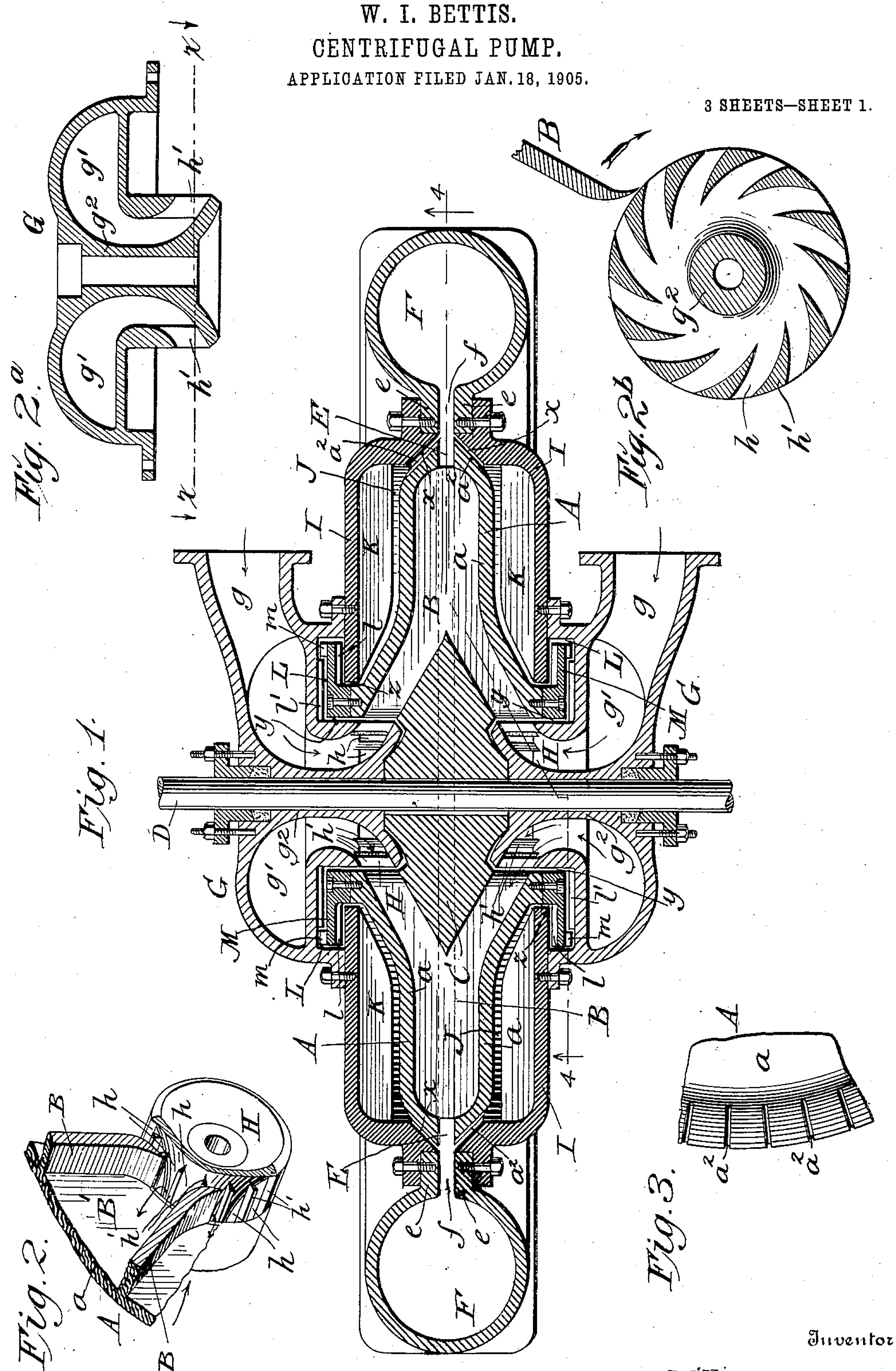
No. 832,230. PATENTED OCT. 2, 1906.

W. I. BETTIS.

CENTRIFUGAL PUMP.

APPLICATION FILED JAN. 18, 1905.

3 SHEETS—SHEET 1.



Witnesses

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Fig. 4.

