K. KIEFER.

CENTRIFUGAL PUMP.

APPLICATION FILED DEC. 6, 1913.

1,183,075. Patented May 16, 1916.

Fig. 3.

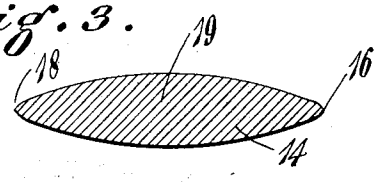


Fig. 4.

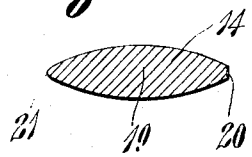


Fig. 1.

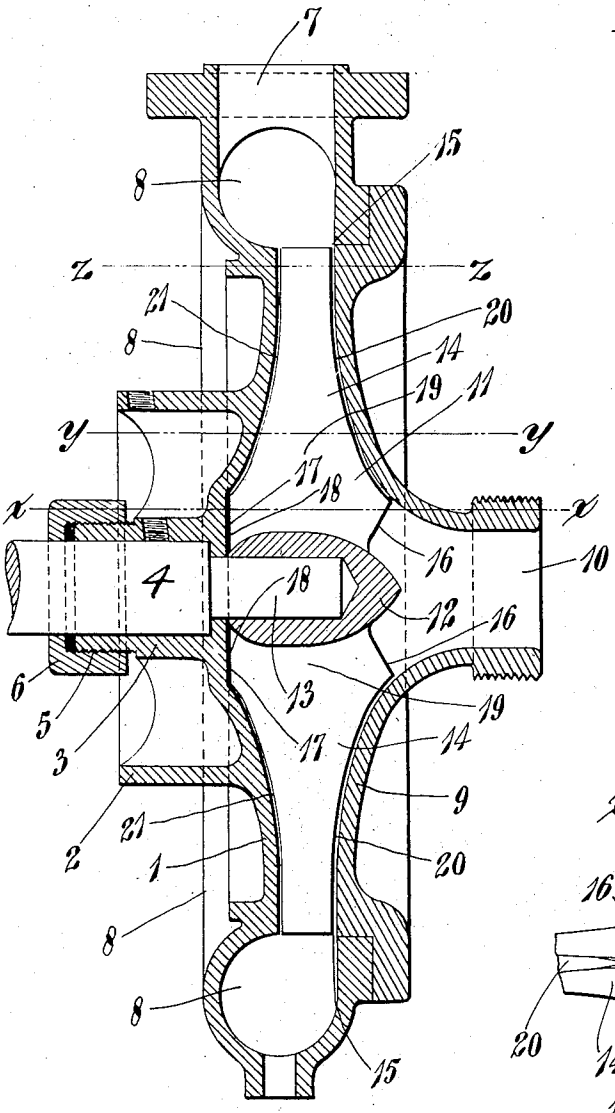


Fig. 5.

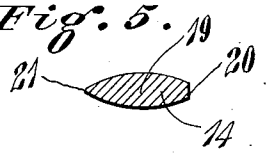
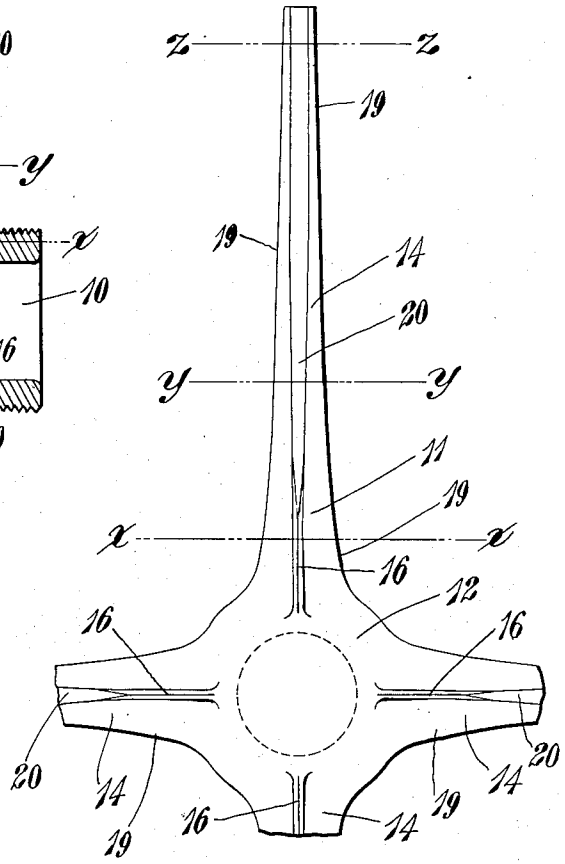


