May 10, 1938. W. E. PRATT 2,117,011

CENTRIFUGAL PUMP

Filed Feb. 27, 1935 2 Sheets-Sheet 1

Fig. 1,

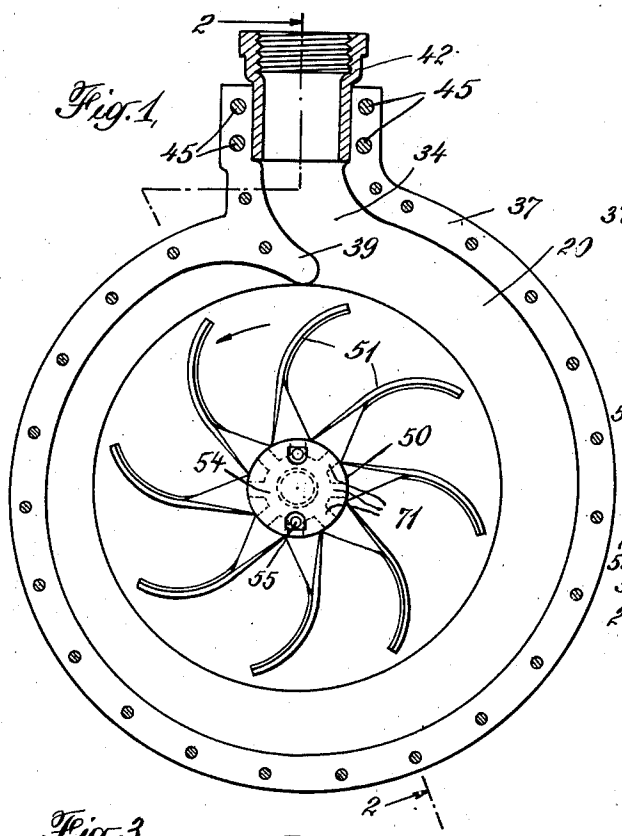


Fig. 2,

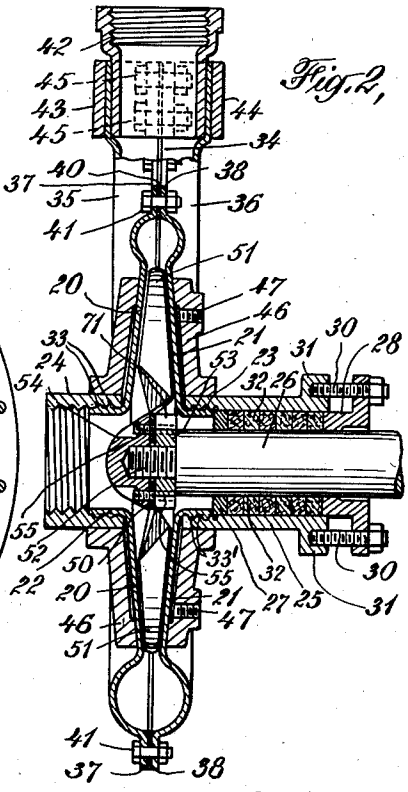


Fig. 3,

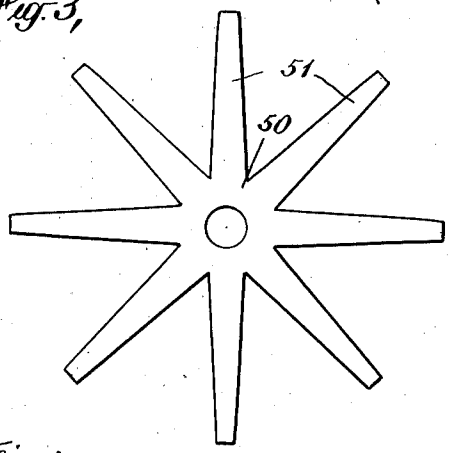


Fig. 4,

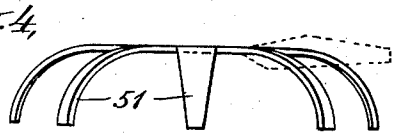


Fig. 5,

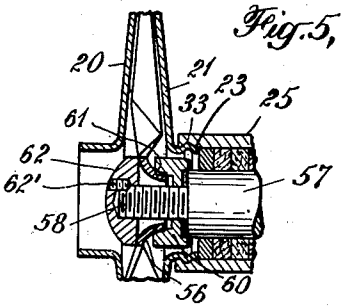
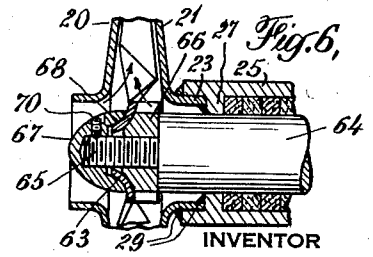