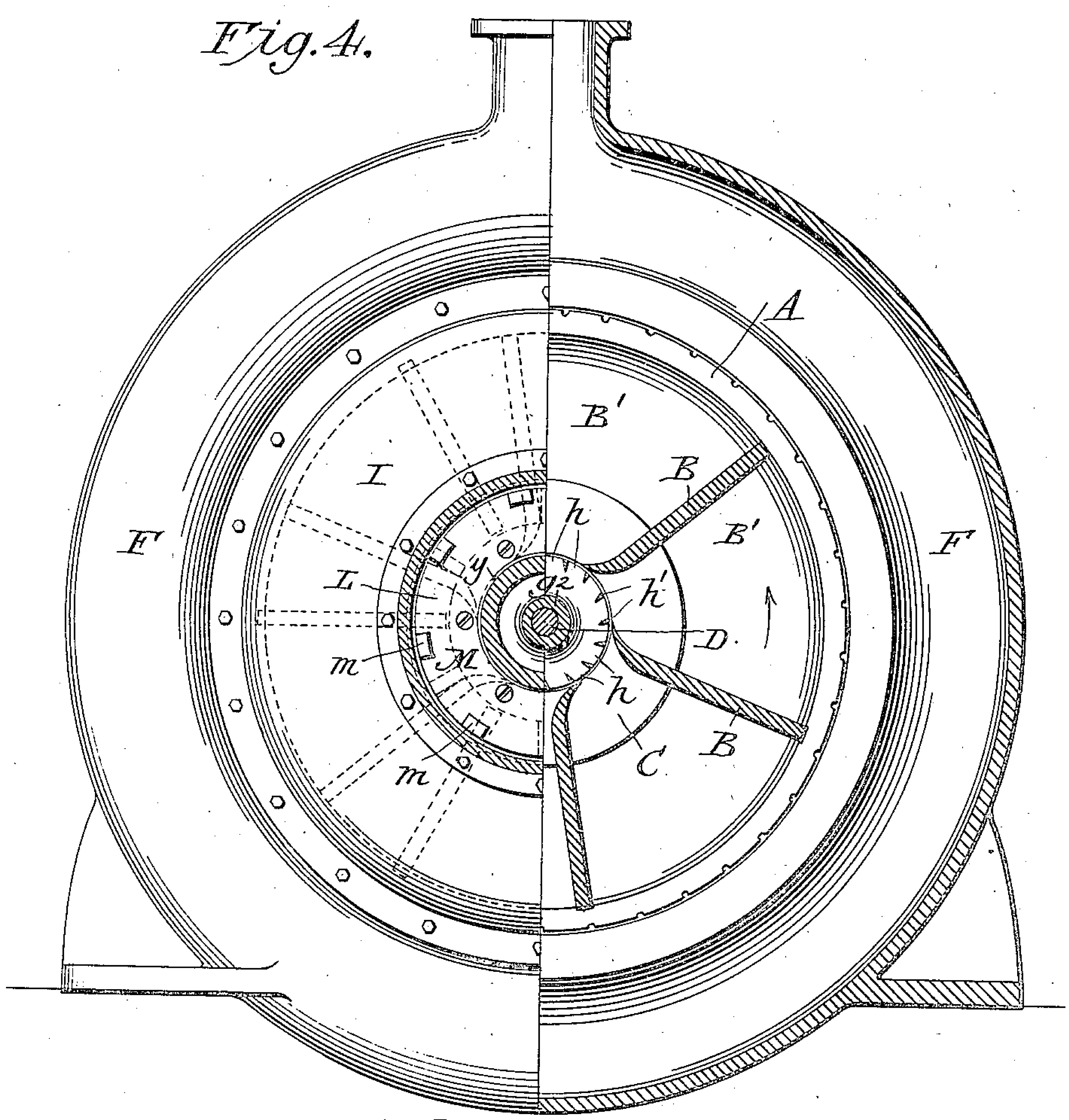


Fig. 5.

