E. S. G. REES.

CENTRIFUGAL TURBINE AND SIMILAR PUMP.

APPLICATION FILED SEPT. 13, 1906.

1,012,438. Patented Dec. 19, 1911.

5 SHEETS—SHEET 1.

Fig. 1.

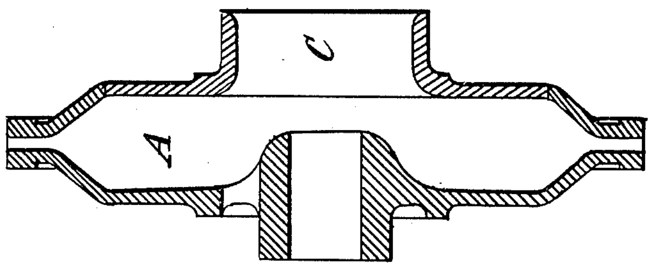
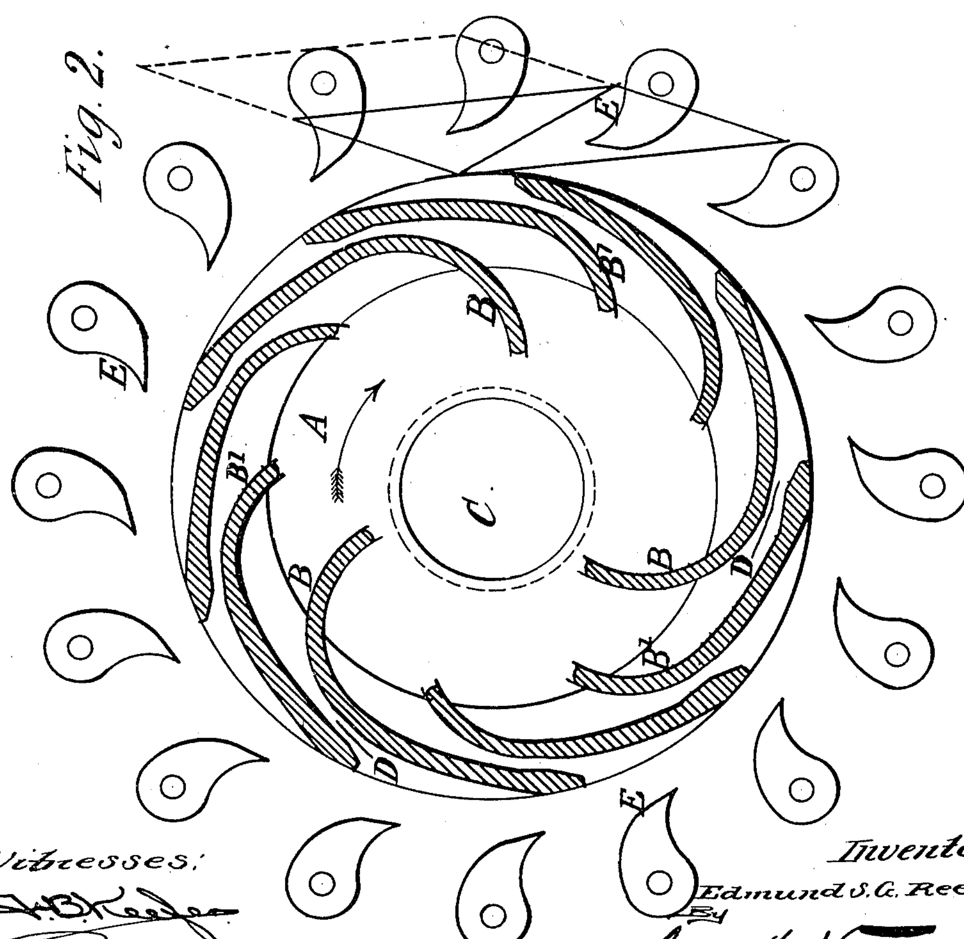


Fig. 2.



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5 SHEETS—SHEET 2.

Fig. 5.

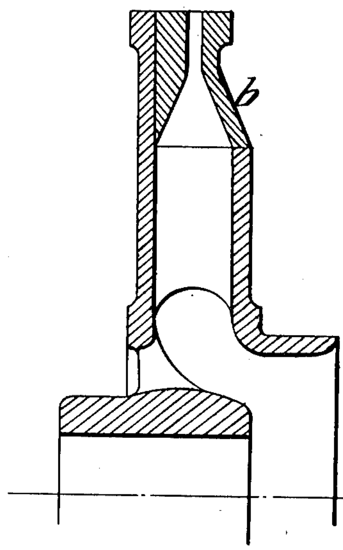


Fig. 5a.

