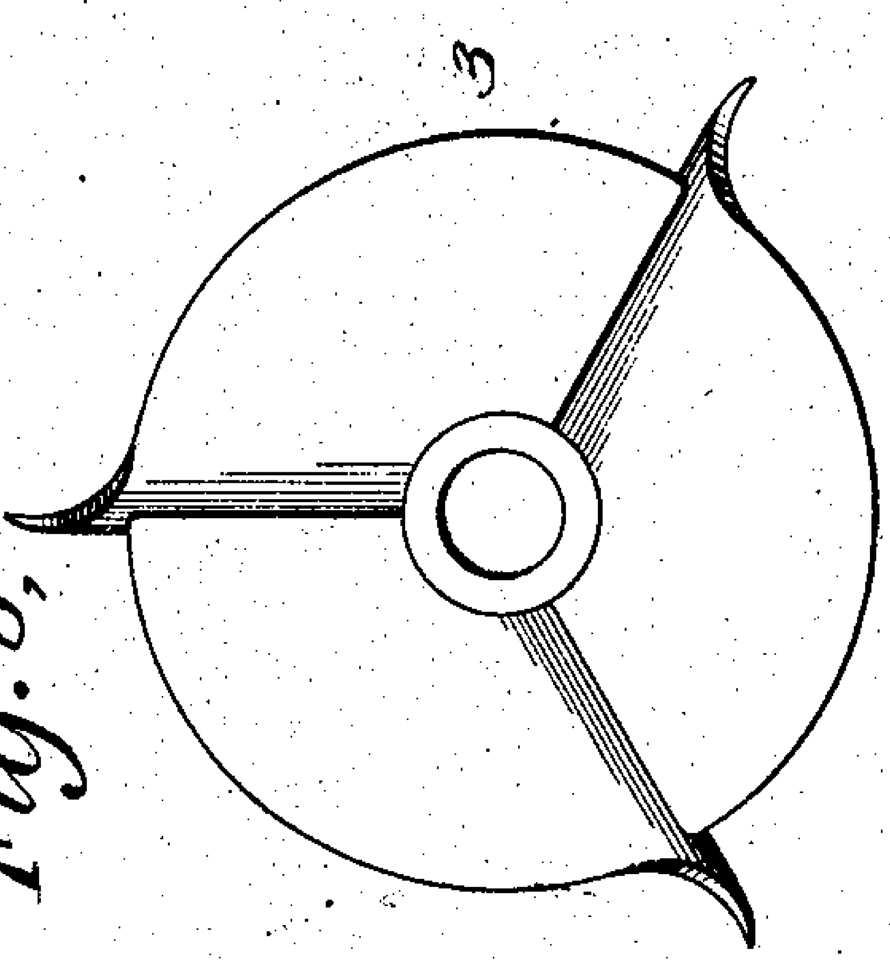


Fig. 7.