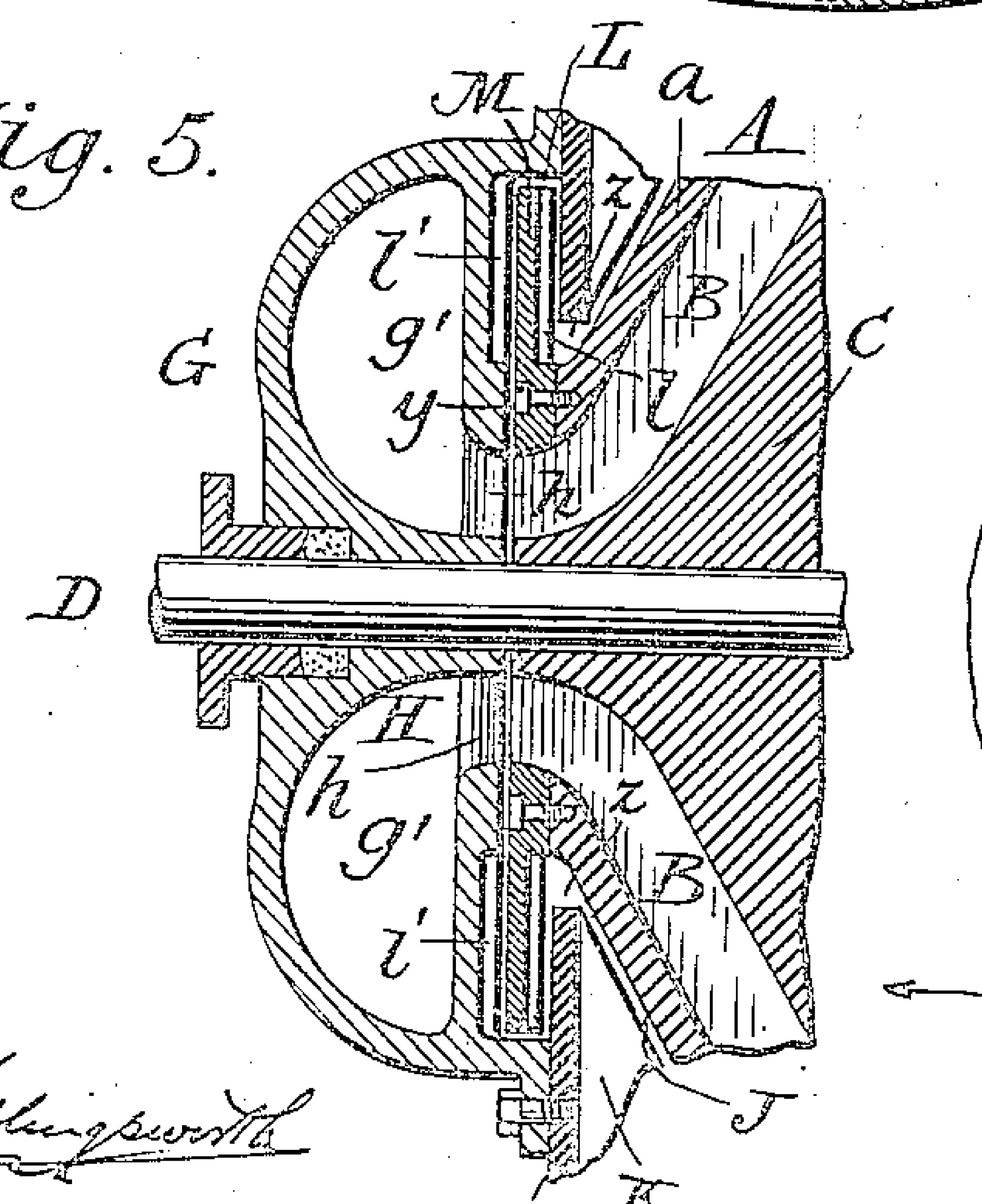
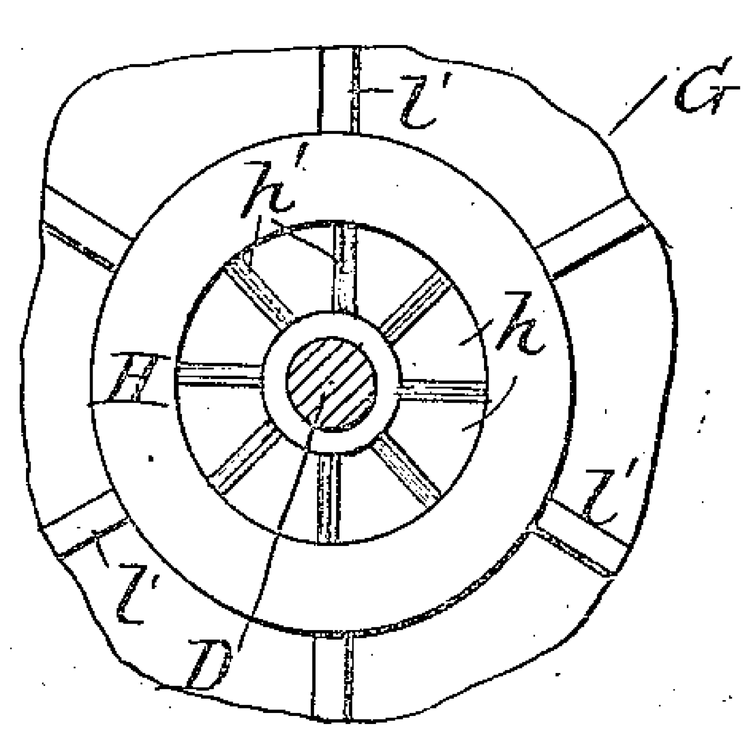


Fig. 6.



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3 SHEETS—SHEET 3.

Fig. 7.

