June 5, 1962 P. J. OLMSTEAD ET AL 3,037,458

GLASS PUMP

Filed April 15, 1957 3 Sheets-Sheet 1

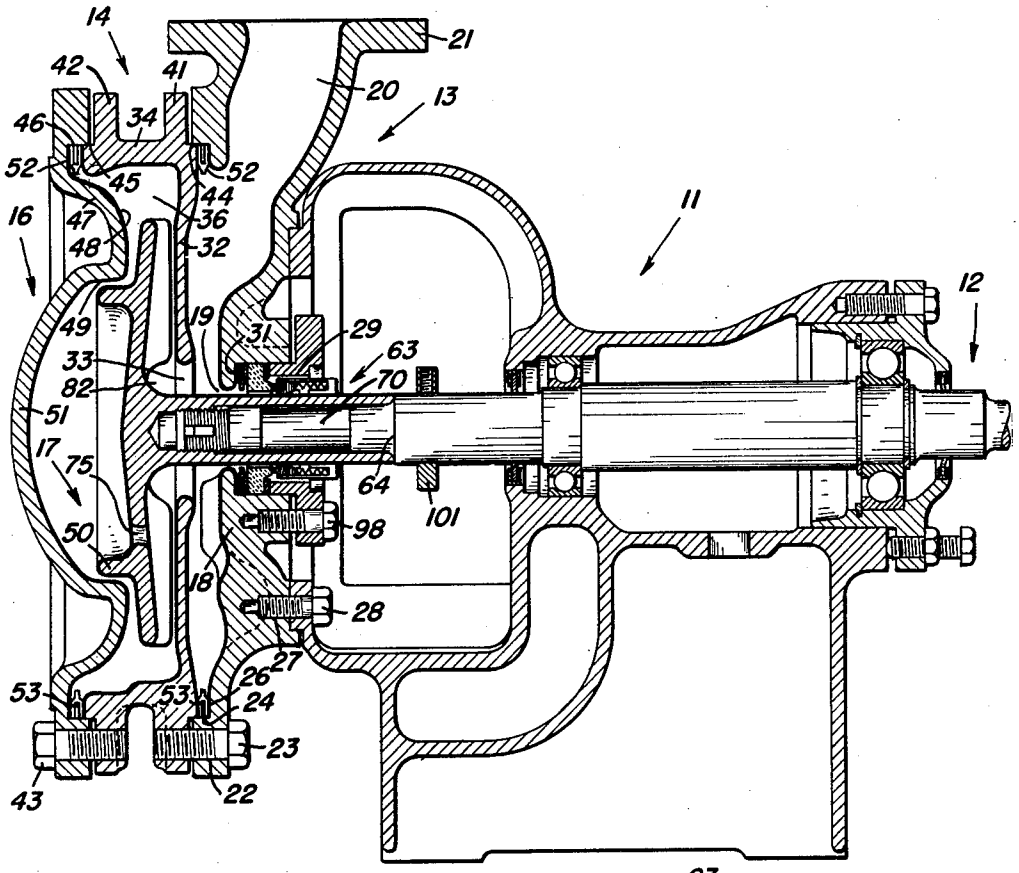
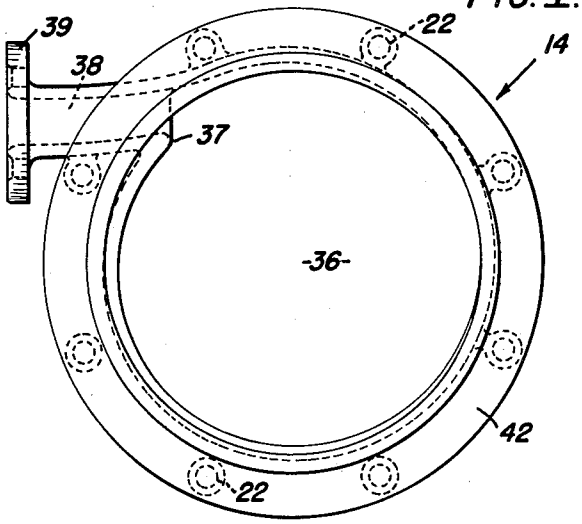


FIG. 1.



