

Dec. 24, 1957

G. FABIG
CENTRIFUGAL PUMPS

2,817,296

Filed Nov. 23, 1955

3 Sheets-Sheet 1

Fig. 1

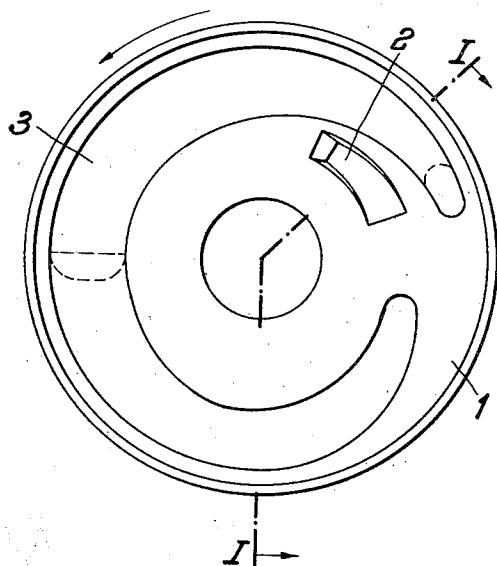


Fig. 2

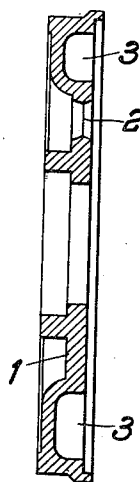
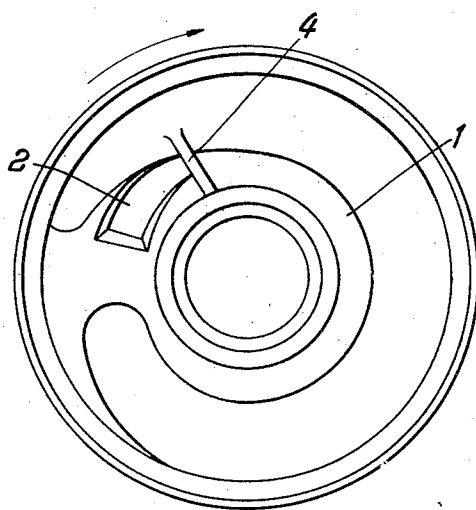


Fig. 3



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Fig. 4

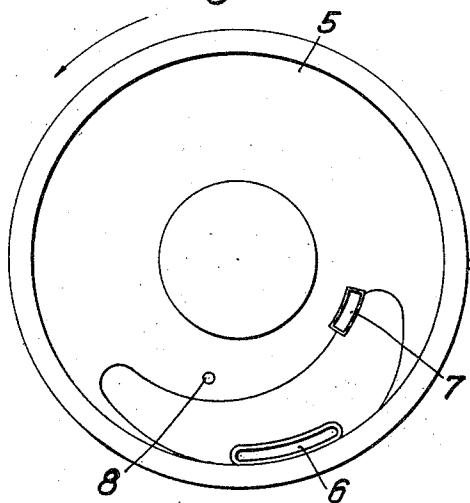


Fig. 5

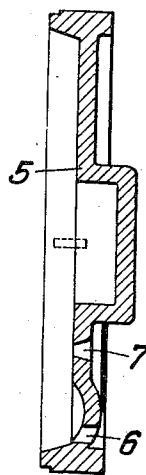
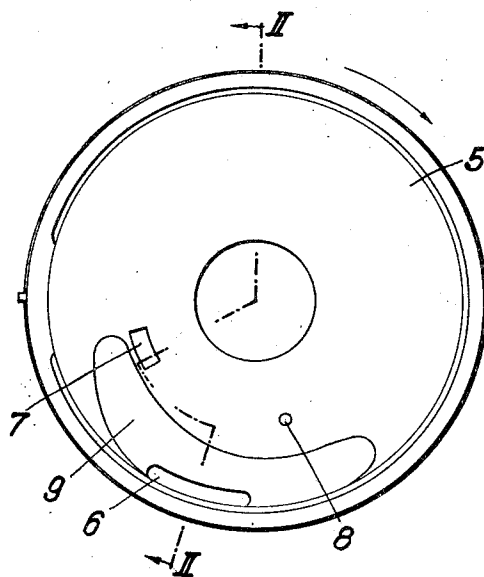