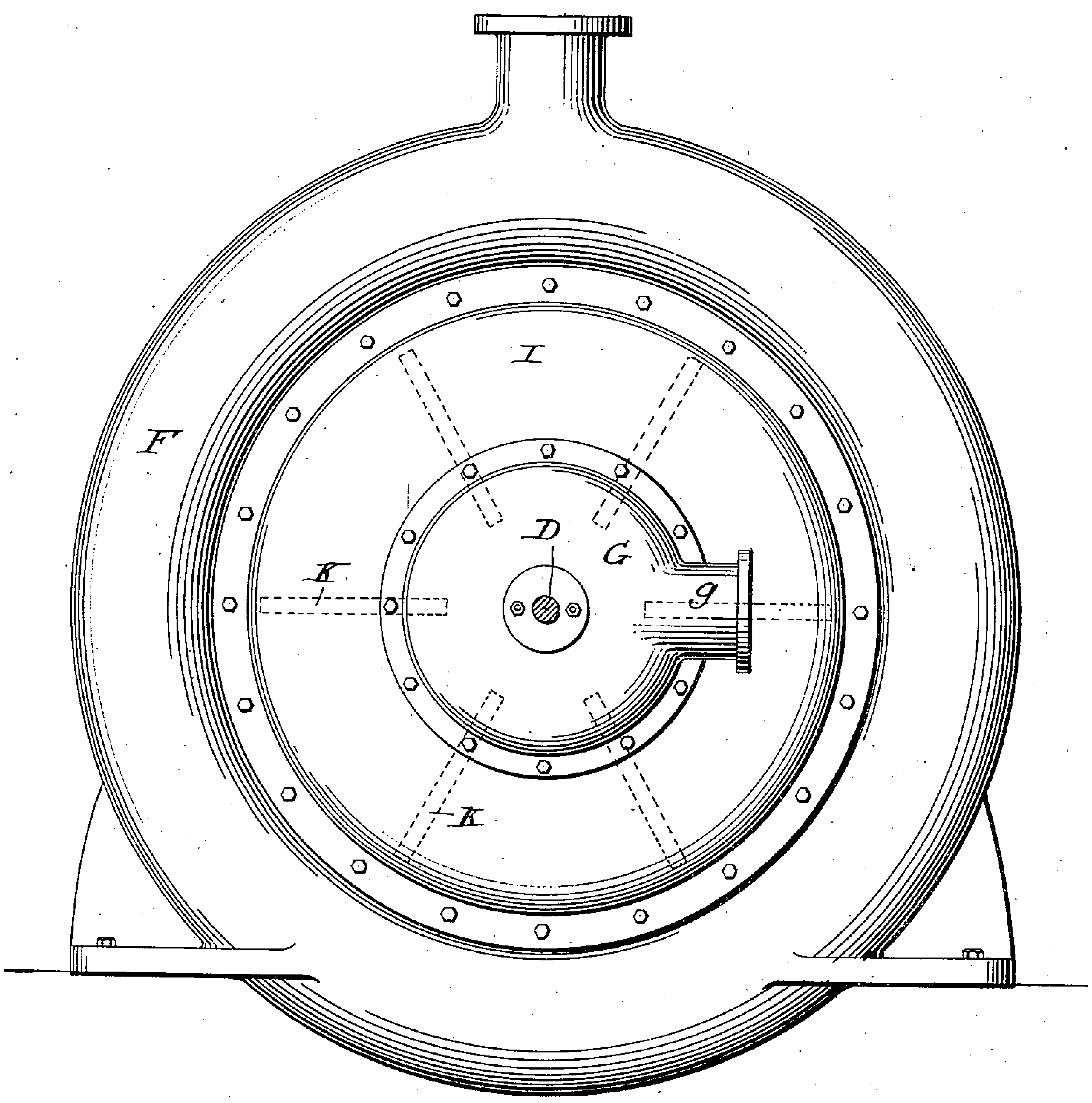
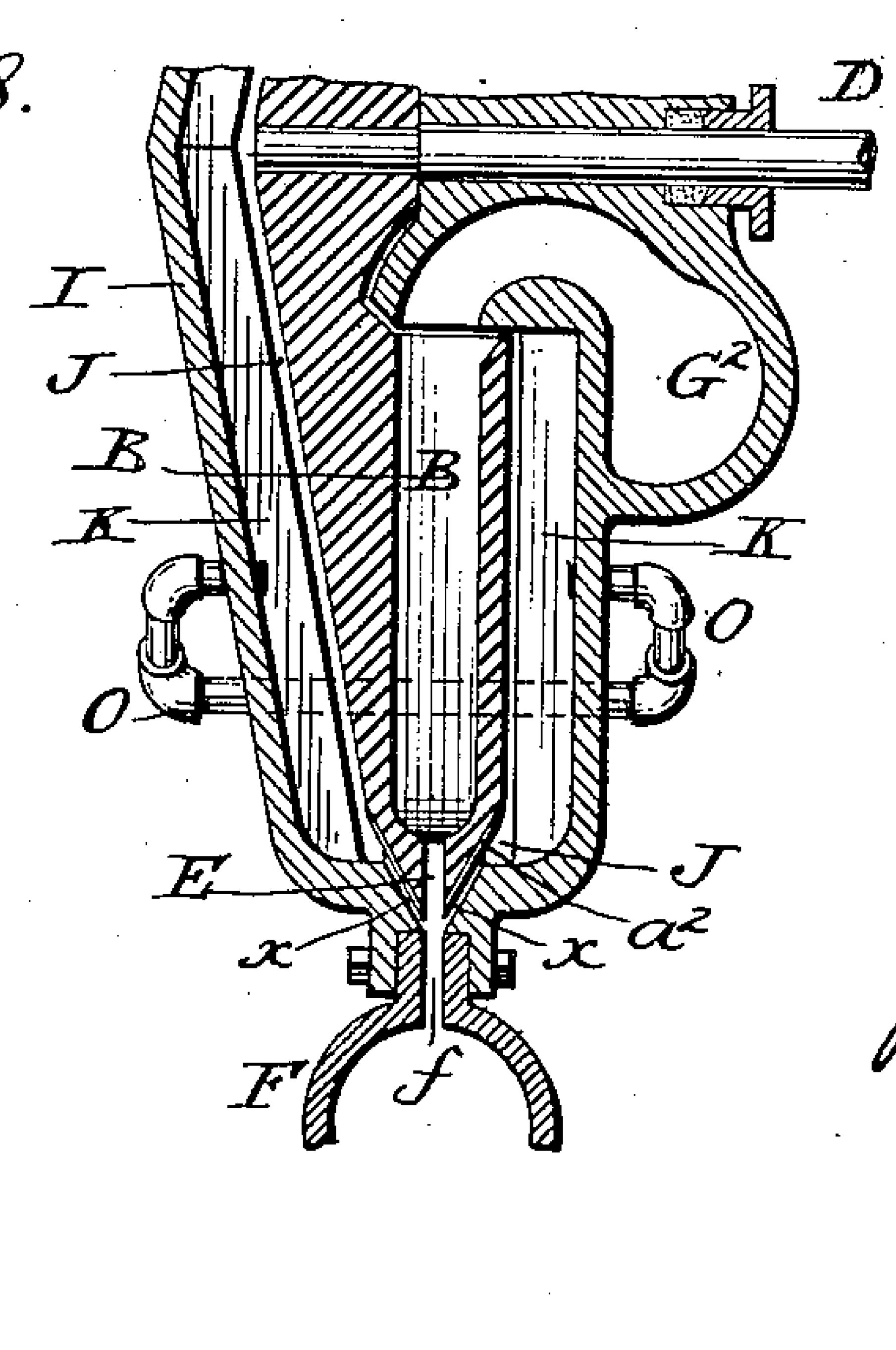