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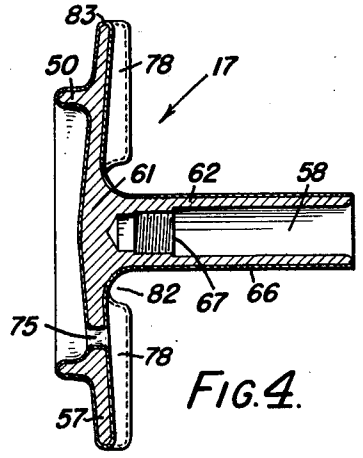

FIG. 4.

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GLASS PUMP

Filed April 15, 1957 3 Sheets-Sheet 2

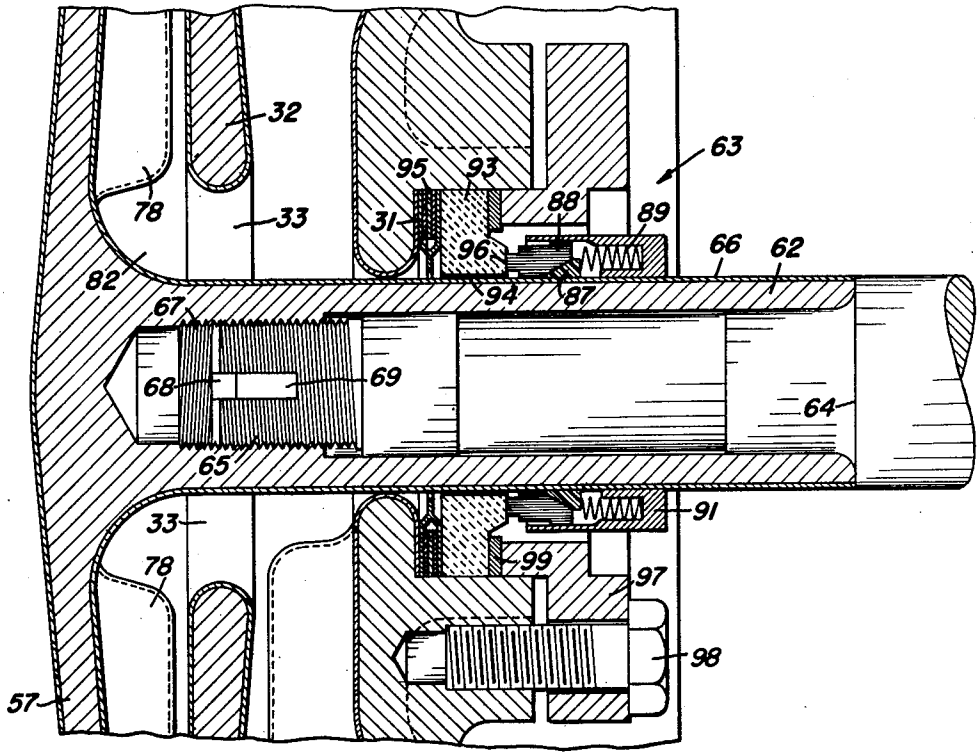

FIG. 2.

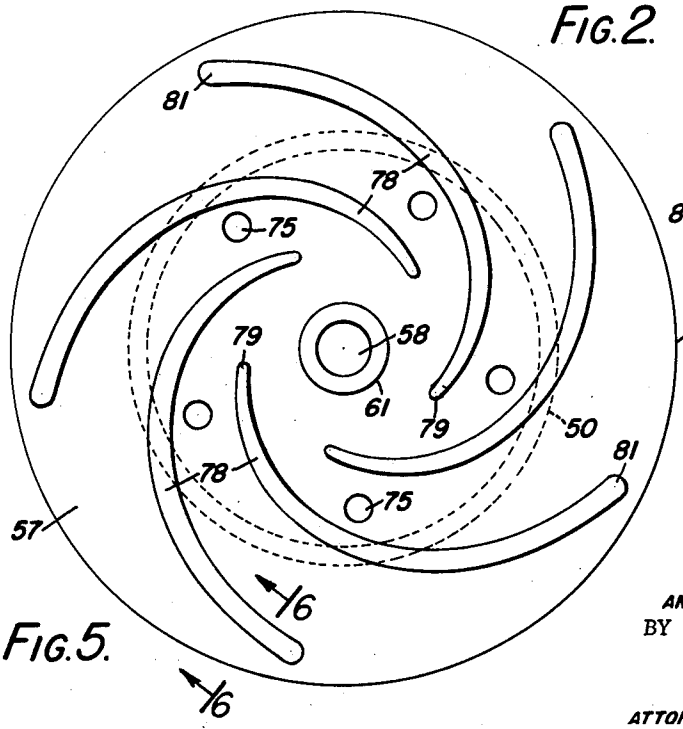

FIG. 5.