Fig. 6



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Fig. 7

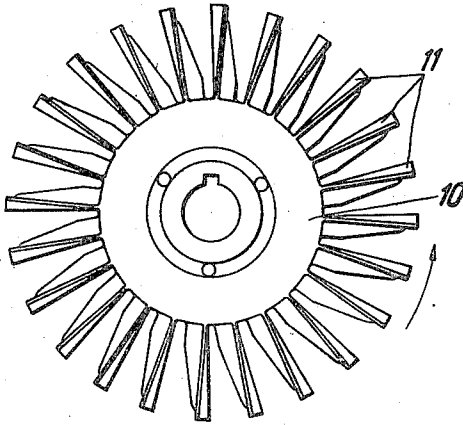


Fig. 8

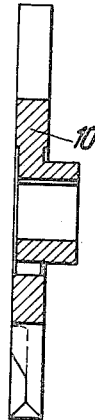


Fig. 9

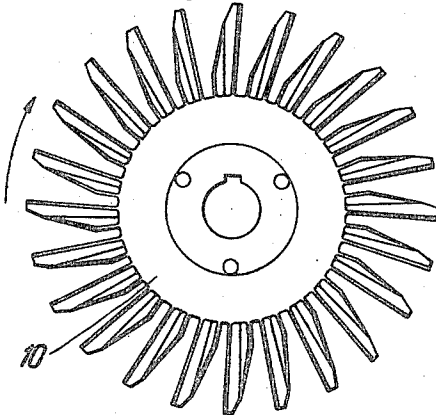


Fig. 10

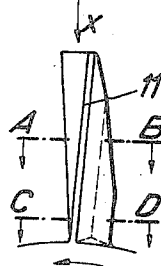


Fig. 11

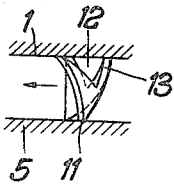


Fig. 12

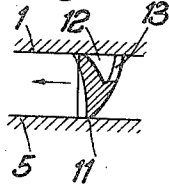
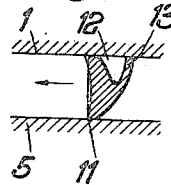


Fig. 13



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CENTRIFUGAL PUMPS

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6 Claims. (Cl. 103—113)

Self-priming centrifugal pumps have heretofore been so constructed that an annular passage is arranged symmetrically with respect to the pump impeller wheel, that is to say an annular passage is provided in each of the two halves of the pump casing. Self-priming centrifugal pumps are also known wherein only a single lateral annular passage is provided. In the known pumps, this passage is usually disposed in the pressure-side half of the pump casing, but has sometimes been disposed in the suction-side half of the casing.

Water-ring pumps are self-priming centrifugal pumps in which the suction effect is brought about by the fact that the impeller wheel of the pump cooperates with a ring of water whose inner surface is eccentric to the axis of the impeller wheel. Such eccentricity can be obtained by providing for the water ring a passage located eccentrically to the axis of the impeller wheel, or a passage whose exterior surface is centric but whose width increases and thereafter decreases in the peripheral direction. The widening of the water-ring passage in most cases has heretofore been provided symmetrically in the two halves of the pump housing in form of so-called side channels.