Fig. 8.



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UNITED STATES PATENT OFFICE.

WILLIAM IRVIN BETTIS, OF HOUSTON, TEXAS, ASSIGNOR OF ONE-HALF TO HUGH HAMILTON, OF HOUSTON, TEXAS.

CENTRIFUGAL PUMP.

No. 832,230. Specification of Letters Patent. Patented Oct. 2, 1906.

Application filed January 18, 1905. Serial No. 241,666.

To all whom it may concern:

Be it known that I, William Irvin Bettis, a citizen of the United States, residing at Houston, county of Harris, and State of Texas, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a specification.

My invention relates to centrifugal pumps in which a rotary impeller, having a fluid-entrance at the eye, discharges into a surrounding discharge-chamber.

More particularly the invention relates to centrifugal pumps of the class in which an incased impeller composed of side disks and intervening radial or tangential vanes receives fluid at the eye and discharges it into a surrounding volute or annular discharge-chamber which communicates with chambers formed in a fixed casing inclosing the impeller.

The object of my invention, generally stated, is to reduce or eliminate the loss of energy due to shock of entrance and also the loss of energy due to friction at the periphery of the impeller due to the drag at the junction between the impeller and the surrounding discharge-chamber.

Further objects of my invention are to relieve the impeller from detrimental pressure at the eye or entrance, as well as on its sides, to prevent leakage at the eye of the impeller and also at the discharging portion thereof, to reduce friction at the sides of the impeller, and generally to increase the efficiency of the pump without complicating its construction.

In the general design of my improved pump the fluid is driven from an incased impeller through a contracted orifice or throat at a velocity corresponding to the difference in pressure between the pressure within the impeller and that in the discharge-casing or volute, and the chambers of the pump-casing are emptied and kept clear of fluid by centrifugal action, as well as by the action of the fluid passing through the throat of the impeller and operating as an injector. The fluid enters the impeller through devices which reduce the area of the entrance-port, and consequently increase the initial velocity of the fluid just as it enters the impeller. These devices are also arranged to deliver the fluid to the impeller in a direction corresponding to the direction in which the impeller is rotating, by which arrangement the drag at the eye and the loss of energy due to shock of entrance is obliterated or greatly reduced.

In the operation of my improved pump the impeller and the chambers of its fixed casing are first filled with the fluid to be pumped in order to properly prime the pump, and then the pump is started and the chambers of the casing are automatically emptied, and in the continued operation of the pump a vacuum is maintained in the casing-chambers, thus relieving the impeller from side friction. In order to insure that there shall be no leakage of fluid from the impeller into the casing-chambers, I provide novel devices which interpose a resistance between the impeller and the chambers of the casing and which cause the fluid to flow along the lines of least resistance, which is through the impeller.

A more detailed description of the operation of the pump and of the specific or preferred construction thereof will be given later on.

In the accompanying drawings, Figure 1 shows a horizontal central section of a centrifugal pump embodying my improvements. Fig. 2 is a detail view in perspective, illustrating the relation between the vanes of the rotary impeller and the stationary or inlet vanes through which the fluid passes from the supply-passage to the impeller. Fig. 2ª shows a central section through the casting containing the inlet-passages and the inlet-vanes. Fig. 2ᵇ shows a section through the inlet-vanes and passages on the line x x of Fig. 2ª, and this figure also shows one of the impeller-vanes. Fig. 3 is a detail view of a portion of the rim or periphery of the impeller. Fig. 4 is a view, partly in side elevation and partly in vertical section, on the line 4 4 of Fig. 1. Fig. 5 is a detail view in section of a modification in which the inlet-vanes are arranged to deliver the fluid to the impeller-vanes horizontally instead of tangentially, as in Fig. 1. Fig. 6 is a side elevation of the inlet-vanes looking in the direction of the arrow in Fig. 5. Fig. 7 shows a side elevation of the pump shown in Fig. 1. Fig. 8 is a view in vertical section of a portion of a centrifugal pump, showing a modification wherein the fluid is delivered at the eye to one side of the impeller only and certain parts illustrated in Fig. 1

are omitted. In this figure I have also shown an equalizing-pipe connecting the casing-chambers on opposite sides of the impeller and serving to equalize the pressure in these chambers.