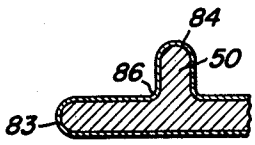

FIG. 6.

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GLASS PUMP

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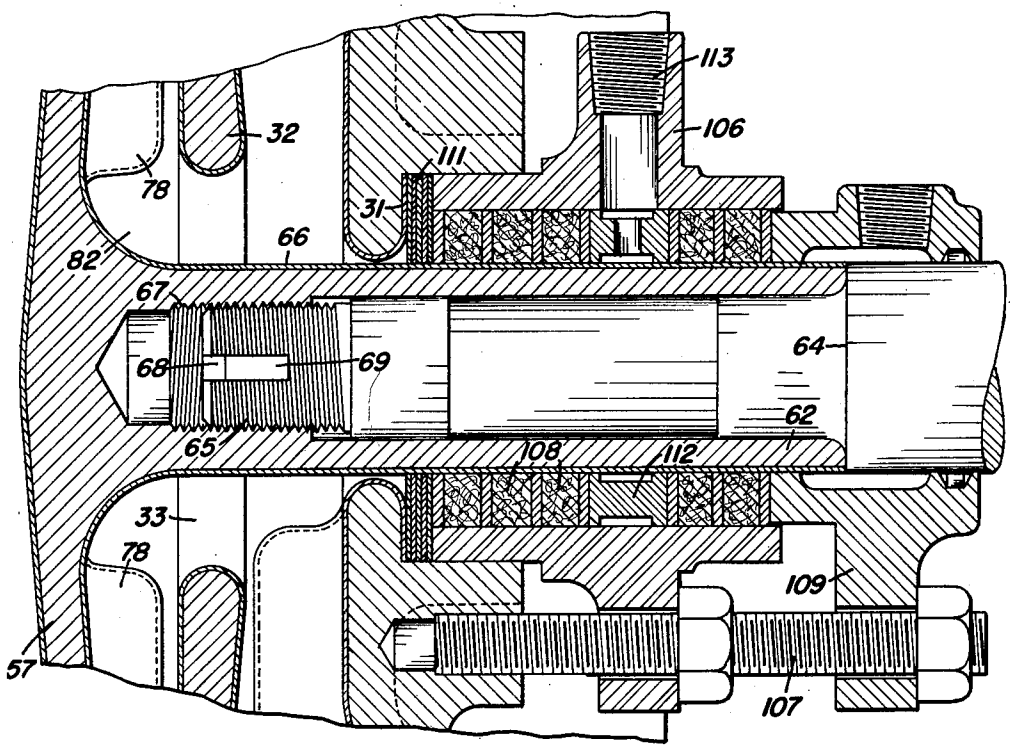

FIG. 7.

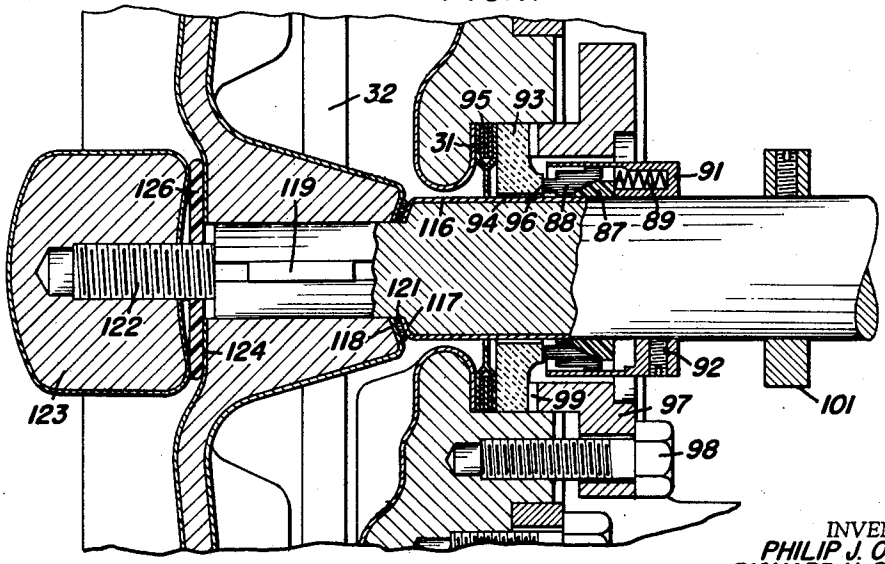

FIG. 8.