Fig. 6,



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CENTRIFUGAL PUMP

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Fig. 7,

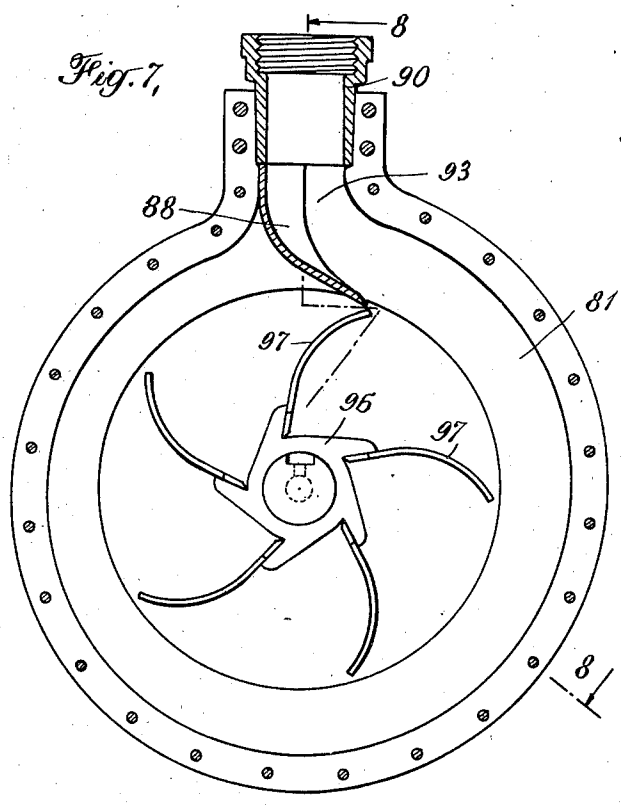


Fig. 8,

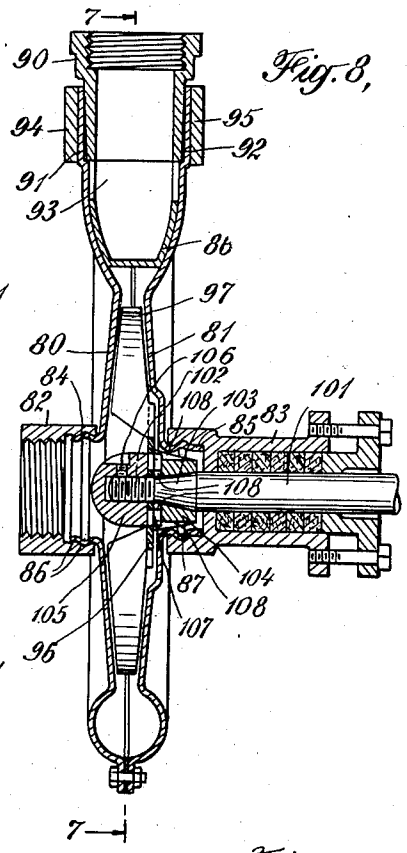


Fig. 9,

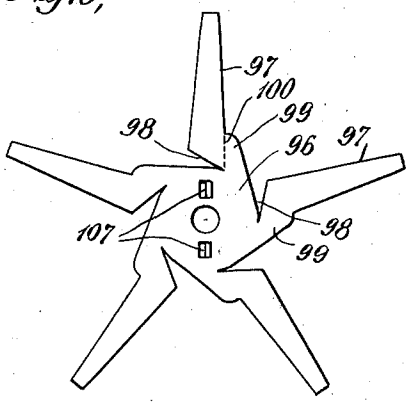


Fig. 11

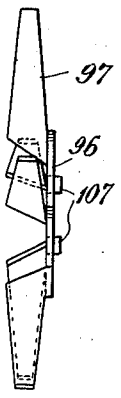
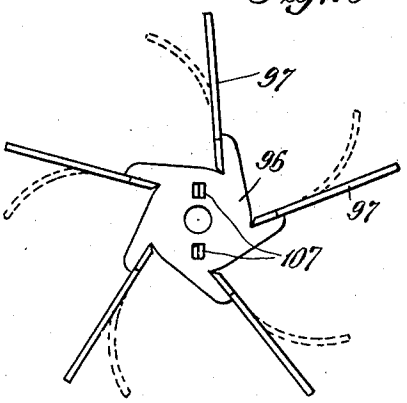


Fig. 10



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UNITED STATES PATENT OFFICE

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CENTRIFUGAL PUMP

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Application February 27, 1935, Serial No. 8,443

6 Claims. (Cl. 103—103)

This invention relates to rotary impeller pumps. It provides a structural design and method of fabrication which makes possible in the construction of such pumps the effective use of materials that can be pressed, rolled, spun, forged or molded, particularly sheet metal, as distinguished from cast materials.

It has been customary to construct centrifugal and like pumps from cast metal parts, particularly the rotors and casing. Cast metal, however, involves certain disadvantages which the present invention overcomes. Thus, for example, certain alloy metals having high corrosion resistant properties, such as the various stainless steels, are relatively expensive when used in the cast form, and unless proper precautions are taken, the casting operation may result in a reduction of the resistance of the metal to corrosion. Moreover, cast metal is relatively less strong than rolled sheet or otherwise mechanically wrought metal. Consequently a greater weight of cast metal is necessary in the manufacture of a pump element of given strength than would be necessary were wrought metal employed. The cast material is also more expensive in many instances.