The impeller A, Fig. 1, is composed of two side plates or disks *a*, arranged a suitable distance apart and connected by intervening vanes B, which divide the space between the disks into a series of chambers B′, through which the fluid passes. The vanes are connected with a centrally-arranged hub C, fast on the driving-shaft D. The hub, vanes, and disks are all rigidly connected together and rotate in unison. The periphery of the impeller is tapered outwardly, and the outer edges of the disks are arranged a suitable distance apart to form a contracted annular discharge orifice or throat E, which runs close to the throat *f* of corresponding width in the volute or annular discharge-chamber F. In the pump having a double supply, as illustrated in Fig. 1, the vanes B are branched or bifurcated and extend inwardly on opposite sides of the hub C. The outer portions of the chambers B′ are of approximately the same width from the edge of the hub C to the throat E, the inner sides of the disks being nearly parallel, as shown in Fig. 1, until they approach close to the throat, where the sides are curved or tapered toward the throat. In this way the chambers are made wide just inside the throat, and a pressure is produced at the throat, while the velocity of the fluid is greatly reduced. As the velocity of the fluid within the impeller is reduced at the outer portion of the impeller-chambers the friction of the fluid on the walls of the impeller-chambers is materially reduced, and thus the efficiency of the pump is enhanced.

The fluid enters the impeller through the supply-passages on opposite sides thereof. These passages on each side are formed in a casing G, provided with an entrance-port *g*, which communicates with a chamber *g*′, surrounding the driving-shaft D and having a hub g^2, extending within the plane of the impeller and beyond the inner edges of the impeller-vanes to the hub C. The fluid which enters at *g* passes into the annular chamber *g*′ and is directed into the impeller in such manner as to partake of the direction of movement of the impeller and to be delivered at the general angle in which the impeller-vanes are arranged. In this way the loss of energy due to shock of entrance is avoided, or at any rate, very materially reduced.

I preferably, as shown in Fig. 1, arrange a series of vanes H in the supply-passages at the inner ends of the impeller-vanes, which are so constructed as to reduce the area of the entrance-port, and consequently increase the initial velocity of the fluid. The construction is also such as to change the direction of flow of the fluid to the impeller in the manner before stated, and thus reduce or obviate entirely the loss of energy due to the shock of entrance. The form of the vanes is clearly indicated in Fig. 2. It is also indicated in Fig. 4, where, as it will be seen, the casing G is provided with an annular series of openings *h*, through which the fluid passes, these openings being separated by vanes *h*′, which are properly inclined to direct the fluid in the proper direction in the manner before described. The construction of the casings of the entrance-passages and of the vanes H on opposite sides of the pump are precisely the same as indicated in Fig. 1. It is of course desirable that there should not be sudden changes in velocity. The vanes H, by reducing the area of the entrance-ports, increase the velocity of the entering fluid, so that it approaches the velocity of the fluid carried around by the inner ends of the impeller-vanes.

In Fig. 8 I have shown a construction in which the fluid is admitted to one side only of the pump. In this figure, G^2 indicates the supply-passage, which delivers to the vanes B in a direction in line with the general direction of the movement of the vanes. In this case the vanes H are omitted, as the pump will operate fairly well without the vanes H, although I prefer to use them.

In Fig. 5 the impeller-vanes are prolonged outwardly and their inner edges are substantially radial, while the vanes H deliver horizontally to the impeller-vanes; but in this case also the fluid leaves the vane H at an increased velocity and in a direction corresponding to the disposition and movement of the impeller-vanes.

Referring again to Fig. 1, it will be observed that the impeller is inclosed in a fixed casing, the casing in this instance consisting of two annular frame pieces or sections I on opposite sides of the impeller. At their periphery the casing-sections are bolted to the flanges *e* of the volute or annular discharge-chamber F. The edges of the casing-sections are inclined or tapered correspondingly with the tapered periphery of the impeller, being parallel therewith, but arranged a short distance therefrom, leaving a clear but narrow space for the passage of fluid from the chambers J of the casing to the discharge-chamber F. The arrangement at this part of the pump is quite important and will be hereinafter again referred to.

A careful inspection of Fig. 1 and also an inspection of Fig. 3 will show that the periphery of the impeller is formed with narrow radial grooves a^2 for a purpose presently explained. The chambers J of the casing are annular and in Fig. 1 are on opposite sides of the impeller. They communicate with the throat E and also the throat *f* at the periphery of the impeller through the narrow annular passages *x* above referred to. The casing-sections I carry radially-arranged baffle-plates or ribs K, which are for the purpose of preventing a rotary movement of the water within the chambers J when the pump is first started.