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3,037,458

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GLASS PUMP

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Filed Apr. 15, 1957, Ser. No. 652,839
3 Claims. (Cl. 103—114)

This invention relates to centrifugal pumps and to the structure thereof and, in addition, to a pump structure wherein all parts exposed to the liquid being pumped may be effectively coated with glass.

Heretofore, it has been proposed to manufacture centrifugal pumps in which the parts thereof that are exposed to the liquid being pumped are glass coated. Insofar as is known no manufacturer has produced or marketed a glass lined pump which has attained any marked degree of commercial success although the patented art does show such pumps.

In pumping a great many chemicals, ordinary metals customarily employed in the manufacture of pumps cannot be used because of the corrosive action of the liquids being pumped. In pumping some chemicals, a conventional cast iron pump will be eaten away and rendered useless within a comparatively few days or weeks. Other materials more resistant to corrosion have been proposed in place of cast iron and are in use such as nickel, high nickel alloys and stainless steel. Pumps made of these materials are expensive and even nickel and stainless steel are not fully resistant to corrosion by many of the chemicals for which it is desired to use such pumps. Pumps made of various plastics have also been proposed and it has also been proposed to apply plastic materials to cast iron or other metals. Insofar as we are aware, none of these solutions of the problems of resisting corrosion have been fully successful.

While, as previously mentioned, the prior art does show glass coated cast iron pumps, they have not attained marked commercial success perhaps because of the intricate shapes and contours inherent in the construction of a centrifugal pump. The problems encountered are difficult of solution because of chipping and crazing of the glass during cooling. Moreover, the sealing of the shaft and the sealing of the parts of the pump casing presents special problems not heretofore fully solved.

An object of this invention is to provide a novel centrifugal pump structure wherein both the pump suction and the pump discharge may be angularly adjusted with respect to the drive shaft axis to enable the pump to be adapted to existing pipe connections or to permit the most efficient layout of the plant pipe connections and still enable convenient and expeditious connection of the piping to the pump suction and discharge.

Another object of the invention is to provide a pump wherein the pump casing is formed in three parts: one part being a suction piece and containing the suction inlet; the second part being a discharge piece and containing the discharge outlet; and the third part being a cover which is independently bolted to the discharge part so that upon its removal, without disconnecting either the suction or the discharge piping, access to the interior of the pump and the pump impeller may be attained for inspection, cleaning or repair.

Another object of this invention is to provide a simple relatively inexpensively constructed pump of the centrifugal type in which all parts of the pump exposed to the liquid being pumped may be coated with materials resistant to corrosion particularly glass which is resistant to almost all chemicals.

Another object of the invention is to provide a centrifugal pump so constructed and arranged that all surfaces exposed to the corrosive action of the liquid being pumped may be expeditiously glass coated and wherein the pump casing comprises three main parts, a suction piece, a discharge piece and a cover piece, the parts being so constructed and arranged that upon removal of the cover piece the interior of the pump is exposed for removal of the impeller, if desired, and repair or cleaning of the pump may be accomplished without disturbing the suction and discharge connections.

Still another object of the invention is to provide a centrifugal pump useful per se but which is so constructed and arranged that the interior contours thereof lend themselves to the application of a glass coating thoroughly bonded to the metal of the interior surfaces and wherein the pump casing is formed of three main parts, one of which includes the suction opening, the second of which includes the discharge outlet and the third of which constitutes a cover piece, the arrangement of the suction and discharge pieces in separate castings enabling the suction piece and the discharge piece to be rotated with respect to each other to enable eight possible positions of the discharge piece with respect to the suction piece, theoretically, and in the particular arrangement shown at least three positions of the suction piece with respect to the discharge piece, thereby enabling the user of the pump to locate the suction and discharge substantially as he may desire.

A further object of the invention is to provide a glass lined pump, the casing of which is formed of three main pieces, one of which contains the suction inlet, the second of which contains the discharge outlet and the third of which constitutes a cover, the meeting faces between these parts being provided with novel interially located sealing means in which the sealing elements may be tightly compressed into sealing relation with the adjacent glass coated casing parts by adjustment of the casing parts with respect to each other.