Fig. 2.



Witnesses:

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CENTRIFUGAL PUMP.

1,183,075. Specification of Letters Patent. Patented May 16, 1916.

Application filed December 6, 1913. Serial No. 804,988.

To all whom it may concern:

Be it known that I, KARL KIEFER, a citizen of the United States, and a resident of Cincinnati, in the county of Hamilton and State of Ohio, have invented certain new and useful Improvements in Centrifugal Pumps, of which the following is a specification.

My invention relates to centrifugal apparatus, and its object is to so construct such apparatus that the axial pressures on the rotor will be neutralized and their effect eliminated, whereby the friction will be minimized and the efficiency of the pump increased.

In the drawing: Figure 1 is a vertical cross section of a centrifugal pump embodying my invention; Fig. 2 is an enlarged front side elevation of the impeller; parts of three of the four blades being broken away for lack of space; Fig. 3 is a cross section through the impeller blade on the line *x*—*x* of Fig. 1 or Fig. 2; Fig. 4 is a similar cross section on the line *y*—*y* of Fig. 1 or Fig. 2; and Fig. 5 is a similar cross section on the line *z*—*z* of Fig. 1 or Fig. 2.

The centrifugal pump chosen for illustration of my invention consists of the casing 1 having a suitable flange 2 for mounting the pump on a base, and having a bearing 3 for the pump shaft 4, with threads 5 receiving a suitable stuffing cap 6. This casing 1 has, at its top, the outlet 7 leading from the conduit 8 that extends entirely around the pump casing; and the front of the casing is closed by a cover 9 having the inlet 10 at the center.

The impeller 11 has the hub 12 by means of which it is fixed on the end part 13 of the pump shaft 4, and has, as here shown, four radial blades 14. The outer circle of rotation of these blades lies in the opening 15, through which opening the main part of the casing communicates with the surrounding conduit 8; so that the impeller 11 thus discharges the fluid from its blades 14 directly into this conduit 8 to escape through the outlet 7, the fluid having entered through the inlet 10 at the center. To freely admit the fluid from the inlet 10, the hub 12 is tapered toward the inlet, preferably of conoidal shape as shown; being cylindrical in its other part near the bearing 3, and preferably having a similar face presented toward the bearing.

The central part of the casing 1 in the region of the inlet 10 and hub 12 is of considerable width, with the inlet 10 flaring into it, but, in the regions near the surrounding conduit 8, the casing is considerably reduced in width, being tapered gradually from the greater to the lesser width preferably along curves presenting their convexities toward each other, as shown. Such a formation of the casing is practically correct to properly dispose of the fluid as it is thrown outward, gaining in velocity and tending more in a radial direction than it did when it entered the pump.

Each impeller blade 14 is shaped to conform with the interior of the casing 1 and made of such width that some clearance is allowed at each side of the blade. At the tapered end of the hub 12, where edges 16 of the blades are presented toward the inlet 10 radially across the annular spaces therein around the tapered part of the hub, these edges 16 of the blades are inclined inwardly of the pump down toward the tapered part of the hub, so that these edges thus extend transversely with respect to the flow of fluid in their respective regions. At the other end of the hub 12, next to the bearing 3, the adjacent wall of the casing 1 is preferably continued at right angles to the axis of the pump shaft for some distance outward from the hub all around, so that it presents a flat annular face 17 around this end of the hub toward the inlet 10, the space thus afforded allowing the inflow to be diverted smoothly outward radially. The edges 18 of the impellers 14 at this end of the hub extend substantially parallel with this face 17.