The rough surfaces of cast parts present a further disadvantage in comparison with wrought material, in that higher friction losses occur when liquids pass over such surfaces at relatively high velocities. Buffing or machining the cast part to produce a smooth surface adds considerably to the cost, particularly when the part so treated is intricate in shape, such as the rotor of a centrifugal pump. Even when buffed or machined, cast metal frequently contains small, even microscopic, cavities or pores which collect solid particles and defy thorough cleansing. This is of considerable importance in the care of pumps for handling food products or other products necessitating scrupulously clean apparatus, such for example as milk, mayonnaise or medicinal products.

Various attempts have been made to overcome the disadvantages inherent in the use of cast metal parts in the construction of centrifugal pumps. Thus, it has been proposed to apply sheet metal liners to the cast parts in order to produce a smooth surface, or to tin the surface of a cast part in order to prevent the collection of solids in the small pores of the casting. These practices involve undue expense, and they frequently fail to accomplish their purposes. Sheet metal liners, for example, may become detached, or liquid may collect between them and the cast metal base, a condition which frequently tends to rapid corrosion of the cast metal. Tinning is quickly eroded from the cast base to which it is applied.

Throughout this specification and the appended claims the term "wrought" is employed to distinguish from cast materials and comprehends such materials as those which are rolled, forged, drawn, spun, molded or pressed into shape. The term "friction joint" is employed to describe joints made by bolting, threading, upsetting riveting, etc. and to distinguish from welded joints.

In accordance with the present invention it is possible to overcome the above and various other objections to the use of cast metal parts in the construction of centrifugal and like pumps, and to achieve other advantages as well.