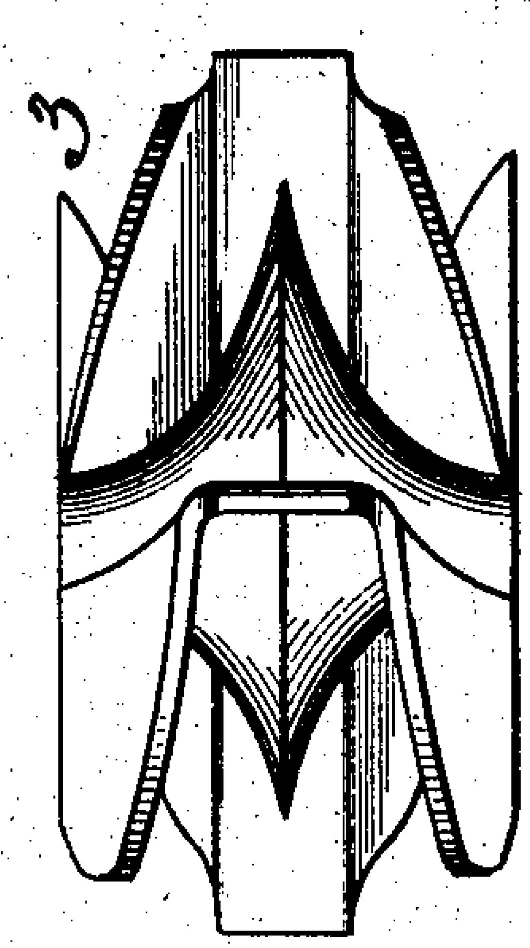
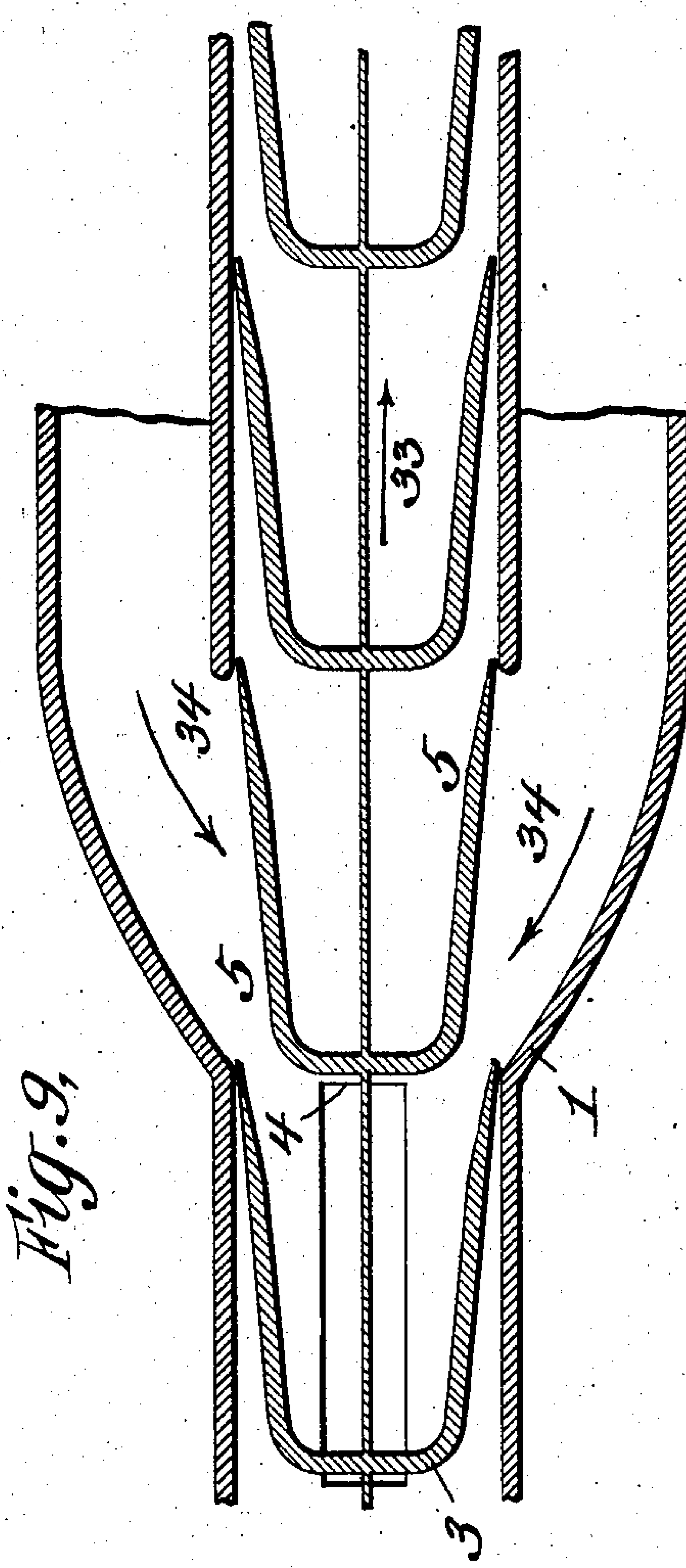


Fig. 9.



WITNESSES:

C. F. Carrington

Minna Pape

INVENTOR

Elmo G. Harris

BY

Chapin Hayward & Marble

his ATTORNEYS

No. 787,039. Patented April 11, 1905.