The invention, in its preferred form, further contemplates a centrifugal pump construction wherein all the interior parts exposed to the corrosive action of the liquid being pumped may be coated with materials resistant to corrosion, preferably glass, and wherein the hub of the impeller includes an elongated sleeve and the hub and sleeve also constitute a nut for application to the threaded end of a drive shaft, the entire exterior of the impeller including the sleeve being glass coated, the sleeve extending through and in sealing relation to a stuffing box and preferably to a position beyond the stuffing box whereby the impeller hub and sleeve completely enclose and protect the end of the shaft from the corrosive action of the liquid being pumped.

Still another object of the invention, in a modified form of the invention, is to provide novel sealing means in a glass line pump between the hub of the impeller and an enlargement on the drive shaft and between the impeller hub and the impeller nut whereby access of the liquid being pumped to the unglassed portions of the shaft and the unglassed portions of the impeller through which the driving connection is made, is prevented.

Still another object of the invention is to provide novel stuffing boxes of both the mechanical seal and conventional seal type, together with sealing means therefor, whereby the parts thereof subject to corrosion are protected, the arrangement of the parts being such that the stuffing box is under suction pressure only.

The invention in addition contemplates a novel impeller construction which may be glass coated together with a casing which surrounds the impeller so constructed and arranged that in cooperation with the impeller, maximum pump efficiency may be attained.

Other objects and advantages of the invention will be

apparent from the following description, when taken in connection with the accompanying drawings, in which:

FIG. 1 is a vertical sectional view taken through the pump of this invention and showing in addition the pump stuffng box and bearing supports for the drive shaft;

FIG. 2 is an enlarged view of a portion of FIG. 1 showing a mechanical type of shaft seal which may be employed with the pump of this invention;

FIG. 3 is a plan view of the discharge piece or casting and has been included for the purpose of illustrating how the suction piece or casting and the discharge piece or casting may be rotated with respect to each other;

FIG. 4 is a detailed sectional view of the pump impeller but in which the vanes have been diagrammatically shown;

FIG. 5 is a view showing the face of the impeller upon which the impeller vanes are formed;

FIG. 6 is a sectional view taken substantially on the line 6—6 of FIG. 5 in the direction indicated by the arrows;

FIG. 7 is a view of a conventional stuffing box which may be employed in connection with the pump of this invention as a substitute for the mechanical seal shown in FIG. 2; and

FIG. 8 is a sectional view showing an alternative way of protecting the drive shaft against the corrosive action of the liquid being pumped.

The major parts of the pump of this invention comprise a pedestal support, generally indicated by the numeral **11**, which carries suitable bearings for supporting a shaft, generally indicated by the numeral **12**, driven by an electric motor (not shown); a suction piece, generally indicated by the numeral **13**; a discharge piece, generally indicated by the numeral **14**; a cover piece generally indicated by the numeral **16**; and an impeller mounted within the casing formed by the pieces **13**, **14** and **16** and generally indicated by the numeral **17**.

The pump, as thus generally described, is useful as a pump construction without regard to any protection of the surfaces of the pump exposed to the liquid being pumped where the character of the liquid to be pumped is such that these surfaces require no protection. However, the contour of the interior of the pump; the arrangement of the parts **13**, **14**, **16** and **17**; and the relationship of these parts to each other have been particularly designed for the reception of a protective coating more especially glass. Notwithstanding these facts, the pump will be described as one in which all the parts of the pump exposed to the liquid being pumped is glass coated.

Considering first the suction piece **13**, it comprises, for the most part, a flat part **18** forming a wall which has an opening **19** through which the shaft **12** may extend. The opening is of a diameter such as to provide free clearance for the shaft. The casting forming the suction piece is flared outward into a suction opening **20** which terminates in a flange **21** defining the suction inlet of the pump and to which the suction pipe (not shown) is connected in any suitable manner.

Extending around the periphery of the suction piece are a plurality, in this case, of eight bolt openings (see FIG. 3 for the corresponding bolt openings in the discharge piece **14**) **22** for the reception of bolts **23**. The outer periphery of the suction piece casting **13**, defining the bolt circle, is somewhat enlarged as shown in FIG. 1 to define an annular shoulder **24**, the purpose of which will later appear. This shoulder or annular ring **24** is machined and not glass coated. However, the annular surafce inside the shoulder **24**, as shown at **26**, is glass coated as well as all other parts of the casting exposed to the liquid being pumped.

