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CENTRIFUGAL PUMPS

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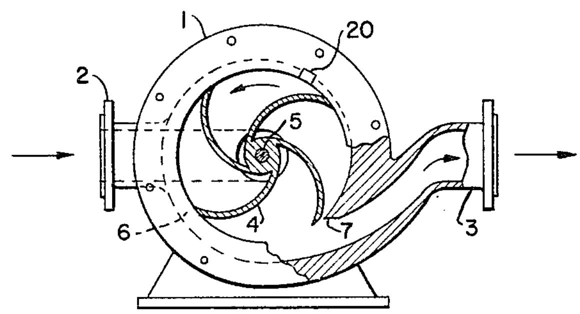

FIG. 1

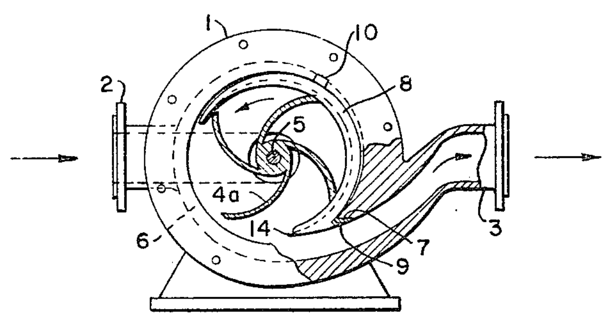

FIG. 2

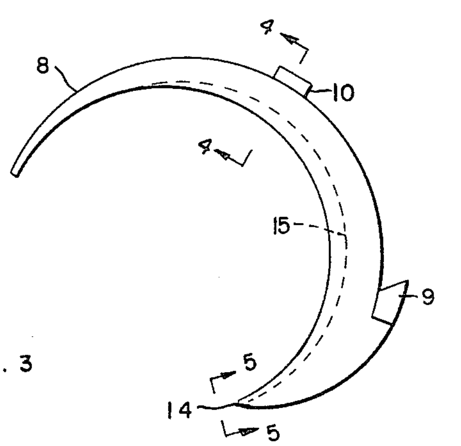

FIG. 3

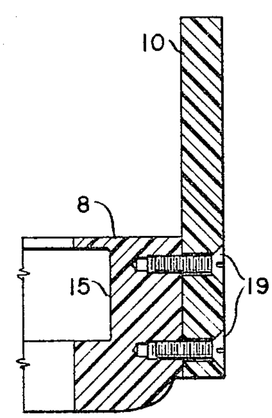

FIG. 4

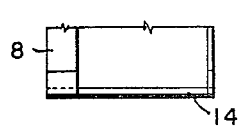

FIG. 5

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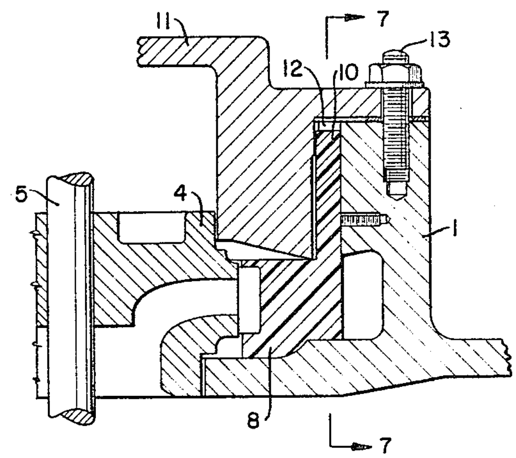

FIG. 6

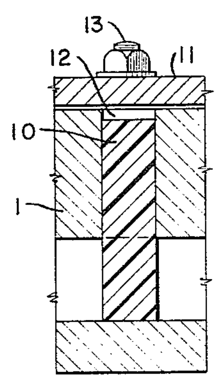

FIG. 7

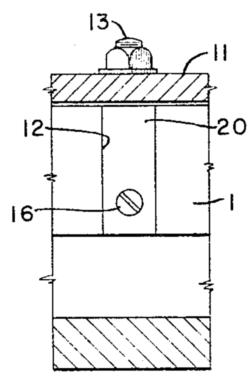

FIG. 8

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CENTRIFUGAL PUMPS

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This invention is particularly concerned with broadening the range of applicability of centrifugal pumps to meet specific pump performance requirements and to increase the efficiency of these pumps.