UNITED STATES PATENT OFFICE.

ELMO G. HARRIS, OF ROLLA, MISSOURI.

CENTRIFUGAL PUMP.

SPECIFICATION forming part of Letters Patent No. 787,039, dated April 11, 1905.

Application filed September 29, 1903. Serial No. 175,032.

To all whom it may concern:

Be it known that I, ELMO G. HARRIS, a citizen of the United States of America, residing at Rolla, in the county of Phelps and State of Missouri, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a specification, reference being had to the accompanying drawings, forming a part thereof.

My invention relates to improvements in centrifugal pumps and comprises, first, an improved form of pump-casing in which the usual vortex-space is eliminated, the cross-sectional area of the discharge-space at any given point being no greater than the opening required to permit passage therethrough at a velocity equal to the peripheral velocity of the wheel of the total volume of water discharged from the wheel up to that point; second, in an improved means for varying the cross-sectional area at the point of discharge; third, in an improved means for clearing the space at the rear of the propeller-wheel of water; fourth, in an improved compound pump; fifth, in a novel construction and arrangement of inlet-opening employed, and, sixth, in certain novel details of construction and combination of parts, as will hereinafter appear.

The objects of my invention are, first, to save churning and friction of the water in its discharge; second, to regulate the amount of discharge in an economical and efficient manner; third, to save water-friction at the rear of the propeller-wheels; fourth, to increase the capacity and efficiency of a compound pump, and, lastly, to generally improve, simplify, and cheapen the construction and operation of centrifugal pumps.

I will now proceed to describe a pump embodying my invention and will then point out the novel features in claims.

In the drawings, Figure 1 shows a view in central vertical section transverse of the pump-shaft of a compound pump embodying my invention, the propeller-wheel being broken away in order to better illustrate the form and shape of the casing and its admission and discharge passages. Fig. 2 shows a partial top view and a view partially in central horizontal section of the same. Fig. 3 shows a rear view of one of the propeller-wheels employed. Fig. 4 shows a view in transverse section of a pump-casing having a modified form of adjustable discharge. Fig. 5 shows a view in transverse section of a pump-casing with propeller-wheel therein embodying certain features of my invention, but in which there is no provision made for adjusting the discharge. Fig. 6 shows a view in longitudinal section of my improved pump in its simple and uncompounded form. Fig. 7 is an edge view of the propeller-wheel which is shown broken away in Fig. 1 removed from its shaft and from the pump-casing. Fig. 8 is a side view of same. Fig. 9 is a diagrammatic view showing the relation of the propeller-blades to the pump inlet and discharge.

In describing my invention I will first refer to the central portion of the apparatus shown in Figs. 1 and 2 and which substantially comprises the single or uncompounded pump shown in Fig. 6. The pump-casing is designated as a whole by the reference character 1 and comprises two portions divided in the plane of rotation of the propeller-wheel and bolted together. The casing incloses a chamber having two substantially cylindrical portions, one of greater diameter than the other. A propeller-wheel shaft 2 is journaled in suitable bearings supported by the casing or other part stationary therewith, and a propeller-wheel 3 of suitable shape and configuration is mounted within the casing and rigidly secured to the said shaft. The propeller-wheel 3 is fitted to the casing and has blades extending throughout both said portions of the chamber and substantially fills same, the vortex or volute space of the ordinary form being dispensed with. The propeller-wheel is preferably of the screw-blade type in which the blades advance both laterally and longitudinally of the axis of rotation of the wheel. The pump is arranged to discharge directly from the propeller-wheel to the discharge-space, said discharge being arranged in the peripheral wall of the larger portion of the casing-chamber and which may extend from the point of cut-off 4 of the casing rearwardly as far as may be desired; but in no case should the cross-sectional area thereof be greater at any given point than that required to permit discharge at a velocity equal to the peripheral velocity of the wheel of the total quantity of water discharged from the wheel up to that point. By this arrangement and construction slip and water friction due to churning is eliminated. In the construction shown in Fig. 1 the opening into the delivery extends for about one hundred and twenty degrees of the entire circle of the casing. In the modified structure shown in Fig. 4 the opening into the discharge extends around for a distance of about one hundred and sixty degrees, while in the further modified structure shown in Fig. 5 the discharge begins at the point 4 and extends all the way around the circle. In all these structures, however, the essential above mentioned is maintained, so that the velocity of the water passing through the pump will not be reduced until after it has passed the point 4 and entered the delivery-pipe. Water enters the casing through an inlet-opening 5 in a lateral wall thereof, entering the smaller portion of the chamber and is received directly by the blades of the propeller-wheel. This inlet-opening is arranged eccentric of the axis of rotation of the propeller and adjacent the discharge-opening. Preferably the inlet-opening will be so placed that admission is effec.ed through the inlet into the space or chamber between any two blades of the propeller-wheel while that chamber is discharging into the discharge-space of the wheel.