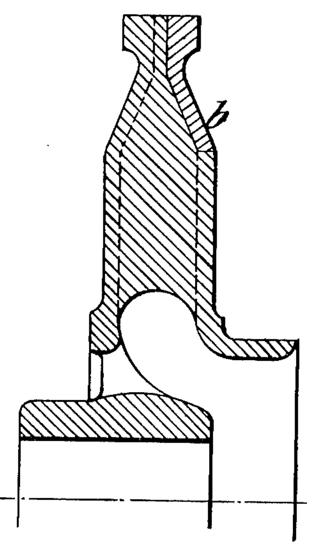
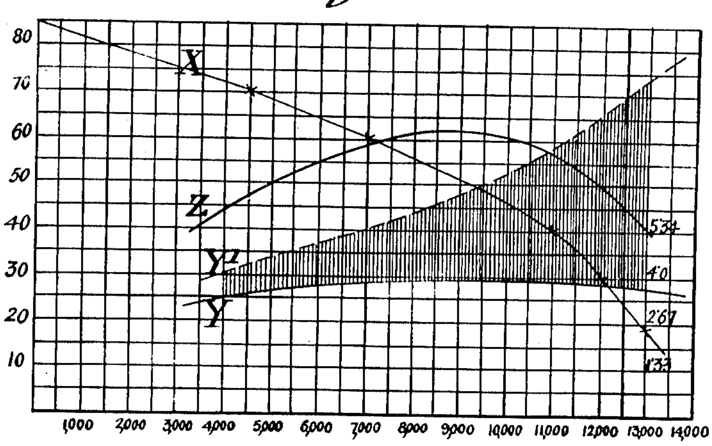


Fig. 1a.



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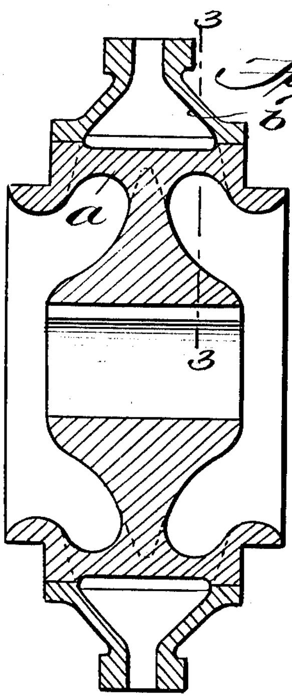

Fig. 3.

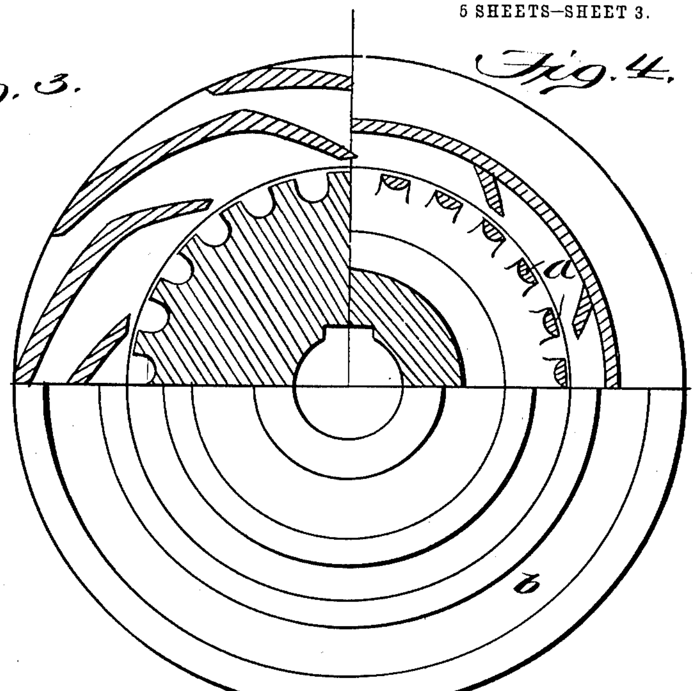

Fig. 4.