Due to the fact that the inner surface of the water ring is eccentric to the axis of the impeller wheel, the water of the ring, during the suction operation, moves at first outwardly relative to the wheel axis and thus partially leaves the chambers of the impeller wheel, whereafter the water again enters into the chambers. The water leaving the wheel chambers causes air to be sucked into the chambers; thereafter, namely when the water again enters into the chambers, the air is compressed and is ultimately forced out of the pressure outlet of the pump. Consequently, between the hub of the wheel, that is between the bottoms of the individual chambers of the wheel on the one hand and the inner surface of the water ring on the other hand, there exists a crescent-shaped hollow space which serves for compressing and discharging the air during the suction operation.

To secure a high suction effect in such a pump it is of utmost importance that the water ring can move in the pump housing as free as possible of friction. Sudden step-like changes in cross section of the water-ring channel must be avoided. For that reason the pump housing, that is its two half portions, must therefore be so designed that the channel portion of largest width will only gradually merge with a smaller width and vice versa.

In centrifugal pumps of the type mentioned, the impeller wheel has also been designed with inclined or helically twisted blades or vanes. The inclination of the blades was such that the leading edge of the front surface of each blade was adjacent the pressure side and tended to retain the liquid in the impeller wheel.

The invention is concerned with a self-priming centrifugal pump having an annular passage for the liquid provided only in the suction-side half of the casing and an impeller wheel provided with inclined or helically twisted blades. According to the invention, a considerable increase in the efficiency of the pump is obtained by pro-

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viding the pressure-side half of the casing with a receiving space extending over only a fraction of the periphery, and arranged substantially symmetrically with respect to an outlet opening into which it runs, and by arranging the blades of the impeller wheel in such a way that they are so inclined that the edges of their front surfaces which are adjacent the receiving space on the pressure side trail in relation to the direction of rotation of the impeller wheel.

In the pump of the invention the blades of the runner are so inclined or helically twisted that they tend to convey the liquid contained in the annular passage from the suction-side half of the casing to the pressure side of the pump. In consequence thereof, favourable flow conditions are obtained in the operation of the pump and the efficiency of the pump is thereby improved.

At the same time, however, owing to the axial conveying action of the impeller wheel, an axial thrust is produced which tends to force the impeller wheel towards the suction-side half of the casing. This axial thrust may be neutralized, in accordance also with the invention, by providing the blades of the impeller, which have a wedge-shaped cross-section which tapers towards the pressure side and is limited at the front and rear surfaces by a concave and convex arc respectively, with a substantially triangular groove or pocket arranged on the thick side of the wedge. Preferably, the free edge of the wall of each blade limiting the pocket or groove at the rear extends obliquely towards the periphery of the impeller, and only commences outside the range of the suction orifice, in such manner that, in the region of the outlet opening, the blade only has a substantially sickle-shaped cross-section.

With such a construction of the blades of the impeller, the liquid entering the pockets or grooves in the blades during the suction action forms a kind of cushion which tends to displace the impeller against the aforesaid axial thrust, so that the axial thrust cannot take effect. At the same time, an improved centrifugal action of the impeller is obtained by means of the pockets or grooves in the blade, especially as the pockets or grooves are provided in the part of the impeller where the peripheral speed is lower.

An embodiment of the invention is shown by way of example in the drawing, in which the figures illustrate the individual parts of the pump.

Fig. 1 is a view of the suction-side half of the casing, seen from the inside, that is, from the right of Fig. 2;

Fig. 2 is a section through said half of the casing on the line I—I of Fig. 1, seen from the left of Fig. 1, and

Fig. 3 is a view of said half of the casing from the outside, that is, from the left of Fig. 2;

Fig. 4 represents a view of the pressure-side half of the pump casing seen from the outside, that is, from the right side of Fig. 5;

Fig. 5 is a section through this half of the casing on the line II—II of Fig. 6, and

Fig. 6 is a view of said half of the casing from the inside, that is, from the left side of Fig. 5;

Figs. 7 to 9 are two end views and a section respectively of the pump impeller wheels, while

Fig. 10 is an elevation of a single blade of the runner and

Figs. 11 to 13 are respectively a view of the blade in the direction of the arrow X and two sections through the blade on the lines A—B and C—D, respectively, in Fig. 10.