In Fig. 9 I have shown a diagrammatic representation of the relation of the propeller-blades to the casing-inlet and discharge. A development of the propeller-wheel is shown at 3, while the casing is diagrammatically shown at 1, the inlet-openings upon opposite sides here represented at 5 5. The discharge-opening is also illustrated, the point of cut-off of same being designated by the reference character 4, as in the other figures. The direction of the movement of the propeller-wheel is designated by an arrow 33, while the direction of the water-intake is shown by the arrows 34 34. By examination of Fig. 9 it will be seen that as water enters the inlets 5 5 between any two sets of blades it will at the same time discharge from between those two sets of blades through the discharge-opening. Thus the water is caused to travel through the shortest space possible and water-friction reduced to a minimum. Preferably also the angular extent of the inlet-opening will be not less than the angular extent of the discharge-space at the point it enters the casing-chamber. When the axis is set horizontally, the propeller-wheel in a single pump or in the central portion of a compound pump is of the duplex variety—that is to say, it has wings or vanes on both sides, and water enters both sides of the casing and is received on opposite sides of the propeller.

In Fig. 6 the admission-pipe 6 is bifurcated and has two branches 7 7, connecting with opposites sides of the casing for the above purpose. The delivery is to a single delivery-pipe 8, and the said delivery-pipe is arranged outwardly flaring, the cross-sectional area of delivery being arranged to increase from the cut-off point 4 of the casing outwardly. By this arrangement the velocity of discharge in the discharge-pipe is decreased and the kinetic energy of the water converted into energy of pressure.

In order to vary the capacity of the pump, I have provided means for varying the amount of water discharged in a curved blade 9, pivoted to the casing at 10, and entering the discharge-pipe at its outer end. The position of the blade 9 may be varied by means of an operating-stem 11, loosely connected thereto at 12 and in threaded engagement with an operating-nut 13. The operating-nut may be rotated by any suitable means, and I have shown the same as conveniently provided with a worm-wheel 14, engaged by a worm 15, mounted upon a shaft 16, journaled in bearings 17, and provided with an operating-wheel 18. The adjustment of the blade 9 will control the quantity of water discharged, while a constant speed of rotation of the propeller-wheel is maintained. This is very desirable, for in many instances the required lift of a pump may be substantially constant while the quantity of water desired to be delivered variable. To vary the quantity of water delivered by varying the speed of the pump is wasteful of energy, for the lift varies with the square of speed, while the quantity with a fixed discharge area varies directly with the speed. In order to get the best efficiency, a pump should be run at a speed just sufficient to maintain the discharge against the lift. In a pump constructed according to this part of my invention I may rotate the same at a uniform speed while adjusting the discharge to vary the quantity of water delivered therethrough.

In Fig. 4 I have shown a stationary but removable blade 19, answering to the blade 9, whereby the said blade may be removed and another one substituted in order to vary the discharge as may be desired.