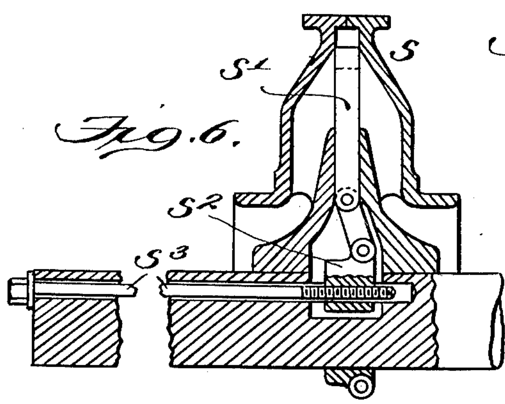

Fig. 6.

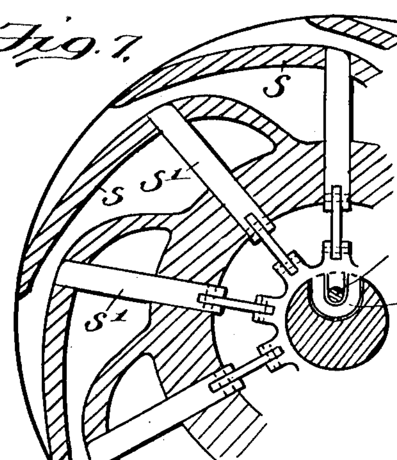

Fig. 7.

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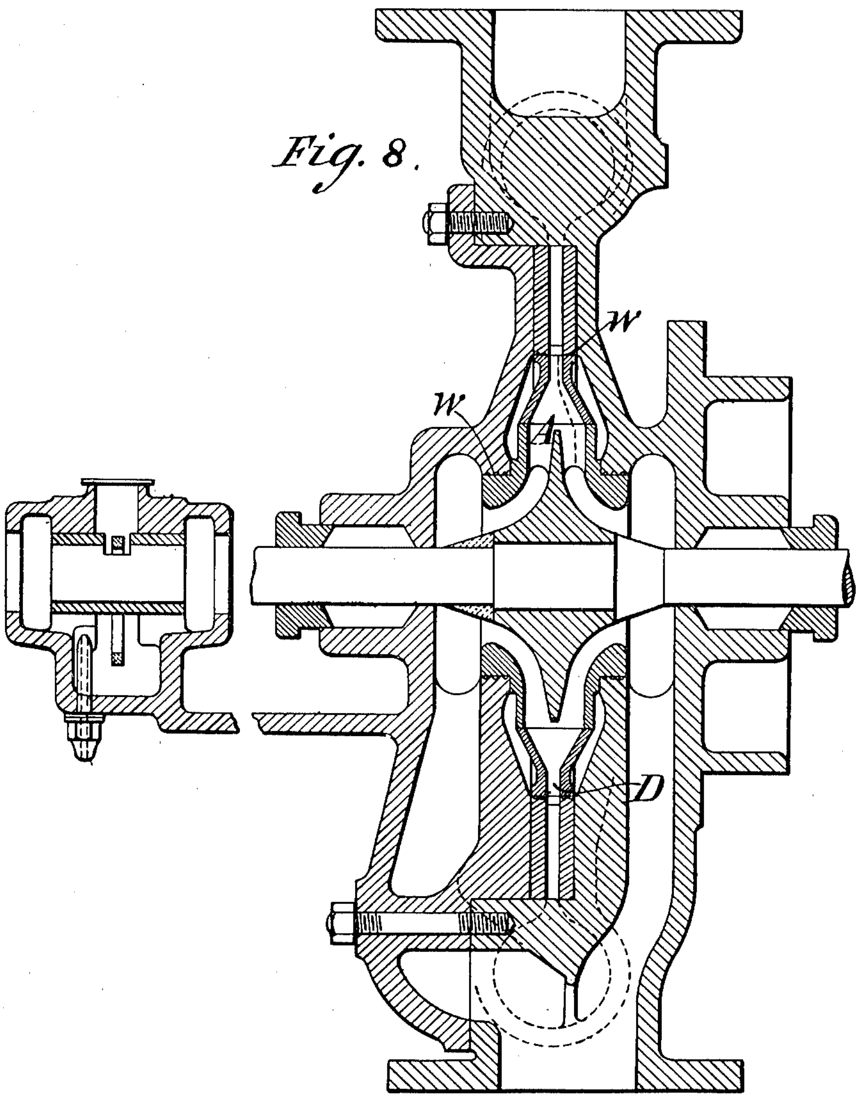
5 SHEETS—SHEET 4.