In the accompanying drawings:

Fig. 1 is an elevation of a pump made in accordance with the invention, the packing gland half of the casing being removed;

Fig. 2 is a section taken substantially along the line 2—2 of Fig. 1;

Fig. 3 is a plan view of a rotor blank;

Fig. 4 is an elevation showing an interemdiate step in the manufacture of the rotor from the rotor blank shown in Fig. 3;

Fig. 5 is a fragmentary view in vertical cross section through the central part of a pump, showing a modified arrangement for mounting the rotor on the shaft, and a modified union between the casing and the packing gland;

Fig. 6 is a section similar to Fig. 5, but showing further modifications in the rotor mounting and union between the casing and packing gland;

Fig. 7 is an elevation of a modified form of pump made in accordance with the invention, similar to Fig. 1 but with the inlet nipple half of the casing removed;

Fig. 8 is a longitudinal section taken substantially along the line 8—8 of Fig. 7;

Fig. 9 is a plan of a modified form of rotor blank;

Fig. 10 is a plan of an intermediate stage in the shaping of a rotor from the rotor blank shown in Fig. 9; and

Fig. 11 is an elevation of a rotor made from the rotor blank shown in Fig. 9.

The invention is shown and described, in certain preferred forms, as applied to a single stage, center intake centrifugal pump of a well known type. Its application to other types of rotary impeller pumps will be understood, from a con-

sideration of differences between what is shown here and what is commonly done in making this type of pump from cast metal parts.

The pump shown in Figs. 1 and 2 comprises a casing having opposed casing halves **20** and **21**, which are mechanically shaped from sheet metal such as stainless steel of the "18—8" variety (18% chromium, 8% nickel, the balance mainly iron). The shaping may be done for example by stamping in suitable dies in one or more steps, or by spinning. The casing illustrated is in the form of a volute, so that a separate set of dies is necessary for each half, the two halves being mirror images of each other rather than duplicates. In the manufacture of small pumps, or where pumping efficiency is of less importance, the casing halves may be substantially circular and in that case the two halves are identical and only one set of dies is needed.

The casing sections of pumps for low pressure work may be made of light-weight sheet metal and so may be formed in a single stamping, spinning, or pressing operation, either hot or cold. For pumps that are to deliver higher pressures a heavier gauge is needed. When employing a relatively heavy gauge of sheet metal, the opposing casing halves should be formed in a series of steps, each step resulting in a greater deformation of the sheet metal than the preceding step. It is sometimes necessary to work the metal hot, preferably with annealing between steps to avoid the development of strains or incipient breaks, which weaken the metal and render it more susceptible to corrosion. On the other hand, the corrosion resistant character of some alloys is lost upon heating and can only be restored by careful heat treatment. When such alloys are employed cold-working or at most moderate heating should be used whenever possible, so that subsequent tempering problems may be avoided.

In shaping each of the opposing casing halves **20** and **21**, central outwardly extending tubular portions or necks **22** and **23** respectively are formed integrally with them. These extend into tubular nipples **24** and **25**. One of the nipples **24** is threaded internally and serves as an inlet nipple by which an inlet conduit (not shown) may be connected to the pump. The other nipple **25**, in axial alignment with the first nipple **24**, serves as the housing or stuffing box of a packing gland through which the rotor shaft **26** extends. A collar **27** within the housing **25** rests against the outer edge of the neck **23**, on the rear casing section and forms the abutment member of the packing gland. A gland closing member **28** is held in place by bolts **30** which engage ears **31** upon the housing **25**, and a packing material **32** is held between this closing member and the abutment member **27** to complete the packing gland assembly.

The nipples **24** and **25** may be made from seamless tubing, they may be turned from bar stock, or in the event that the nature of the pump service is such that cast flow surfaces are not objectionable they may be cast. Preferably the neck portions are disposed within the nipples. In such case, the inner surfaces of the nipples **24** and **25** are grooved as at **33** and **33'**, in the regions where they overlie, i. e. the neck portions **22** and **23** of the casing sections. The nipples and neck portions, which fit snugly, are rolled together to form pressure-tight rolled joints. In this manner, the casing sections are firmly locked to the respective nipples. In the apparatus shown in Fig. 2, the nipples and the corresponding neck portions are rolled together in such a manner as to preserve the inner surface of the nipples in a smooth and substantially cylindrical condition.