Referring now to the compounding features shown in Figs. 1 and 2, it will be seen that I provide two single pumps, one on each side of the central duplex pump just described. I provide the said single pumps with separate intakes 20, which, however, may be connected together by a bifurcated branch connection, such as shown in Fig. 6 for the duplex pump therein illustrated, and I have arranged to deliver from the discharge side of the single pumps to the intake sides of the central duplex pump. Each of the single pumps comprises a casing 21, which may be secured to or, if desired, form a part of the central duplex-pump casing 1. The shaft 2 passes through the casings 21, and single propeller-wheels 22—that is to say, propeller-wheels having blades on one side only—are secured to the said shaft and mounted one in each said casing 21. The rear sides of the propeller-wheels 22 are provided with means for setting fluid in motion, and such means may comprise small wings or vanes 23, which will set in motion any water which may accidentally pass to the rear of the said wheel. A mere roughening of the surface of the wheel at the rear without the actual employment of blades or vanes may be sufficient for the purpose. Air may be admitted at the rear of the propeller-wheels near their axis of rotation in order to take the place of water discharged, and preferably this air will be admitted under pressure. For this purpose I have shown air-pipes 24, which communicate with the interior of the casing at points at the rear of said propeller-wheels and near their axis of rotation. At their other ends the said pipes connect with the pump at some point in the discharge, the pressure in the discharge being of course greater than atmospheric pressure and, further, being greater than the maximum pressure possible to be exerted in the opposite direction upon the rear side of the propeller-wheel. In order to supply air, I place a small air-inlet pipe 26 in the intake side of the pump and control same by means of a valve 27. The intake side of the pump being under pressure less than atmospheric pressure, air will be drawn in through the pipe 26 and will follow the water around through the pump, and hence will pass through the discharge. The point of connection 28 of the pipe 24 with the discharge is at a high point in the discharge-pipe, and hence at a point at which air will be traveling. Air will hence pass through the pipe 24 and be delivered under pressure to the casing at the rear of the propeller-wheel 22.

It is obvious, of course, that means other than the pressure in the pump-discharge may be employed to force air into the casing at the rear of the chamber; but the construction illustrated and above described is a simple and efficient means for accomplishing this purpose.

In the operation of a compound pump water is drawn in through the branches 20 and passes through the two side pumps and is delivered therefrom to the outwardly-flaring discharge-heads 29. The discharge-heads 29 connect with and form part of discharge-pipes 30, which continue around the shell or casing of the pump and connect with the inlet of the duplex portion of the pump arranged in the middle. Thence water passes through the duplex portion of the pump and is discharged therefrom through the outwardly-flaring discharge-head 8, forming part of the final delivery-pipe. The outwardly-flaring portions 29 are preferably provided with adjustable blades similar to the blade 9, illustrated and described in connection with the central duplex portion of the pump. Operating-stems 31 similar to the operating-stem 11 may be operated by worm-gearing 32, controlled by the shaft 16 and wheel 18, so that synchronous movement of all the blades is enforced. This is desirable, as uneven adjustment of the blades would result in an uneconomical operation of the pump. It will be noted that the area of the discharge increases rapidly from about the cut-off point 4 in all the constructions shown. This is for the purpose of decreasing the velocity of the water after it is delivered by the wheel, and hence converting the kinetic energy thereof into energy of pressure.

In Fig. 5 I have shown a form of pump without the adjustable discharge. This form of pump, however, embodies that feature referred to in the other forms of pump comprised in the peculiar construction of the discharge. In this form of pump the discharge-opening commences at the point 4 and has a constant increase through the entire three hundred and sixty degrees round to the same point again. At no point, however, is the cross-sectional area of the discharge-space greater than that required to permit passage therethrough at a velocity equal to the peripheral velocity of the wheel of the total volume of water discharged from the wheel up to that point. If it is desired to employ the adjustable blade, it is not practicable to carry the discharge-opening so far round, and thus in the construction employing this feature I have shown the discharge-opening as only extending a portion of the distance. In practice the discharge-opening may be quite long, and where a removable and replaceable blade is employed, as in Fig. 4, a longer discharge-opening may be used than in the construction shown in Fig. 1. In the construction shown in Fig. 1 the increase of area of the discharge-passage up to the cut-off point 4 will not be perfectly constant in all positions of the blade 9, for when constant in one position it cannot be constant in another with the blade inflexible. Because of this I have made the blade of such a shape as to best average up the differences, carefully preserving, however, the essential qualification above referred to, that the velocity of the water will never be decreased until after it has passed the point 4.