Fig. 8.



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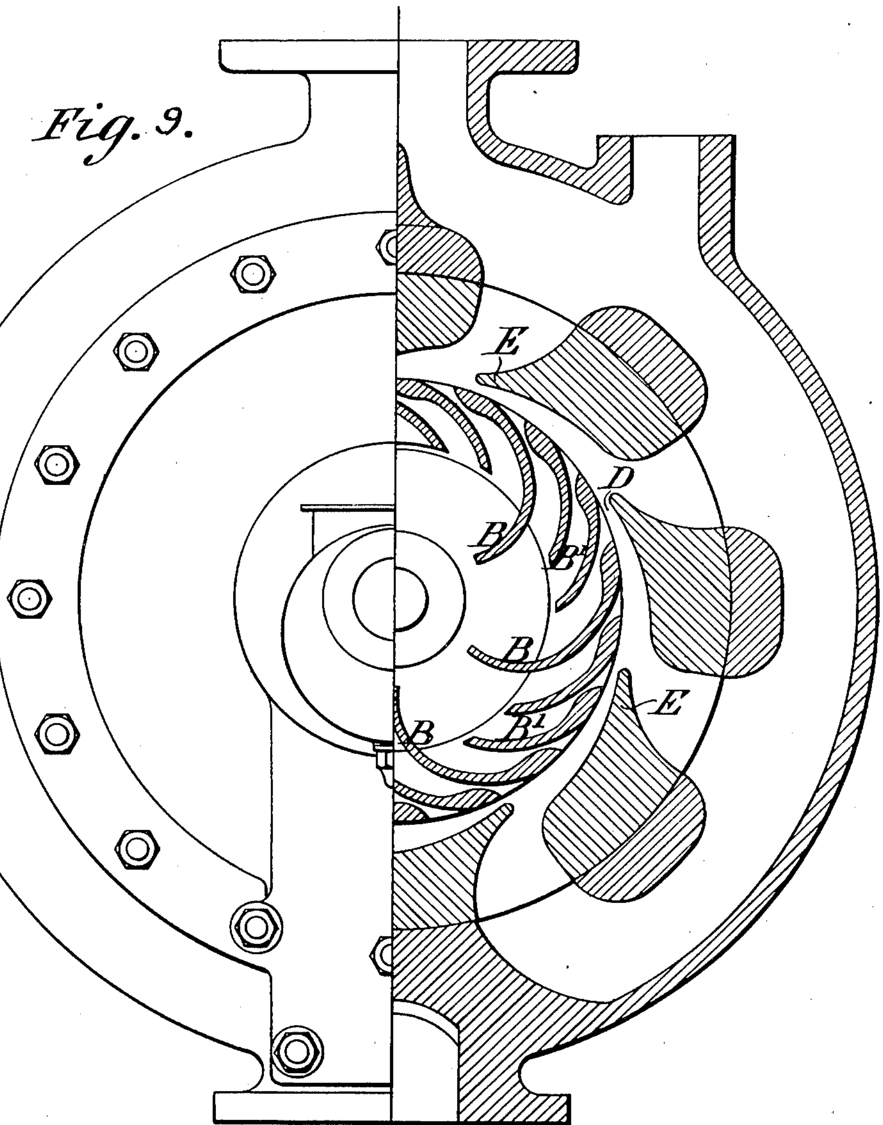
5 SHEETS—SHEET 5.

Fig. 9.



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UNITED STATES PATENT OFFICE.

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CENTRIFUGAL TURBINE AND SIMILAR PUMP.

1,012,438. Specification of Letters Patent. Patented Dec. 19, 1911.

Application filed September 13, 1906. Serial No. 334,456.

To all whom it may concern:

Be it known that I, Edmund Scott Gustave Rees, a subject of the King of Great Britain, residing at Wolverhampton, in the county of Stafford, England, have invented certain new and useful Improvements in Centrifugal Turbine and Similar Pumps, of which the following is a specification.

This invention relates to centrifugal pumps for incompressible fluids, and consists in an improved construction wherein the pressure necessary to overcome the head against which the pump is working is in the main produced within the impeller itself by centrifugal force, instead of being produced mainly by the conversion into pressure in the fixed casing of the speed energy of the water generated in the impeller.

