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F. W. BUSE ET AL
CENTRIFUGAL PUMPS

3,289,598

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2 Sheets-Sheet 1

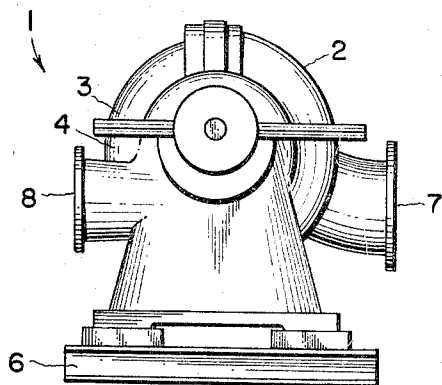


FIG. 1

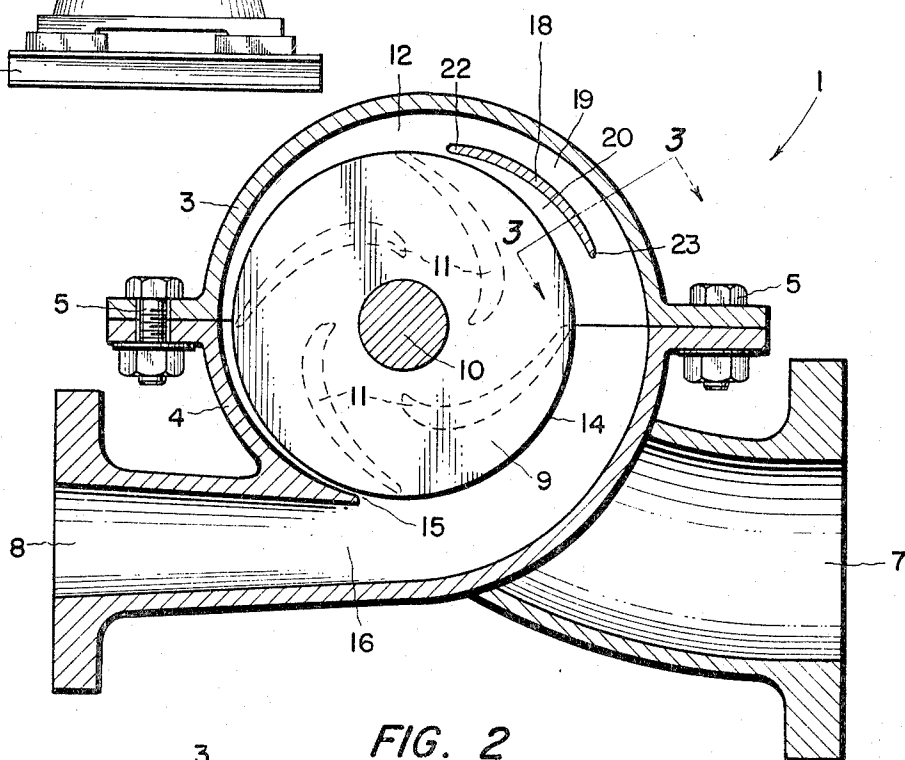


FIG. 2

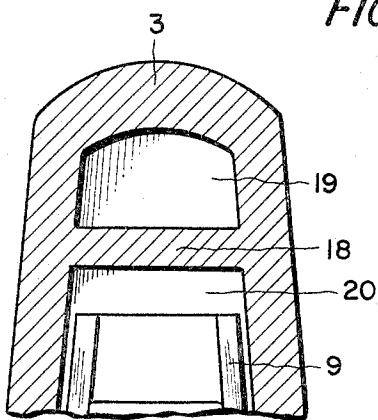


FIG. 3

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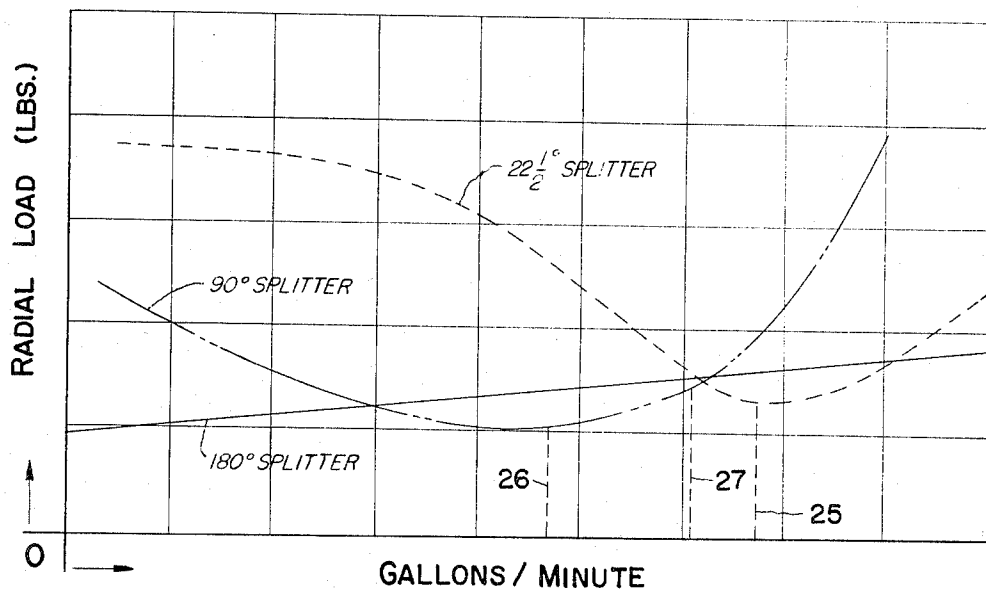


FIG. 7

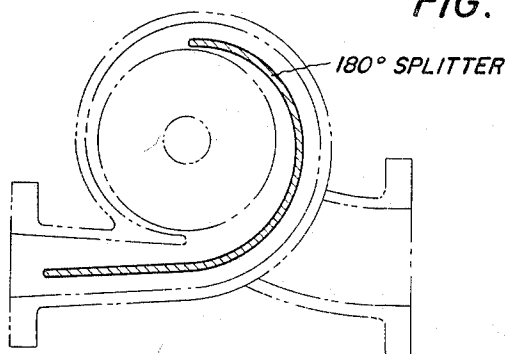


FIG. 4

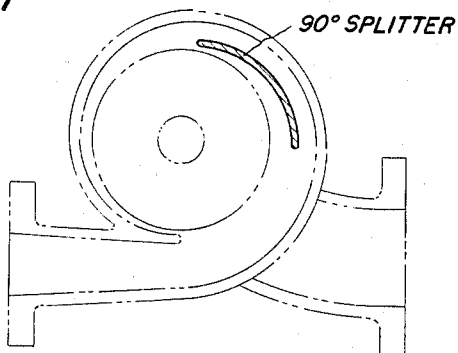


FIG. 5

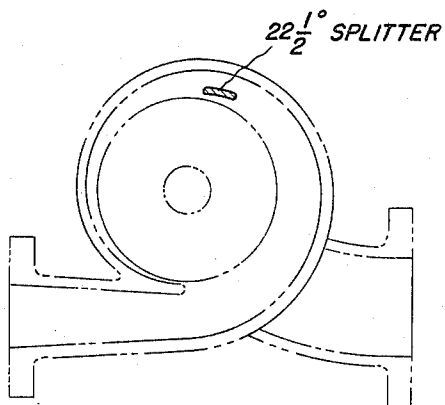


FIG. 6

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CENTRIFUGAL PUMPS

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7 Claims. (Cl. 103-103)

This invention relates to centrifugal pumps having a volute-shaped discharge chamber surrounding the impeller.

A centrifugal pump containing a single volute-shaped discharge chamber creates high unbalanced radial loads on the impeller which makes it necessary to use large, heavy shafts and bearings in such pumps to withstand these loads. In order to reduce these unbalanced radial loads, pump designers have used the twin volute type of centrifugal pump which contains an internal wall known as a "splitter" extending around the impeller for about 180 degrees and dividing the annular chamber surrounding the impeller into two volute chambers. Generally, this splitter is cast integrally into the pump housing.

While the use of a 180 degree or "full" splitter greatly reduces the unbalanced radial loading on the pump impeller, it creates other problems. For example, a pump containing a splitter has a larger and heavier housing than an equivalent pump of the single volute design. Secondly, the casting of the splitter integrally with the housing is difficult because the portions of the mold forming the splitter must be accurately held by special core supports. Notwithstanding these core supports, such portions frequently shift during molding causing spoilage of the resulting casting. Another problem is caused by the fact that the splitter extends around the housing for about 180 degrees which makes it difficult to inspect, clean and smooth or grind the surfaces of the casting hidden by the splitter. Finally, centrifugal pump housings generally comprise a pair of separable half-sections for convenience of assembly of the pump. In such pumps, a full splitter will extend over portions of both half-sections which makes it necessary for the portions of the splitter in both half-sections to be aligned in the assembled housing. The need of alignment of the splitter portions further increases the need for accuracy in the positioning of the splitter in the housing during the casting process.