It will be obvious that the foregoing is but one embodiment of my invention and that the same is capable of many and varied modifications within the spirit and scope of my invention, and, further, that certain parts may be employed in connection with other parts of different construction. Hence I do not desire to be limited only to the precise details of construction and combination of parts herein.

What I claim is—

1. In a centrifugal pump the combination of a rotary propeller-wheel and a casing therefor

having a discharge-space the cross-sectional area of which at any given point is no greater than the opening required to permit passage therethrough, at a velocity equal to the peripheral velocity of the wheel, of the total volume of water discharged from the wheel up to that point.

2. In a centrifugal pump the combination of a rotary propeller-wheel and a casing therefor having a discharge-space commencing at a point contiguous to the outer periphery of the propeller-wheel and progressively enlarged toward the point at which it enters the discharge-pipe, the cross-sectional area of which at any given point is no greater than the opening required to permit passage therethrough, at a velocity equal to the peripheral velocity of the wheel, of the total volume of water discharged from the wheel up to that point.

3. In a centrifugal pump the combination of a propeller-wheel and a casing therefor having a discharge-pipe and a discharge-space connecting with said discharge-pipe and with the interior of the casing, the cross-sectional area of the discharge-space at any given point being no greater than that required to permit passage therethrough, at a velocity equal to the peripheral velocity of the wheel, of the total volume of water discharged from the wheel up to that point, and the said discharge-pipe being outwardly flared, whereby the velocity of the water will decrease as it passes therethrough.

4. In a centrifugal pump the combination of a rotary propeller-wheel with a casing, the discharge-space of which is so proportioned as to discharge water from the casing into the delivery-pipe at a velocity not less than the peripheral velocity of the wheel.

5. In a centrifugal pump the combination with a rotary propeller-wheel and a casing therefor having a discharge-pipe and a discharge-space connecting with the discharge-pipe and with the interior of the casing, the said discharge-space being so proportioned that water discharged therefrom into the discharge-pipe will have a velocity not less than the peripheral velocity of the wheel and the discharge-pipe so proportioned that the velocity of the water will be decreased therein.

6. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing therefor, said pump arranged to discharge into a discharge-pipe and having a discharge-space connecting with the discharge-pipe, and a blade or vane located partially within the discharge-space in the casing and partially within the discharge-pipe, one end of said blade or vane arranged in proximity to the peripheral wall of the chamber within which the wheel rotates.

7. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing therefor, said pump arranged to discharge into a discharge-pipe and having a discharge-space connecting with the discharge-pipe, and a movable blade or vane located partially within the discharge-space in the casing and partially within the discharge-pipe.

8. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing therefor, said pump arranged to discharge into a discharge-pipe and having a discharge-space connecting with the discharge-pipe, a blade or vane located partially within the discharge-space in the casing and partially within the discharge-pipe, and means for adjusting the position of the said blade or vane.

9. In a centrifugal pump, the combination with a rotary propeller-wheel, and a casing therefor having a discharge-opening, of an adjusting blade or vane located in proximity thereto, and coacting with the walls of said casing to adjust the area of said discharge-opening.

10. In a centrifugal pump, the combination with a rotary propeller-wheel, and a casing therefor having a discharge-opening, of an adjusting blade or vane located in proximity thereto, and coacting with the walls of said casing to adjust the area of said discharge-opening, and means for adjusting the said blade or vane.

11. In a centrifugal pump the combination with a propeller-wheel and a casing therefor having a discharge-space arranged to discharge into a discharge-pipe, of a blade or vane pivoted to the casing at a point adjacent the outer periphery of the wheel, said blade or vane located partially within the discharge-space and partially within the discharge-pipe and means for adjusting the position of the blade or vane.

12. In a centrifugal pump the combination with a propeller-wheel, of a casing therefor having a discharge-space, a blade or vane located in said discharge-space and pivoted to the casing at a point adjacent the periphery of the wheel, an operating-stem for said blade or vane passing through the casing to the exterior thereof and operating means for the said operating-stem.

13. In a centrifugal pump the combination with a casing and a propeller-wheel therein, said propeller-wheel provided at the rear thereof with means for setting fluid in motion, of means for admitting air between the casing and the rear of said propeller-wheel.