The above described edges 16 and 18 are made acute, and the material necessary to give the blade 14 the required rigidity is confined to the middle part 19 of the blade cross-section, as shown in Fig. 3. By making the blade thus of substantially symmetrical cross section with both edges acute and with the cross section sides conformed to intersecting arcs, and thus tapering gradually from the acute edges to a wide middle, I am enabled to provide a blade of the required strength and rigidity, and at the same time eliminate the effect of axial pressure which is present if one edge of the blade presents materially more surface at a substantial angle to the axial direction than does the other edge. Thus, the edge 16 is very desirably made acute, so as to offer a minimum of resistance to the fluid

entering through the inlet 10, and which must pass through the annular space around the adjacent tapered end of the hub 12; but, if this edge 16 be tapered and the opposite end 18 in this region be flat, there will be an excess of pressure axially on the shaft 4 in the direction of the inlet 10, due to the contact of the fluid with this edge thus flattened. With the edge 18 as well as the edge 16 acute, the axial pressures are neutralized and their effect eliminated. The end of the hub next to the bearing 3 is tapered for the same reason.

Highly satisfactory results are attained by making the blade 14 of the cross section shown in Fig. 3 throughout the length of the blade, with both edges acute, for the reasons above given. However, there is another tendency, manifesting itself in a pull on the impeller and shaft in direction toward the inlet 10, due to the reaction incident to the suction of the fluid into the pump by the centrifugal action of the impeller; and this tendency is present in any centrifugal pump or other centrifugal machine operating in a similar manner. In order to compensate for this excess of pressure in direction toward the inlet 10, I prefer to flatten the curved edge 20 of each impeller blade 14 from the junction of this curved edge with the straight inclined edge 16, the flattening preferably being of increasing width radially outward toward the end of the blade. This is best seen in Fig. 2, and as is indicated by the sections on the lines *y*—*y* and *z*—*z*, taken across this region of the blade. It will be noted that the other curved edge 21 of the blade continues acute from its junction with the edge 18 out to the end of the blade; and it is by virtue of the difference in surfaces thus presented by the two edges 20 and 21, that the pressure the flattened edge 20 receives compensates for the pull on the impeller and shaft toward the inlet, as before alluded to. By properly proportioning these different edges of the impeller blade in each instance, a pump may be designed wherein any of the axial pressures due to any of the above tendencies are neutralized; so that the pump shaft will have practically no endwise pressure or friction.

It will be understood that I am not limited to the example herein given but that the principle of construction and formation of the impeller blade or element is applicable in any centrifugal apparatus operating upon similar principles.

Therefore, what I claim as new and desire to secure by Letters Patent is:

1. A centrifugal impeller element having substantially acute edges presented in both directions axially of the centrifugal action, and of increased width at the middle of its cross section.

2. A centrifugal impeller element having substantially acute edges presented in both directions axially of the centrifugal action, and of increased width at the middle of its cross section, the sides of the element tapering gradually from the substantially acute edges to the widened middle.

3. A centrifugal impeller element having sides presented, in both directions axially of the centrifugal action, at an inclination from the axial direction less than their inclination from the plane of rotation.

4. A centrifugal impeller blade or element of cross section the outline of which may be represented substantially by intersecting arcs.

5. In centrifugal apparatus having an inlet and an outlet, an impeller element and means for rotating it, said element presenting a substantially acute edge in axial direction away from said inlet.

6. In centrifugal apparatus, a casing, a shaft, a bearing for the shaft at one side of the casing, said casing having an inlet at the other side, and having an outlet, a hub fixed on the shaft inside the casing, and an impeller blade or element carried by the hub inside the casing, said blade having a substantially acute edge presented toward the side having the bearing.