The essential feature of novelty of this improved construction resides in the combination of a rotating tank or chamber of large capacity having an inlet or inlets constructed to pick up the water in the usual manner, with a series of peripheral discharge nozzles, preferably rearwardly directed, leading from this tank or chamber, which nozzles are of short length and small width in the direction of the axis of the impeller compared with the width of the latter, and also of small width in the transverse direction at the point of maximum construction, so that the sum of the areas of all the nozzles at this point is a small fraction of the circumferential area of the chamber from which they lead. With an impeller so constructed a large mass of water is maintained under a constant and high pressure within the rotating tank or chamber, and a part of this pressure is converted into speed energy in the water issuing through the discharge nozzles. It is found that with nozzles inclined from 10° to 20° to the tangent in the rearward direction, maximum efficiency is obtained when 25 per cent. of this internal pressure is converted into velocity in the nozzles, giving a velocity of flow through the nozzles equal to 50 per cent. of the forward peripheral velocity of the impeller. Under such circumstances, therefore, 75 per cent. of the pressure corresponding with a given peripheral velocity is provided directly in the rotating tang, and only the balance has to be derived from the conversion of the speed energy of the water in suitable expanding channels in the fixed casing. Consequently, since only a comparatively small part of the total external pressure need be obtained by the known devices for converting speed energy of the water into pressure, and as such conversion can only be effected with any great efficiency by means of carefully designed appliances, the efficiency of which can only be maintained under ideal conditions and would soon decrease, for example when dealing with gritty water, one source of inefficiency in centrifugal pumps is very materially reduced by the present invention. With rearwardly directed nozzles such as described, the rim of the impeller acts as a reaction turbine, so that if the head for which the pump is designed is reduced, the increasing flow of water due to increasing difference between the constant pressure maintained by centrifugal force in the rotating tank and the external head increasingly assists in driving the impeller, thereby preventing the power taken from the driving motor from increasing with increasing quantity of water delivered from an impeller running at constant speed. The more the direction of the nozzles approximates to that of the radius of the impeller, the less will be this turbine effect, but theoretically, and within limits also practically, the greater will be the external pressure of the pump, since the greater will be the absolute velocity of the water entering the casing. The cross section of the fluid space in the impeller from the eye toward the rim being increasingly large, the relative velocity of the water in the impeller and consequent frictional losses are small, and moreover, since that part of the water path in the impeller in which the relative velocity of the water is at all considerable, viz. the peripheral nozzles, is very short, the frictional losses here are also small.

The fundamental principle of the invention as set forth above is embodied in the various figures of the accompanying drawings, in which:

Figures 1 and 2 are respectively a longitudinal and a transverse section of an impeller constructed in accordance with the said invention. Fig. 1ª illustrates graphically the self-regulating properties of a pump constructed as shown in Figs. 1 and 2. Figs. 3 and 4 are respectively a longitudinal section and a side elevation, partly in section, of a modified construction of impeller having a nozzle ring and reservoir separately constructed. Figs. 5 and 5^a are part longitudinal sections showing further modifications in the construction of these parts. Figs. 6 and 7 are respectively a part longitudinal section and part transverse section of an impeller drawn to a somewhat enlarged scale and showing one means of varying the area of the impeller nozzles. Figs. 8 and 9 are respectively a longitudinal section and a side elevation partly in transverse section of an improved pump as actually constructed.

As shown in Figs. 1 and 2 and certain of the other figures, the impeller is constructed with what may be called a hydraulic pressure reservoir or central pressure producing chamber A of large capacity in which a considerable volume of liquid is stored and maintained at a high pressure, by centrifugal force due to the rotation of the impeller, in the region within the peripheral discharge nozzles, and in addition to the capacity of this chamber being large, its area concentric with the periphery is also large compared with the total area at the point of maximum constriction of the rearwardly directed discharge outlets D which are formed by or between the peripheral vanes B, B′. Some of these vanes B are shown as continued inward toward the eye C of the impeller with the object of reducing or preventing slip between the mass of liquid as a whole and the body of the impeller, but the same object may be attained by additional vanes which do not constitute or go to form the discharge nozzles D. As shown in the drawing, the point of maximum constriction of the nozzles D is a short distance within the periphery. Consequently in this case the velocity of the fluid through the nozzles at the point of maximum constriction is partly re-converted into pressure before the fluid leaves the impeller. In addition to obtaining the reactive effect due to the rearwardly directed streams of liquid, the independent velocity imparted to the issuing streams relative to the impeller consequent on the maintenance of the steady pressure within the impeller reservoir enables a resultant velocity with respect to the casing to be given to the liquid streams which can be varied both in magnitude and direction within wide limits. The practical advantage of this is that since the forward tangential component of the velocity of the fluid due to rotation can be to a large extent neutralized by the rearwardly directed component due to internal pressure, the resultant velocity of the fluid with respect to the cutwaters E (Fig. 2) and the casing is considerably reduced for any given head and consequently there is a corresponding freedom from wear in the cutwaters and other parts subjected to the action of the issuing streams which are frequently charged with grit.