Referring to the drawing, the suction-side casing half 1 shown in Figs. 1 to 3 is provided with a suction opening 2 and a lateral annular passage 3. The annular passage has a cross-section which, starting from the region of the suction opening 2, gradually becomes larger and finally

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becomes smaller again in the direction of rotation indicated by the arrow. The last part of the passage 3 is brought closer to the axis of the pump, in spiral fashion. Since the suction opening 2 extends obliquely in the direction of rotation of the pump, the wall thickness of the casing half 1 is considerably reduced at the end of the opening 2. For this reason, a reinforcing rib 4 is provided at this point, as shown in Fig. 3.

Figs. 4 to 6 show the pressure-side casing half 5 of the pump. This half of the casing is provided with an outlet opening 6 for the liquid conveyed by centrifugal action and an outlet opening 7 for the liquid conveyed due to the effect of displacement. Furthermore, an auxiliary orifice 8 is provided in front of the outlet opening 6, with reference to the direction of rotation of the pump, approximately at the same distance from the axis of the pump as the outlet opening 7, through which auxiliary orifice liquid can enter the compartments of the impeller wheel during the suction process, so as thereby to improve the suction effect. Arranged substantially symmetrically in the part 5 of the casing with respect to the outlet opening 6 is a receiving space 9 extending over only a fraction of the periphery, said receiving space having its greatest depth in the region of the opening 6 and gradually decreasing in width in both directions.

The impeller wheel of the pump shown in Figs. 7 to 9 comprises blades having the shape illustrated in detail in Figs. 10 to 13. The individual blades are inclined or helically twisted in such a manner that those edges of their front surfaces which are disposed towards the pressure-side half of the casing trail relative to the edges of the front surfaces on the suction-side of the casing, with respect to the direction of rotation of the impeller. These trailing edges are marked 11 in the drawing. Moreover, the blades of the impeller 10 have a wedge-shaped cross-section tapering towards the pressure side 5 and of which the front and rear surfaces are bounded by a concave and a convex arc respectively, and having a substantially triangular groove or pocket 12 provided on the blunt side of the wedge, as illustrated in Fig. 13. In this way, a wall 13 limiting the hollow space of the pocket or groove 12 at the back is provided. This wall 13 is so sloped off or inclined towards the periphery of the impeller that it begins only outside the range of the suction opening 2 (see Figs. 1 to 3), whereas in the region of the outlet opening 6 (see Figs. 4 to 6) the individual blades have a substantially sickle-shaped cross-section (see Figs. 11 and 12).

The pump described operates as follows: During the suction process, the air sucked in passes through the opening 2 in the suction-side casing half 1 into the compartments of the impeller 10. Owing to the water present in the annular passages when the pump is running, the air is conveyed through the outlet opening 7 into the pressure connection (not shown) of the pump owing to the displacement effect of the pump. During the suction process, the compartments of the impeller 10 are filled with liquid as usual through the auxiliary orifice 8 in the pressure-side casing half 5 and the suction effect of the pump is thus improved. The liquid entering the pump through the opening 2 together with the air sucked in passes partly into the compartments between the blades of the impeller 10 and partly into the grooves 12 in the individual blades. The liquid is thrown outwards by centrifugal force, so that the ring of liquid in the annular passage is strengthened and the suction effect is further improved.

Finally, the pump is completely filled with liquid. It then still operates partly on the displacement principle, but conveys the liquid mainly by centrifugal force. The liquid thrown outwards by centrifugal action therefore places the annular passage 3 in the suction-side casing half 1 under high pressure. The pressure liquid can now only pass into the pressure connection of the pump

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through the two outlet openings 6 and 7 in the pressure side casing half 5. In this process, the liquid must pass out of the annular passage 3 across the compartments of the impeller into the receiving space 9 and via the latter into the outlet opening 6. This flow of the liquid conveyed is assisted by the inclination of the blades of the impeller 10. Since the blades of the impeller 10 have a substantially sickle-shaped cross-section in the region of the outlet opening 6, the liquid can enter the outlet opening 6 without considerable losses due to turbulence or the like. The particularly high efficiency of the pump of the invention appears to be due to these conditions.