In the operation of my improved pump the impeller, casing-chambers, and supply-passages are all first completely filled with the fluid to be pumped in order to prime the pump. Then a rotary movement is imparted to the impeller, and the fluid is discharged through the throat of the impeller, the chambers J being at this time filled with the fluid, which not only produces a pressure on the impeller, but also creates a detrimental side friction which it is desirable to avoid. In my improved pump soon after the rotary movement of the impeller commences the fluid in the chambers J passes out through the passages x by gravity by the injector force caused by the rush of water through the throats E and f and also by the centrifugal action caused in the passages x by the rapid rotation of the inclined periphery of the impeller. In this way the chambers J are quickly emptied and vacuums are formed in the casing-chambers, the impeller thus being relieved entirely of friction on its sides. If by reason of increased pressure in the discharge-chamber or any other cause the fluid tends to pass inwardly through the passages x to the chambers J, it will pack by capillary attraction in these passages along the overhanging faces of the casing-sections and will be caught by the rotating periphery of the impeller and expelled through the passages x out into the throat of the volute or discharge-casing. This expelling action is sometimes, of course, accompanied by the expelling action due to the rush of fluid through the throats E and f; but even though there should be no injector action such as above mentioned the centrifugal force would be sufficient to prevent the passage of the fluid to the casing-chambers. The grooves a^2 on the periphery of the impeller assist in thus catching the fluid and discharging it, although a plane ungrooved or unribbed periphery would work fairly well. Any tendency for the pump to leak at the junction of the throats E and f is compensated for by this construction, because any tendency to leak back into the pump-casing is obviated or compensated for by the action above described, which throws any fluid which enters the passages x into the throat of the discharge-chamber.

The arrangement at the eye of the pump is such as to cause the fluid to pass easily into the chambers of the impeller which offers the least resistance to the fluid, so that there is little tendency for the fluid to leak at the eye into the casing. To avoid any possibility of leakage at the eye, I provide the devices indicated in Fig. 1. As there shown the casing G on each side of the pump is formed with an annular chamber L, within which is arranged an annular plate or ring M, bolted to the impeller and rotating therewith. This annular plate extends into the chamber L beyond the inner edges of the casing-section, and it is formed with radial ribs l, arranged close to without touching the outer side of the casing-section next the chamber L. The casing G within the annular chamber L is formed with stationary radial ribs l', lying close to the outer face of the plate M. These ribs terminate a short distance from the outer wall of the chamber L and are overlapped by small radial ribs m on the plate M. Any fluid which may leak at the joint y will pass into the chamber L and will tend to pass around the outer edge of the plate M and into the chamber J through the joint z. This is the only way by which the fluid can enter the chamber J; but this is prevented in the following way: As the impeller rotates any fluid which may pass out at the joint y and into the chamber L will be thrown outward by centrifugal force and carried around at the outer end of the chamber L, and this centrifugal force is such that no fluid will pass down into the joint z. In this way a rotary fluid seal is formed which will absolutely prevent any fluid from entering at the eye of the pump into the chambers of the casing. Therefore it will be understood that after the pump has been set into operation and the fluid has been expelled from the chambers of the casing no fluid can reënter said chambers as long as the pump is in operation, because it cannot leak at the eye, for the reasons just described, and it cannot pass into the chambers at the periphery of the pump, for the reasons before explained. Thus I am enabled to use an incased or housed pump so constructed as to prevent all leakage between the impeller and volute or discharge-chamber, and at the same time I am enabled to relieve the impeller from any pressure or friction which would be caused by the presence of fluid in the casing-chambers. It has heretofore been attempted to relieve this side friction or pressure by depending on the injection action at the throat of the pump to withdraw the fluid from the casing-chambers and to employ mechanical packing at the eye of the pump; but this is not sufficient, for the reason that a variation in the head of pressure in the discharge-chamber may stop the ejector action, which would cause the casing-chambers to immediately fill, while in my pump, even if the head varies and the injector action is reduced or suspended, the fluid is still kept out of the casing-chambers by the centrifugal action afforded by the special construction of the periphery of the impeller and the portion of the casing surrounding the impeller's periphery.

I have not dwelt upon the special construction or arrangement of the vanes of the impeller as these may be arranged radially, tangentially, or may be curved; but I prefer the construction and arrangement illustrated.

The fluid need not necessarily be admitted to the opposite sides of the impeller, though this is preferred.

In Fig. 8 the construction of a pump where the entrance is only at one side is clearly illustrated. The pressure in the chambers J on opposite sides of the impeller may be equalized by means of a pipe connection O.

The general principles of construction of the pump illustrated in Fig. 1 are present in the pump illustrated in Fig. 8 so far as the means provided for emptying the casing-chambers or for maintaining a vacuum therein are concerned. In the pump illustrated in Fig. 8, however, I have omitted the vanes H at the entrance to the impeller and have also omitted the devices for preventing leakage at the eye from the impeller into the casing-chambers, as I find that under some conditions there is not necessarily any leakage or any tendency to leak at the eye, because the path which leads from the supply-entrance to the impeller is that of least resistance.

It will be observed also that both in Figs. 1 and 8 the joint at y is a horizontal one and there is no tendency for centrifugal action to throw the fluid through this joint, as there would be if this joint were a vertical one.

It will be observed that the vanes B do not enter the throat E, in which there is an unobstructed rotary whirlpool or diffusion-chamber. The edges of the vanes are thus held away from the fluid in the stationary chamber, and thus the drag at the periphery of the impeller, often found in pumps of this class, is greatly reduced.

I claim as my invention—

1. A centrifugal pump comprising an impeller having an annular contracted discharge-throat formed in its tapered periphery, a discharge-chamber surrounding the impeller and communicating therewith, and a fixed chambered casing inclosing the impeller and having a tapered or inclined communication between its chambers and the discharge-chamber.