The principal object of this invention is to eliminate or substantially minimize the objections and problems encountered with the use of the conventional centrifugal pump design employing a splitter.

Other important objects of this invention are: to provide a centrifugal pump having a splitter which is easy to cast and which makes it easy to inspect, clean, and grind surfaces of the housing hidden by the splitter; to provide a pump design employing a splitter which does not require matching of the portions of the splitter in the separate halves of the pump housing; and to provide a centrifugal pump design which substantially reduces the amount of unbalanced radial loading on the impeller without substantially increasing the size of the pump casing.

In brief, the objects of this invention are attained by limiting or shortening the splitter to extend over an angle of much less than 180 degrees, forming the shortened splitter wholly in one of the pump casing halves and locating the shortened splitter in the casing where it greatly reduces the unbalanced radial loading on the impeller when the pump is operating under normal fluid output conditions.

The invention is described in connection with the accompanying drawings wherein:

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FIG. 1 is a side elevation of a centrifugal pump made in accordance with the disclosed invention;

FIG. 2 is an enlarged section of the centrifugal pump shown in FIG. 1 and taken across the axis of the impeller;

FIG. 3 is a fragmentary enlarged section taken on the line 3-3 of FIG. 2;

FIGS. 4, 5 and 6 are diagrammatic sectional views illustrating centrifugal pumps employing, respectively, a 180° splitter, a 90° splitter and a 22½° splitter; and

FIG. 7 is a curve illustrating the change in unbalanced radial loads applied to the impeller in each of the pumps shown in FIGS. 4, 5 and 6 as a function of the pump output.

The centrifugal pump 1 shown in FIGS. 1 to 3 includes an outer housing or casing 2 formed by a pair of separable halves, including an upper half 3 and a lower half 4, fastened together by bolts 5. The housing 2 is mounted on a base 6 and contains a fluid inlet 7 and a discharge outlet 8, both of which are formed in the lower half 4 of the housing 2. A pump impeller 9 is mounted in the housing 2 on a shaft 10 and contains a series of pumping vanes 11. The housing 2 forms a volute-shaped chamber 12 surrounding the circumference 14 of the impeller 9 and having a cutwater area 15 located at its small end and a throat area 16 at its large end. All of the foregoing structure is conventional in the centrifugal pump art.

This invention resides in providing a splitter partition 18 in the chamber 12 to divide the space in the chamber adjacent the splitter 18 into two portions, including an outer space 19 located outside the splitter 18, and an inner space 20 located on the inside of the splitter 18 between it and the impeller circumference 14. The splitter 18 is formed in the upper half 3 of the housing 2 and is positioned so that the cross-sectional area of the outer space 19 remains substantially constant along the length of the splitter 18. The inner space 20 has a volute shape extending in the direction of the length of the splitter 18, as illustrated in FIG. 2.

The splitter 18 illustrated in FIG. 2 extends over an angle of about 60°. In general, the angular length of the splitter 18 can vary between a minimum of about 22½° and a maximum of about 90°. The inlet end 22 of the splitter 18 will begin at a point located approximately diametrically opposite the cutwater area 15 of the chamber 12. Both the inlet end 22 and the outlet end 23 of the splitter 18 are tapered to reduce flow losses caused by turbulence.

It will be noted that the splitter 18 is located wholly within the upper half of the housing 2. This eliminates the need for matching or aligning two splitter portions located in separate halves of the housing which is the case in the prior art using a 180° splitter. Furthermore, the splitter 18 is short enough for hidden internal surfaces located in the housing behind the splitter to be easily inspected, cleaned and smoothed or ground whenever necessary.

The radial load curves of pumps having a 22½° splitter and a 90° splitter are illustrated in FIG. 7. Each of these curves have a vertical axis indicating the unbalanced radial load on a pump impeller and a horizontal axis indicating pump output in gallons per minute. In addition, FIG. 7 illustrates a curve showing the operation of a pump having a "full" or 180° splitter. FIGS. 4, 5 and 6 diagrammatically illustrate the various types of pumps having curves shown in FIG. 7.