A large number of centrifugal pumps designed to meet the various pumping requirements of industry exist. These are commonly employed in the chemical, petroleum and other industries.

In view of this wide use there is a great need for standardization of centrifugal pumps. Some progress has been made along this line through industry-wide standardization programs. However, there is the continual problem of establishing a specific pump size which will handle the largest range of head and capacity. Generally a pump size is set as the standard for a particular range over which the operating efficiencies do not become so low that increased operating costs completely offset the capital savings realized by using the standardized pump. This problem is discussed in the paper presented at the A.S.M.E. Annual Meeting, Atlantic City, New Jersey, November 29–December 4, 1959, and published in "Mechanical Engineering," February 1960 issue, pages 57–59.

It is therefore an object of this invention to provide a centrifugal pump that can readily be altered to meet efficiently a broad range of specific pump performance characteristics.

Another object is to provide a means whereby a given number of different pumps and parts can be used to serve an extended range of pumping requirements.

Another object is to provide a centrifugal pump so constructed that a single pump casing can be used to accommodate different impeller sizes without reducing the efficiency of the pump.

A further object of the invention is to provide a means for closely matching a pump to performance requirements.

Other objects and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing which forms a part hereof.

FIG. 1 is a side view, partly in section of a conventional centrifugal pump with cover removed and a maximum diameter impeller in place.

FIG. 2 is a similar view of the centrifugal pump of FIG. 1 with a reduced size impeller and an insert volute in place.

FIG. 3 is a side view of the insert volute.

FIG. 4 is an enlarged sectional view taken along line 4—4 of FIG. 3.

FIG. 5 is a view taken along the line 5—5 of FIG. 3.

FIG. 6 is a detailed sectional view of part of a centrifugal pump showing an insert volute locating and locking lug.

FIG. 7 is a cross-section taken along the line 7—7 of FIG. 6.

FIG. 8 is a front view of part of the casing wall with a filler lug in place.

Referring to FIG. 1 of the drawing, the pump casing consists of a main body structure **1** provided with an inlet piece **2** and an outlet piece **3**. In the pump shown in FIG. 1, an impeller **4** of such dimensions as to closely fit the casing **1** is mounted on a central shaft **5** mounted on bearings external to the pump casing **1**.

The inside surface of the casing is so shaped as to

form a spiral or volute **6**, concentric and in close proximity to the periphery of the impeller **4**. The inner end of the volute terminates in a cut water tip **7**.

In FIG. 2, wherein elements common to FIG. 1 are given like numerals, a reduced size impeller **4*a*** is shown which is generally similar in design to the impeller **4** shown in FIG. 1. Interposed between the impeller **4*a*** and the volute area **6** of the casing is an insert element **8** with cut water **14** which is sometimes called for convenience the insert volute. This insert volute can be clearly seen by reference to FIGS. 2–7 and is located and held in the casing by means of lugs **9** and **10**. The lug **9** of the insert volute **8** is so shaped that it closely fits the contour of the cut water tip **7** formed integral with the casing. The lugs **9** and **10** are firmly attached to the insert volute by suitable connecting means such as screws **19** shown in FIG. 4 or are formed as a part of the insert volute. The lugs **9** and **10** extend laterally from the face of the insert volute toward the casing cover. A portion of such cover is shown in FIG. 6 and is indicated by numeral **11**.

The casing is provided with slots or grooves such as **12** for receiving the lugs **9** and **10**. When in place in the slots the lugs hold the insert volute **8** locked in position.

The casing cover **11** is securely fastened and is fitted liquid-tight to the casing **1** by suitable connecting means such as by studs **13**.

The operation of the invention will be understood from the following.

As is well known, a conventional single stage centrifugal pump has essentially the parts shown in FIG. 1, with, of course, the addition of a cover plate to the casing **1**. The pumps may be individually mounted but quite often the pumps are arranged to be closely coupled to electric motors of suitable horsepower.