Fig. 1^a illustrates graphically the actual performance of a pump constructed as shown in Figs. 1 and 2, the ordinates of the curves X, Y showing respectively the head in feet, and the brake power absorbed by the pump, the abscissæ representing the corresponding volumes of water delivered per hour measured in gallons. The curve Z is the corresponding curve of efficiency derived from curves X, Y. The fourth curve Y′ represents approximately the power which would be absorbed by a rotary pump of usual construction working under the same conditions in which the power used is substantially proportional to the quantity of water passed through the impeller. The shaded portion between the two power curves is a measure of the turbine effect or the power given back to the rim of the pump disk, in the case of a pump constructed according to the present invention, by the extra water passed through the impeller.

In the modified construction of Figs. 3 and 4, the body of the impeller is cast with a peripheral grid having partitions a, and a separate nozzle ring b is shrunk or screwed or otherwise secured on the periphery of the grid. One advantage of this construction is that in order to reverse the direction of rotation of the machine it is only necessary to reverse the nozzle ring, and if cutwaters are used they may be similarly mounted in a reversible ring on the casing or cover, so that the machine may be converted into a pump or a turbine running in either direction.

Figs. 5 and 5^a show details illustrating two modifications of the method of attaching the nozzle ring to the body of the impeller, the ring in the former case constituting the nozzles independently of the impeller blades but being supported by extending one side of the impeller to the tip of the nozzles, while in Fig. 5^a one side of the nozzles is constituted by the impeller itself.

It may be in some cases desirable to provide the impeller with adjustable nozzles, and this may be accomplished for example as shown in the construction of Figs. 6 and 7 by constructing the nozzle-forming vanes in two parts s, s', one of which s is fixed, while the other part s' is slidable therein so as to vary the constriction of the nozzle. The various inner sections s' may be correlated so as to be moved outward and inward simultaneously to the same extent by any suitable means, as for example, by linking them with an internally screwed collar or sleeve s^2 movable axially on the shaft by means of a screwed rod, such as s^3.

In the complete pump shown in Figs. 8 and 9, the doubly constricted peripheral nozzles D formed between the vanes B, B′ and the converging side walls of the nozzle ring, which is shown as constructed separate from the body of the impeller A, discharge into expanding ducts between cutwaters E which are provided in a cutwater ring formed separate from the main body of the fixed casing, in which ducts the speed energy due to the absolute velocity of the water is converted into pressure which, together with the effective static pressure of the water in the impeller, gives the pressure of the water in the delivery pipe O.

What is claimed is:

1. A centrifugal pump for incompressible fluids, comprising an impeller which is constructed with a liquid reservoir of very large capacity and peripheral outlets leading therefrom and contracting both transversely and circumferentially from the reservoir toward their discharge ends, the constricted parts of the said outlets being very short and the sum of the areas of the constricted parts a small fraction of the peripheral area of the liquid reservoir.

2. A centrifugal pump for incompressible fluids, comprising an impeller which is constructed with a liquid reservoir of very large capacity and rearwardly directed peripheral outlets leading therefrom and contracting both transversely and circumferentially from the reservoir toward their discharge ends, the constricted parts of the said outlets being very short and the sum of the areas of the constricted parts a small fraction of the peripheral area of the liquid reservoir.

3. A centrifugal pump for incompressible fluids, comprising an impeller constructed with inlet vanes adapted to pick up the water at the inlet and with a chamber of large capacity for the storage of liquid under pressure within the impeller rim, the passages from the inlet to the pressure chamber being constructed of increasing area from the inlet end so as to deliver the water at a low velocity of progression to the pressure chamber, and a series of nozzles in the rim of short length and of such a section that the area of the water passage is reduced rapidly in both transverse and circumferential directions from the pressure chamber toward the periphery, whereby the pressure of the water within the pressure chamber is partly converted into velocity within the impeller.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

EDMUND S. G. REES.

Witnesses:
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