14. In a centrifugal pump the combination with a casing and a propeller-wheel therein, said propeller-wheel provided at the rear thereof with means for setting fluid in motion, of means for admitting air under pressure between the casing and the rear of said propeller-wheel.

15. In a centrifugal pump the combination with a casing and a propeller-wheel therein, said propeller-wheel provided at the rear thereof with means for setting fluid in motion,

said pump having means within itself for forcing air under pressure into the space between the rear of the propeller-wheel and the casing and at a point near the axis of rotation thereof.

16. In a centrifugal pump the combination with a casing and a propeller-wheel, of means for admitting air on the intake side of said pump, and for conveying air, so admitted and discharged through the pump, from the discharge side thereof to the rear of said propeller-wheel near the axis of rotation thereof, said propeller-wheel provided at the rear thereof with vanes.

17. In a centrifugal pump the combination with a plurality of propeller-wheels and casings therefor, of blades or vanes located in the discharge of the casings for each propeller-wheel, and means for simultaneously adjusting the position of all the said blades or vanes.

18. In a centrifugal pump the combination with a single shaft, a duplex propeller-wheel secured thereto and single propeller-wheels secured to said shaft on opposite sides of said duplex propeller-wheel and facing in opposite directions, of casings for the said propeller-wheels, the discharge of the casings for the outer propeller-wheels connected with the intake of the casing for the middle propeller-wheel, a blade or vane located in the discharge-space of the casings for each of said propeller-wheels, pivoted in the casings and extending into the discharge-pipes, and means for simultaneously adjusting the position of all the said blades.

19. In a centrifugal pump the combination with a single shaft, a duplex propeller-wheel secured thereto and single propeller-wheels secured to said shaft on opposite sides of said duplex propeller-wheel and facing in opposite directions, said single propeller-wheels provided at the rear thereof with means for setting fluid in motion, of casings for the said propeller-wheels, the discharge of the casings for the outer propeller-wheels connected with the intake of the casing for the middle propeller-wheel, and means for admitting air under pressure between the outer casings and the rear of the outer propeller-wheels near their axis of rotation.

20. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing therefor having a lateral inlet eccentric of the axis of rotation of the propeller-wheel, and a peripheral discharge-opening extending a portion only of the distance around same, the angular extent of the inlet-opening being not less than the angular extent of the discharge-opening.

21. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing therefor having a lateral inlet eccentric of the axis of rotation of the propeller-wheel, and a peripheral discharge-opening extending a portion only of the distance around same, one end of the inlet-opening being adjacent to one end of the discharge-opening, and the angular extent of the inlet-opening being not less than the angular extent of the discharge-opening.

22. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing therefor having a lateral inlet eccentric of the axis of rotation of the propeller-wheel, and a peripheral discharge-opening extending a portion only of the distance around same, the point of cut-off of the discharge-opening being adjacent to the commencement of the inlet-opening, and the angular extent of the inlet-opening being not less than the angular extent of the discharge-opening.

23. In a centrifugal pump the combination with a rotary propeller-wheel, of a casing for said propeller-wheel having a lateral inlet eccentric of the axis of rotation of the propeller-wheel, and a peripheral discharge-opening extending a portion only of the distance around same, the inlet and discharge openings being so disposed with relation to each other that admission is effected through the inlet into the chamber between any two blades of the wheel while that chamber is discharging into the discharge-space of the wheel.

24. In a centrifugal pump the combination of a rotary propeller-wheel with a casing, the discharge-space of which is so proportioned as to discharge water from the casing into the delivery-pipe at a velocity not less than the peripheral velocity of the wheel, said casing provided with a lateral inlet-opening eccentric of the axis of rotation of the propeller-wheel.

25. In a centrifugal pump the combination of a rotary propeller-wheel with a casing having a peripheral discharge-opening extending a portion only of the distance around same, and so proportioned as to discharge water from the casing into the delivery-pipe at a velocity not less than the peripheral velocity of the wheel and having a lateral inlet-opening eccentric of the axis of rotation of the wheel.

ELMO G. HARRIS.

Witnesses:
A. L. McRae,
Jno. B. Scott.