In FIG. 7, it will be noted that the unbalanced radial load created by a pump having a 22½° splitter is rather high, when the pump output is low (a 22½° splitter provides about 50% of the radial loading, at low outputs, created in a pump which does not have a splitter), and that it then drops off to a load which is below the radial load created by a pump having a 180° splitter in the

vicinity designated by the vertical dashed line 25, located on the pump output axis of the curve. A pump having a 90° splitter creates a somewhat reduced radial load at low output, compared to the pump with a 22½° splitter, and then drops off to a load well below the load curve 5 produced by the pump having a 180° splitter. The lowest load created by the pump having a 90° splitter occurs in the region of the dotted line 26 located on the pump output axis.

As should now be obvious, when the pumps having the 22½° splitter or the 90° splitter are operated with pump outputs occurring in the regions generally indicated by the dotted lines 25 and 26, the unbalanced radial loads on the impeller are minimized and, in some cases, below that which are applied to the impeller by a pump having a 180° splitter. It has been found that the maximum efficiency of pumps having reduced splitters, in accordance with this invention, occurs in the vicinity of the output values which correspond to the reduced radial loads on the impeller. For example, both of the pumps containing 22½° and 90° splitters have a maximum efficiency when operating in the vicinity of the dotted line 27 located along the pump output axis.

The invention in this case is believed to be the discovery that a pump having a greatly shortened or reduced length splitter, of much less than 180°, can provide a large reduction in unbalanced radial loading on the impeller of a centrifugal pump at all pump output conditions. When a pump is operated at a point on its output curve providing maximum pump efficiency, which is generally its normal operating output, a shortened splitter provides substantially the same or better results than a 180° splitter when the pump is delivering its normal output or capacity. In addition, even when a pump is normally operated at a reduced output, less than an output providing maximum efficiency, a shortened splitter often reduces the radial loading on the impeller enough to make it unnecessary to use heavier shafts and bearings in the pump. In cases where the higher radial loads of a shortened splitter can be tolerated, it is believed that the many advantages provided by the shortened splitter are sufficiently attractive to justify its use in place of a full splitter.

While only a single embodiment of the invention is described and illustrated in detail, this invention is not limited simply to the described embodiment, but contemplates other embodiments and variations which utilize the concepts and teachings of this invention.

Having thus described our invention, we claim:

1. A centrifugal pump comprising:
 - a casing surrounding the impeller and containing a volute-shaped chamber extending around the circumference of the impeller and including a cutwater area at one end and a throat outlet area at the other end; said casing being divided into two halves for purposes of assembly of the pump;
 - one of said halves containing said cutwater area; and
 - a splitter partition located in said volute chamber and wholly contained in the other of said casing halves for dividing the discharge flow of the impeller into two paths extending along a portion of said volute chamber.

2. The pump of claim 1 wherein: said splitter partition has an inlet edge located in said casing substantially diametrically opposite said cutwater area of said volute chamber.
3. The pump of claim 2 wherein: the area of said chamber located on the outside of said splitter partition remote from said impeller is substantially constant in cross section throughout the length of said splitter partition.
4. The centrifugal pump of claim 3 wherein: the area on the inside face of the splitter partition adjacent the impeller forms a smaller volute chamber extending along the length of the splitter partition.
5. The pump of claim 4 wherein: said splitter partition is located so that the pump fluid discharged from both sides of the splitter has substantially the same velocity.
6. The pump of claim 5 wherein: said splitter partition extends along the circumference of said impeller over an angle located in a range extending between substantially 22½° and substantially 90°.
7. A centrifugal pump comprising:
 - an impeller;
 - a casing surrounding the impeller and containing a volute-shaped chamber extending around the circumference of the impeller and including a cutwater area at one end and a throat outlet at the other end opposite said cutwater area;
 - a splitter partition located in said volute chamber approximately midway between said cutwater area and said throat outlet and extending over an angle located in a range extending between substantially 22½° and substantially 90°;
 - said splitter partition being curved generally in the direction of said volute chamber and extending substantially parallel to the outer peripheral wall of said casing defining said volute chamber; and
 - said splitter partition being circumferentially spaced from said throat outlet by a portion of said volute-shaped chamber forming a single passage which is bordered by said casing and said impeller and receives fluid discharged from both the inner and outer faces of said splitter partition.

References Cited by the Examiner

UNITED STATES PATENTS

111,026	1/1871	Williams	103—103
126,639	5/1872	Leffel	103—111
1,390,391	9/1921	Skidmore	103—111
2,764,944	10/1956	Lawrence	103—111
2,849,960	9/1958	Olmstead et al.	103—111
2,955,540	10/1960	Pawlicki	103—111

FOREIGN PATENTS

687,311	2/1940	Germany.
7,730	4/1905	Great Britain.
407,568	11/1944	Italy.

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