The casing **1** of the pump shown has a cast volute **6** which terminates at its closest axial point in a cut water. This cut water is located between the exit of the volute and the outside running edge of the impeller at a point where the volute has its smallest radius and maintains an adequate clearance for the impeller. The impeller on receiving a liquid at its suction side moves it under a rotational motion (anticlockwise), as shown in FIGS. 1 and 2, discharges the liquid by centrifugal force into a progressively expanding spiral casing, wherein the velocity of the liquid gradually decreases. The cut water limits the amount of liquid carried back into the small section of the volute. A correctly designed cut water makes a definite dam seal whereby nearly all the velocity energy is converted into pressure energy. In the large majority of centrifugal pumps the cut water edge is not of efficient design owing to the fact that the casing is cast and it is not practical to provide the sharp edge cut water desirable.

The variable volute insert is designed primarily to increase the pump efficiency in situations where a maximum diameter impeller is reduced in a standard sized casing, for example, in situations where a head-capacity relationship is called for which is less than that which can be given by a maximum sized impeller. As will be seen from FIG. 2, the variable insert volute is so arranged that a knife edge is presented to the running edge of the impeller with a minimum permissible clearance for the particular impeller diameter. The variable volute insert is further designed to fit the contour of the existing volute **6** forming part of the casing **1** and to be complementary thereto. As a result, the total volute of the pump with the reduced diameter impeller is continuous, and in the form of a gradually expanding spiral proportional to the reduced liquid velocity.

The insert volute may be cast of suitable metal and machined, or cast of a suitable smooth plastic material which is resistant to corrosion by the liquid which is being handled by the pump.

In the construction shown in FIGS. 3 and 4, the insert volute is cast or molded of an epoxy resin suitably reinforced with glass fibers. The cut water indicated at **14** and shown in FIG. 5 is hardened and is fabricated of a corrosion resistant metal formed into a knife edge.

As will be seen from FIGS. 4 and 6, the outside surface of the insert volute is formed to accurately fit the contour of the pump casing at least for a substantial distance from the original cut water of the casing in a direction anticlockwise towards the pump outlet **3**. The inside surface of the insert volute is designed so that it closely follows the periphery of the reduced diameter impeller for a substantial distance from the cut water in an anticlockwise direction. Gradually, however, the inside surface wall of the volute spirals outwardly so that a gap between the periphery of the impeller is formed which increases as the distance from the cut water increases. As a result of utilizing the insert volute of our invention, a volute of reduced radius is formed in the pump casing. This insert volute is provided with a smooth inner surface which also aids in improving the efficiency of the pump.

It will be appreciated that by using the insert volute, excessive clearance and points of surface roughness and stream turbulence will be reduced which in turn decreases hydraulic losses and decreases the horsepower necessary to drive the pump.

It should be noted that the section of the insert volute close to the cut water is so contoured on its peripheral surface as to form a streamline surface with the outlet **3** of the pump. This feature also increases the efficiency of the pump.

As will be seen from FIGS. 4 and 6, the insert volute may be of modified **U** section over part of its length, and as indicated at **15** on FIG. 4. This **U** section further increases the efficiency of the pump.

When a maximum size impeller is used in the casing, filler lugs **20** such as shown in FIG. 8 are inserted into the slots in the casing. The filler lugs may be held in place by screws or pins **16**.

As will be apparent to those skilled in the art, the use of the insert volute as described in this specification enables pump standardization programs to be carried out so that besides the reduced capital expenditure required,

the operating efficiency of the pumping units is greatly improved.

By using one casing and volutes designed for each size of impeller a large range of pumping requirements can be met with a small number of elements.

We claim as our invention:

A centrifugal pump comprising: a casing having an inlet opening and a discharge opening, a portion of the casing adjacent said discharge opening forming a fixed cut water, a first volute integral with said casing extending from said cut water around the inner periphery of the casing and discharging into the discharge opening, a molded resin second volute removably mounted in said casing to form a liner to said first volute, said second volute being crescent-shaped and contoured to fit closely to said first volute and to provide an inner surface in a continuing spiral therewith, a stainless steel cut water on said second volute, a rotatable impeller having a suction inlet adjacent its center operable in said casing and discharging liquid peripherally into said second volute, said impeller being of such diameter that it closely clears the inner surface of said second volute throughout a major portion of its length.

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