I claim:

1. A self-priming centrifugal pump comprising an impeller wheel, inclined impeller blades on said wheel, a casing enclosing said wheel and blades, the casing having a suction-side and a pressure-side, suction and outlet openings in said casing, a lateral substantially annular passage for liquid in the suction-side part of said casing, a liquid-receiving space in the pressure-side part of said casing, said space extending only over a fraction of the periphery of said casing and being arranged substantially symmetrically, in circumferential extent, with respect to and merging into said outlet opening, said outlet being the centrifuged liquid outlet, the liquid passing out of the annular passage, across the impeller blades into the liquid-receiving space, and the inclination of said blades being such that the edges of their front surfaces adjacent said pressure-side part of said casing trail relative to the edges of the front surfaces on the suction-side of the casing, in the direction of rotation of the impeller wheel, said blades being of wedge-shaped cross-section with the thin end of the wedge adjacent the pressure-side part of said casing and their front and rear surfaces being respectively concave and convex and the blunt edge of said wedge being formed with a pocket of substantially triangular shape.

2. A self-priming centrifugal pump comprising an impeller wheel, inclined impeller blades on said wheel, a casing enclosing said wheel and blades, the casing having a suction-side and a pressure-side, suction and outlet openings in said casing, a lateral substantially annular passage for liquid in the suction-side part of said casing, a liquid-receiving space in the pressure-side part of said casing, said space extending only over a fraction of the periphery of said casing and being arranged substantially symmetrically, in circumferential extent, with respect to and merging into said outlet opening, said outlet being the centrifuged liquid outlet, the liquid passing out of the annular passage, across the impeller blades into the liquid-receiving space, and the inclination of said blades being such that the edges of their front surfaces adjacent said pressure-side part of said casing trail relative to the edges of the front surfaces on the suction-side of the casing, in the direction of rotation of the impeller wheel, said blades being of wedge-shaped cross-section with the thin end of the wedge adjacent the pressure-side part of said casing and their front and rear surfaces being respectively concave and convex and the blunt edge of said wedge being formed with a pocket of substantially triangular shape, said pocket being limited on the rear side by a wall which is rearwardly inclined.

3. A self-priming centrifugal pump comprising an impeller wheel, inclined impeller blades on said wheel, a casing enclosing said wheel and blades, the casing having a suction-side and a pressure-side, suction and outlet openings in said casing, a lateral substantially annular passage for liquid in the suction-side part of said casing, a liquid-receiving space in the pressure-side part of said casing, said space extending only over a fraction of the periphery of said casing and being arranged substantially symmetrically, in circumferential extent, with respect to and merging into said outlet opening, said outlet being the centrifuged liquid outlet, the liquid passing out of the annular passage, across the impeller blades into the liquid-

receiving space, and the inclination of said blades being such that the edges of their front surfaces adjacent said pressure-side part of said casing trail relative to the edges of the front surfaces on the suction-side of the casing, in the direction of rotation of the impeller wheel, said blades being of wedge-shaped cross-section with the thin end of the wedge adjacent the pressure-side part of said casing and their front and rear surfaces being respectively concave and convex and the blunt edge of said wedge being formed with a pocket of substantially triangular shape, said pocket being limited on the rear side by a wall which is rearwardly inclined to the direction of rotation, the said wall beginning outside the region of the outlet opening.