The suction piece casting is also provided with an annular ring of bolt openings **27** for the reception of bolts **28** by which the suction piece and therefore the pump as a whole, as will presently appear, may be secured to the pedestal support **11**. Any desired number of bolt openings **27** and bolts **28** may be provided for the application of the suction piece to the pedestal **11** so that the suction opening **20** may lie in any angular relation desired with respect to the axis of the shaft. However, it is usually sufficient if the arrangement of bolts and bolt openings is such that the pump suction opening may extend vertically, as shown, or face either toward or away from the plane of the paper (FIG. 1). The suction piece casting also includes a bore **29** for the reception of a stuffing box. This bore is unglassed and is machined to receive the stuffing box. The annular ring **31** defined by the bore **29** is glass coated as appears from the drawing.

In the drawings all parts which are glassed have been defined by heavy black marginal lines in FIG. 1 and in FIGS. 2, 4, 6–8 by cross hatching for clarity and convenience. It will be understood that the physical structure of the pump per se is useful as a centrifugal pump and has distinct advantages over present commercial pumps. One of the major purposes of the design of the pump shown is to enable the application of a glass coating with a minimum of crazing, chipping or imperfections in the glass likely to cause failure. While the pump will be described as glass coated, it will be understood that where the corrosion characteristics of the liquid being pumped permit, other coatings such as plastic materials may be employed.

The discharge piece **14** includes a wall **32** having an opening **33** which communicates with the suction inlet **20** in the suction piece **13**. The wall **32** is substantially planar and extends essentially radially outward in approximate spaced running clearance with the impeller. The wall **32** is turned substantially at right angles to its plane, as shown at **34**, to define a discharge space **36** for receiving the discharge of the impeller **17**.

As shown most clearly in FIG. 3, the margins of the discharge piece casting **14** defining the discharge space **36** are volute shaped. The volute is preferably formed wholly in the discharge piece **14**. The reason for this is that the cover casting may then be made symmetrical, avoiding sharp corners and minimizing the problems of glassing this piece. The discharge piece in which the volute is wholly formed is constructed so that sharp corners are avoided and undercut surfaces which are difficult to glass are minimized. While the shaping to form a volute is done preferably wholly in the discharge casting, the cover piece does of course cooperate therewith to form the volute or discharge space **36**.

The volute includes a cutwater **37** (FIG. 3) and extends around the impeller from the cutwater in a counterclockwise direction, as viewed in FIG. 3, and terminates in a discharge passage **38**. The end of the discharge passage is defined by a flange **39** adapted to be connected to a discharge pipe (not shown) in any suitable manner.

The discharge piece **14** includes two annular flanges **41** and **42** which carry threaded bolt openings, in this case eight in number, for the reception of the bolts **23** and bolts **43** by which the cover piece is connected to the discharge piece as will presently appear. The discharge piece has two machined annular rings **44** and **45**, the machined annular ring **44** mating with the machined shoulder or annular ring **24** formed on the suction piece and the machined annular ring **45** mating with a machined annular shoulder or ring **46** formed on the cover piece **16**. The cover piece includes a wall **47** which is shaped at **48** or curved backward to define an annular cutback surface to provide, in cooperation with the shaping of the interior of the discharge piece, a volute of sufficient capacity to accommodate the volume of the liquid being pumped. The cutting or rounding of the wall backward further provides space for the cutwater **37** which necessarily substantially bridges the discharge space **36**. The wall **48** is rounded downward toward the center of the cover piece and merges in a smooth curve into a substantially radially

extending annular wall **49** which forms, with the remainder of the cover, a dish shaped enlargement **51**.

One of the important aspects of the invention is the means provided for sealing the meeting surfaces between the suction piece **13** and the discharge piece **14** and between the discharge piece **14** and the cover piece **16**. The seal comprises two annular sealing members **52** which are preferably identical. The sealing members include an exterior envelope **53** of "Teflon" which is closed at its inner side or the side subject to the liquid being pumped. Interiorly of the envelope **53** is an annular ring of any suitable material which is not highly compressible. On opposite sides of this annular ring, in sandwich relation, are two annular rings of asbestos. The asbestos is highly compressible and inert while the "Teflon" is impervious to most chemicals.

It will be particularly noted, since the sealing rings **52** are highly compressible and yielding, that pressure applied to them by drawing up on the bolts **23** and **43** will not cause damage to the glass surfaces which they engage. When the bolts **23** and **43** are drawn up, the machined surfaces **24** and **44** may shift with respect to each other and the machined surfaces **45** and **46** may shift with respect to each other to allow for the formation of a tight seal without damage to the glassed surfaces which the seals engage. It will be particularly noted that removal of the cover piece does not disturb the sealing ring **52** between the suction and discharge pieces **13** and **14**.