2. A centrifugal pump comprising an inclosed impeller having an annular contracted discharge-throat formed in its tapered periphery, an annular discharge-chamber surrounding the impeller and having an annular contracted throat communicating with the throat of the impeller and a fixed chambered casing inclosing the impeller and having a tapered or inclined communication on opposite sides of the impeller between its chambers and the discharge-chamber.

3. A centrifugal pump comprising an impeller having a tapered periphery and an annular contracted discharge-throat, an annular discharge-chamber having a contracted throat communicating with the throat of the impeller, a fixed chambered casing for the impeller and an annular passage along the tapered periphery of the impeller for establishing a communication between the chambers of the casing and the discharge-chamber.

4. A centrifugal pump comprising an impeller having a tapered radially-grooved periphery, and discharging through its periphery, a discharge-chamber surrounding the impeller and communicating therewith, and a fixed chambered casing inclosing the impeller and communicating with the discharge-chamber by a passage along the grooved periphery of the impeller.

5. A centrifugal pump comprising a rotary impeller communicating with a discharge-chamber surrounded by a casing and having a peripheral surface which moves at a higher speed than the vanes and which is constructed to throw fluid therefrom by centrifugal action into the discharge-chamber, and means for preventing leakage at the eye of the impeller.

6. A centrifugal pump comprising a rotary impeller having a tapered periphery, a discharge-chamber communicating with the impeller, a fixed casing surrounding the impeller and having vacuum-chambers communicating with the discharge-chamber, and vanes at the eye of the impeller for reducing the entrance-port and thus increasing the velocity of the entering fluid.

7. A centrifugal pump, comprising a rotary impeller, a discharge-chamber communicating therewith, a fixed casing at the side of the impeller which is emptied by the impeller and contains a chamber communicating with the discharge-chamber, a seal at the eye of the impeller and means within said fixed casing for preventing any centrifugal action, thereby breaking the pull of fluid through the seal at the eye of the impeller when the pump is first started.

8. A centrifugal pump, comprising a rotary impeller, a discharge-chamber communicating therewith, a fixed chambered casing surrounding the impeller and communicating with the discharge-chamber, fixed ribs within the chambered casing, for preventing the rotation of the fluid therein when starting the pump, a seal at the eye of the impeller, and means for exhausting the fluid from said chambered casing after the pump is started.

9. A centrifugal pump comprising a rotary impeller, a discharge-chamber communicating therewith, a fixed chambered casing surrounding the impeller and communicating with the discharge-chamber, fixed ribs within the chambers for preventing the rotation of the fluid therein, and a centrifugal water seal

at the eye of the impeller for preventing the entrance of fluid to the chambers of the fixed casing.

10. A centrifugal pump comprising a rotary impeller, a fixed chambered casing therefor, a discharge-chamber communicating with the chambers of the casing and a centrifugal water seal for preventing fluid from entering the casing-chambers while the pump is in operation.

11. A centrifugal pump comprising a rotary impeller, a discharge-chamber communicating therewith, a chambered casing surrounding the impeller, a casing containing a supply-passage at the eye of the impeller and formed with an annular chamber around the eye, and a ribbed plate carried by the impeller and operating in said annular chamber for producing a centrifugal water seal to prevent leakage of the pump at the eye.

12. A centrifugal pump comprising a rotary impeller having impeller-vanes and sides extending beyond the outer tips of the vanes to provide between them a rotary whirlpool-chamber, in combination with a discharge-chamber, communicating with the whirlpool-chamber, a fixed casing inclosing the impeller and vanes in the eye of the impeller for increasing the velocity of the entering fluid and for directing the fluid to the impeller-vanes.

13. A rotary impeller having impelling-vanes and a contracted discharge-throat in its rim outside the tips of the vanes so proportioned as to gradually increase the area or capacity of the throat radially outward and thus gradually decrease the discharge velocity of the fluid and so providing a rotary whirlpool or diffusion chamber in the rim of the impeller in combination with the discharge-chamber or volute surrounding the impeller.

14. A centrifugal pump comprising a rotary impeller communicating with a discharge-chamber surrounded by a casing and having means on its periphery moving at a higher speed than the impeller-vanes and adapted to throw fluid therefrom by centrifugal action into the discharge-chamber.

15. A centrifugal pump comprising an impeller having an annular contracted discharge-throat formed in its tapered periphery outside the tips of the impeller-vanes to provide a rotary whirlpool or diffusion chamber, a discharge-chamber surrounding the impeller and communicating with the discharge-throat thereof, and a casing for the tapered periphery of the impeller, for the purpose specified.

16. A centrifugal pump, comprising a rotary impeller communicating with a discharge-chamber, surrounded by a casing at its sides and having means traveling in a path outside that traversed by the tips of the impeller-vanes adapted to throw fluid therefrom and prevent a backflow from the discharge-chamber by centrifugal action sufficient to overcome a head due to the action of the impeller-vanes.

In testimony whereof I have hereunto subscribed my name.

WILLIAM IRVIN BETTIS.

Witnesses:

LLOYD B. WIGHT,

K. H. FENNING.