4. A self-priming centrifugal pump comprising an impeller wheel, inclined impeller blades on said wheel, a casing enclosing said wheel and blades, the casing having a suction-side and a pressure-side, suction and outlet openings in said casing, a lateral substantially annular passage for liquid in the suction-side part of said casing, a liquid-receiving space in the pressure-side part of said casing, said space extending only over a fraction of the periphery of said casing and being arranged substantially symmetrically, in circumferential extent, with respect to and merging into said outlet opening, said outlet being the centrifuged liquid outlet, the liquid passing out of the annular passage, across the impeller blades into the liquid-receiving space, and the inclination of said blades being such that the edges of their front surfaces adjacent said pressure-side part of said casing trail relative to the edges of the front surfaces on the suction-side of the casing, in the direction of rotation of the impeller wheel, said blades being of wedge-shaped cross-section with the thin end of the wedge adjacent the pressure-side part of said casing and their front and rear surfaces being respectively concave and convex and the blunt edge of said wedge being formed with a pocket of substantially triangular shape, said pocket being so arranged that, in the region of said outlet opening, the blades are of solid, sickle-like cross-section.

5. A self-priming centrifugal pump that delivers one portion of the sucked-in liquid by displacement and another portion by centrifugal action, comprising an impeller wheel, inclined impeller blades on said wheel, a casing enclosing said wheel and blades, the casing having a suction-side and a pressure-side, a suction inlet opening, in the suction-side, and displaced liquid and centrifugally delivered liquid outlet openings in the pressure-side of said casing, a unilateral substantially annular passage for liquid in the suction-part of the casing, and providing a unilateral ring of liquid whose inner surface is eccentric to the axis of the impeller wheel, said eccentric ring of liquid not being provided in the pressure-side of said casing, a restricted liquid-receiving space in the pressure-side of the casing, said space extending only over a fraction of the periphery of the casing and being arranged substantially symmetrically, in circumferential extent, with respect to and merging

with said outlet opening for centrifugally delivered liquid, the liquid passing out of the annular passage across the impeller blades into the receiving space, the inclination of the blades being such that the edges of their front surfaces adjacent said pressure-side of the casing trail relative to the edges of the front surfaces on the suction-side of the casing, in the direction of rotation of the impeller wheel, said blades being of wedge-shaped cross-section with the thin end of the wedge adjacent the pressure-side part of said casing and their front and rear surfaces being respectively concave and convex and the blunt edge of said wedge being formed with a pocket of substantially triangular shape.

6. A self-priming centrifugal pump that delivers one portion of the sucked-in liquid by displacement and another portion by centrifugal action, comprising an impeller wheel, inclined impeller blades on said wheel, a casing enclosing said wheel and blades, the casing having a suction-side and a pressure-side, a suction inlet opening, in the suction-side, and displaced liquid and centrifugally delivered liquid outlet openings in the pressure-side of said casing, a unilateral substantially annular passage for liquid in the suction-part of the casing, and providing a unilateral ring of liquid whose inner surface is eccentric to the axis of the impeller wheel, said eccentric ring of liquid not being provided in the pressure-side of said casing, a restricted liquid-receiving space in the pressure-side of the casing, said space extending only over a fraction of the periphery of the casing and being arranged substantially symmetrically, in circumferential extent, with respect to and merging with said outlet opening for centrifugally delivered liquid, the liquid passing out of the annular passage across the impeller blades into the receiving space, the inclination of the blades being such that the edges of their front surfaces adjacent said pressure-side of the casing trail relative to the edges of the front surfaces on the suction-side of the casing, in the direction of rotation of the impeller wheel, said blades being of wedge-shaped cross-section with the thin end of the wedge adjacent the pressure-side part of said casing and their front and rear surfaces being respectively concave and convex and the blunt edge of said wedge being formed with a pocket of substantially triangular shape, said pocket being limited on the rear side by a wall which is rearwardly inclined to the direction of rotation, the said wall beginning outside the region of the outlet opening for centrifugally delivered liquid.

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