7. In centrifugal apparatus having a central inlet and a radially outwardly located outlet, a shaft, a hub fixed on the shaft and an impeller blade or element carried by the hub, said blade or element presenting a substantially acute edge in axial direction away from said inlet.

8. In centrifugal apparatus, a casing, a shaft, a bearing for the shaft centrally of the casing at one side, said casing having an inlet substantially concentric with the shaft at the other side, and having a radially outwardly located outlet, a hub fixed on the shaft inside the casing, an impeller blade or element carried by the hub, extending outward in the casing, said blade having a substantially acute edge presented toward the side having the bearing.

9. In centrifugal apparatus, a casing, a shaft, a bearing for the shaft centrally of the casing at one side, said casing having an inlet substantially concentric with the shaft at the other side, and having a radially outwardly located outlet, a hub fixed on the shaft inside the casing and presenting a tapered end toward the inlet whereby an annular space is left around the hub to afford the required inlet capacity, an impeller blade or element carried by the hub, extending outward in the casing, said blade having a substantially acute edge adjacent to the tapered part of the hub across the annular inlet space, and having an acute edge presented toward the bearing.

10. In centrifugal apparatus, a casing, a shaft, a bearing for the shaft centrally of

the casing at one side, said casing having an inlet substantially concentric with the shaft at the other side, and having a radially outwardly located outlet, a hub fixed on the shaft inside the casing and presenting a tapered end toward the inlet, whereby an annular space is left around the hub to afford the required inlet capacity, an impeller blade or element carried by the hub, extending outward in the casing, said blade having a substantially acute edge adjacent to the tapered part of the hub across the annular inlet space, and having an acute edge presented toward the bearing, this edge of the blade continuing substantially acute out to the end of the blade.

11. In centrifugal apparatus, a casing, a shaft, a bearing for the shaft centrally of the casing at one side, said casing having an inlet substantially concentric with the shaft at the other side, and having a radially outwardly located outlet, a hub fixed on the shaft inside the casing and presenting a tapered end toward the inlet, whereby an annular space is left around the hub to afford the required inlet capacity, an impeller blade or element carried by the hub, extending outward in the casing, said blade having a substantially acute edge adjacent to the tapered part of the hub across the annular inlet space, and having an acute edge presented toward the bearing, this edge of the blade continuing substantially acute out to the end of the blade, but the other edge of the blade, toward the inlet, being somewhat flattened in its part near the end of the blade or element.

12. In centrifugal apparatus, a casing, a shaft, a bearing for the shaft centrally of the casing at one side, said casing having an inlet, substantially concentric with the shaft, at the other side, and having a radially outwardly located outlet, a hub fixed on the shaft inside the casing and presenting a tapered end toward the inlet whereby an annular space is left around the hub to afford the required inlet capacity, the other end of the hub being also tapered toward the bearing, and an impeller blade or element carried by the hub and having a substantially acute edge presented across the annular space around the tapered part of the hub transversely of the direction of inflow through this annular space, and having a substantially acute edge at the other end of the hub.

13. In centrifugal apparatus, an impeller comprising a hub and a series of impeller blades or elements carried by the hub, each of said blades or elements presenting substantially acute edges axially of the hub in both directions.

14. In centrifugal apparatus, an impeller comprising a hub with both ends tapered and a series of impeller blades or elements carried by said hub, each of said blades or elements having a substantially acute inclined edge extending out from each tapered part of the hub, said edges being presented axially of the hub.

15. In centrifugal apparatus, an impeller comprising a hub and a series of impeller blades or elements carried by the hub, each of said blades or elements having sides presented, in both directions axially of the hub, at an inclination from the axial direction less than their inclination from the plane of rotation.

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

KARL KIEFER.

Witnesses:
CLARENCE PERDEW,
OTTO F. WINKELMANN.