The pump impeller has been shown in detail in FIGS. 4, 5 and 6. It has an annular flange **50** on its rear face extending in close relation to the adjacent wall **49** of the cover piece to minimize loss of pressure from the discharge space **36**. This clearance is maintained at a minimum and is an approximate or spaced running fit as leakage from the discharge space **36** through this clearance represents a loss. The impeller is essentially a metal disc **57** which is glassed on both sides. In fact all surface thereof are glassed except the bore **58** which is machined to receive the end of the drive shaft **12**.

One of the important aspects of the invention is the means provided for preventing access of the corrosive liquid being pumped to the shaft **12** and the bore **58** of the impeller. It will be appreciated that any part of the pump such as the castings forming the casing or the impeller, each considered as whole, is only as good as the coated surface is at its weakest point. The most minute pinhole, even one invisible to the naked eye, will permit the liquid being pumped to gain access to the metal and result in failure. In the case where highly corrosive liquids are being pumped, this failure is not a slow erosion but may occur in a matter of days. The slightest craze or crack in the glass surface caused by stresses set up in the glass surface may result in rapid failure.

For the purpose of protecting the bore **58** and the shaft **12**, the hub **61** of the impeller is elongated to provide a sleeve **62** which projects through a stuffing box, generally indicated by the numeral **63**, and terminates in an annular machined end. The end of the sleeve butts against a shoulder **64** formed on the shaft **12**. The exterior surface **66** is glassed throughout its extent and well beyond the stuffing box. The glassed exterior of the sleeve is accurately but lightly ground to provide a precisely dimensioned cylinder at least where it passes through the stuffing box, to the end that the stuffing box may form a liquid tight seal with the ground glass surface of the sleeve.

The extended end **70** of the shaft **12** projects into the bore of the sleeve and is threaded as indicated at **65**. The bore of the sleeve is threaded, as shown at **67**, to match with the threads **65** to enable the impeller to be threaded on the shaft until the end of the sleeve is butted against the shoulder. Preferably the end of the shaft is slotted, as shown at **68**, to receive a locking device **69** of deformable material. Such deformable locking devices in which threads are cut as the impeller is threaded on the shaft are well known in the art. The construction shown and described provides protection, almost absolute, for the impeller and the shaft.

The impeller is preferably of the semi-open type and has a plurality of openings **75** to equalize pressure on opposite sides thereof. The impeller has a plurality of vanes **78** raised from the surface of the disc **57**. The vanes curve outward from adjacent the center of the disc, as from **79**, to a point adjacent to but removed from the edge of the disc, as shown at **81**. With the vanes starting at a point removed from the axis of the disc, a smoothly shaped liquid entrance throat **82** (FIG. 1) is provided and sharp angled surfaces which are difficult to glass are avoided.

One of the problems encountered in manufacturing a glass lined pump is to secure pump efficiency while still avoiding sharp angles. If an attempt is made to glass two adjacent surfaces which meet at a sharp angle, when the glass cools, unequal contraction occurs and the glass tends to spall off and crack. When this occurs, of course, the pump is rendered useless or at least that part in which failure has occurred. By terminating the vanes adjacent to but removed from the edge of the impeller disc **57**, as shown at **81**, the edge **83** of the disc may be rounded as indicated in FIG. 6, so that the glass coating does not have to extend around a sharp corner. Likewise, it will be noted, the vanes have a rounded outer surface **84** (FIG. 6) and the meeting surfaces between the disc and the vanes are curved on radii, as shown at **86**. The result is a construction which may be readily glassed, in which unequal expansion and contraction is to a large extent avoided during the glassing operation and its subsequent cooling and a protected surface is provided.

The mechanical seal, shown in FIG. 2, comprises a "Teflon" wedge **87** which presses against a carbon sealing element **88** under the urging of a plurality of radially arranged springs **89**. The wedge **87** and the sealing element **88** are both resistant to corrosion. These elements are mounted within a cage **91** and are secured to the shaft so as to rotate therewith by a set screw **92**. A ceramic sealing element **93** is free with respect to the shaft as indicated at **94**. The ceramic ring **93** is highly resistant to corrosion and faces toward the glass surface **31** of the casing.

A "Teflon" sealing ring **95** is interposed between these parts, the "Teflon" sealing ring being compressible and being similar to the "Teflon" sealing rings **52**. A seal is formed between the rotating part **88** and the stationary ceramic ring **93** at **96**. A seal is also formed along the shaft by the "Teflon" wedge **87** and the carbon sealing element **88**. Pressure on the sealing ring **95** is primarily provided by a gland **97** which is drawn up by a plurality of bolts **98**, a compressible asbestos gasket **99** being interposed between the ceramic corrosion resistant ring **93** and the gland **97**.

As will be observed from the drawings, and as previously mentioned the impeller hub or sleeve is glassed from the part within the pump casing to the end abutting the shaft shoulder **64**. The unglassed shaft is fully protected from exposure to the liquid being pumped by the glassed sleeve. A liquid slinger **101** is provided on the shaft adjacent the end of the sleeve. The glassed surface of the sleeve is ground as previously mentioned to remove the slight waviness inherent in glassed surfaces. The ground sleeve forms a true and accurately cylindrical surface with which the mechanical seal may cooperate to avoid leakage.

In FIG. 7 we have shown, instead of a mechanical seal, a conventional stuffing box which includes a housing **106** held in position on the suction piece **13** by means of bolts **107**; packing rings **108** which may be of "Teflon" impregnated with mica; a packing gland **109** drawn up by bolts **107**; and a sealing ring **111** similar to the sealing ring **95**. The stuffing box may be provided with a lantern ring **112** the purpose of which is well known in the art through which water is circulated by means indicated at **113**. By drawing up on the bolts **107**, seal **111** is com-

pressed between the glassed surface **31** and the housing **106**.

After the facing surfaces of the nut and the impeller hub have been glassed, these surfaces are slightly wavy due to expansion and contraction. It has been found that if these surfaces are faced off by a light grinding or lapping operation, the flat surfaces thus formed may be sealed by a suitable impervious gasket such as "Teflon." "Teflon," while impervious to most liquids, has a tendency to cold flow. When this occurs the nut may loosen and allow leakage of the fluid being pumped to the unglassed portions of the shaft and impeller and this cold flowing appears to be aggravated if the surfaces are not flat.

In FIG. 8 we have shown a modified form of the invention wherein the exterior surface of the shaft is glass coated as indicated at **116**. The shaft extends through a sealing means which may be similar to that described above in connection with the preferred form of the invention. Internally of the pump casing the shaft is decreased in diameter to provide a shoulder **117** which may be machined in the form of a frustum of a cone. This conical surface is glass coated and matches with a glassed frustoconical surface **118** formed on the end of the hub of the impeller. The impeller is keyed to the shaft as indicated at **119**.

For the purpose of preventing the liquid being pumped from gaining access to the bore of the impeller, the key and the end of the shaft, a "Teflon" gasket **121** is interposed between the surfaces **117** and **118**. The shaft extends through the impeller and its extended end **122** is threaded to receive a nut **123**. All surfaces of the nut except the threaded interior thereof are glass coated. The surface of the impeller which faces the nut is also glassed and the impeller is preferably recessed, as shown at **124**, for the reception of a "Teflon" gasket **126**. The arrangement shown forms tight seals on both sides of the impeller hub and the surfaces provided are such as to minimize cold flowing of the "Teflon" gaskets.

While we have shown and described the preferred forms of the invention, it will be appreciated that various changes may be made, particularly in the form and relation of parts, without departing from the spirit of the invention as set forth in the appended claims.

We claim:

1. A centrifugal pump comprising, in combination, a casing, an impeller mounted in said casing, a drive shaft extending into said casing and operatively connected to said shaft, said casing being of a base metal coated internally with glass, said casing having at least two casing parts, said casing parts having an outer joint between them defined by an inwardly facing annular machined surface on one of said parts and an outwardly facing annular machined surface on the other of said parts, said surfaces being slidable telescopically with respect to each other, an annular glassed surface on each of said parts internally of the casing, an annular ring of resilient packing between said glassed surfaces and means for telescoping said machined surfaces to compress said packing and seal said joint.

2. A centrifugal pump in accordance with claim 1 in which said machined surfaces are substantially concentric with the axis of the shaft and said glassed surfaces are substantially normal to the axis of the shaft.

3. A centrifugal pump in accordance with claim 1 in which the casing has three separate parts, a suction inlet part, a cover part and a discharge outlet part interposed between said suction inlet part and said cover part and, between each two adjacent of said parts, the joint set forth in claim 1 is provided, each of said joints being independent of the other whereby each resilient packing may be independently compressed.

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