In Fig. 5 is shown a modified rolled joint, in which the neck portion **23** of the casing half **21** is rolled together with the stuffing box nipple **25** in such a manner that the resulting inner surface of the tubular portion is corrugated, a portion of the metal of the neck **23** having been bent outwardly into a groove **33** formed in the nipple **25**. In Fig. 6 is shown a welded joint **29** between the nipple **25** and the neck portion **23** of the casing half **21**. Incidentally, the stuffing box nipple **25** is shown in Fig. 6 as a casting, and it will be seen that in this type of construction the collar or abutment member **27** may be formed integrally with the housing nipple **25**. It is possible of course but less desirable to use these same modified joints on the inlet side, but there the smooth inner surface of the Fig. 2 form is preferable.

In shaping the opposing casing halves **20** and **21**, they are so formed as to provide a discharge conduit **34**. The walls **35** and **36** of the discharge conduit are formed integrally with the casing halves **20** and **21** respectively during the shaping thereof. An inwardly projecting member or "splitter" **39** formed integrally with each casing half is provided adjacent the discharge conduit to direct the flow of liquid under pressure to the discharge opening. The casing halves are also provided with integral peripheral flanges **37** and **38** which match and have holes for bolts by which the two casing sections are united.

A discharge nipple **42** to which a discharge pipe (not shown) may be connected, is held between the walls **35** and **36** of the discharge conduit **34** by semi-cylindrical clamp members **43** and **44** which are placed around the upper end portions of the walls **35** and **36** of the discharge conduit. The clamp members **43** and **44** are bolted together, the bolts **45** passing through the flanges on the opposing casing halves. In assembling the pump the casing halves are fastened together and the discharge nipple is driven into the discharge conduit until a tight fit is obtained. In the event that additional strength of connection between the nipple **42** and the discharge conduit **34** is required, the discharge nipple **42** may be provided with suitable ears (not shown) which may be connected by bolts with corresponding ears (not shown) on the clamp members **43** and **44**.

If desired for an additional margin of safety against unexepected internal stress, or to prevent distortion of the casing halves due to the weight of the nipples and drive shaft, or other eccentric loading at the axis of the pump, re-enforcing members **46** may be provided for the casing walls, preferably in the form of rings which are mounted fixedly on the nipples **24** and **25** and which have radial flanges or spokes lying against the casing walls. Bosses **47** may be formed integrally with one or both of the re-enforcing members for providing means for mounting the pump. The bosses may also be formed as annular rings of raised metal on the outer surfaces of the re-enforcing rings.

The rotor or impeller for the pump is likewise mechanically shaped from sheet metal. A blank comprising a central portion **50** and a number of radial blade portions **51** are cut from the sheet metal (Fig. 3), preferably with a blanking die. The blade portions **51** may be bent first toward the rotor axis to a shape which provides the

proper curvature for rotor or impeller blades (Fig. 4), and then twisted through about ninety degrees around their respective radial axes to bring them back into the plane of the rotor. If desired, this operation may be reversed, i. e. the blades may be twisted first about their radial axes, and then bent along these axes. This mechanical shaping of the rotor from the blank may be accomplished by pressing or stamping the blank in suitable dies, or by hand with the aid of hand tools and templates. It is sometimes advantageous to impart a slight transverse curvature to the rotor blades to increase their stiffness, particularly if the sheet material from which the rotor has been formed is relatively thin, or in case the liquid to be pumped is relatively viscous or a considerable pressure is to be developed. If the sheet metal employed is relatively thin, the shaping may be carried out in one step with the metal substantially at room temperature, but sheet metal of relatively heavy gauge should be worked hot in a series of steps preferably with annealing between successive steps to avoid the formation of strains or incipient breaks.

There are a number of ways in which such a rotor may be mounted on a shaft. In Fig. 2, the end 52 of the rotor shaft 26 has been reduced and threaded. A collar nut 53 is screwed on the reduced portion 52 of the shaft, the central portion 50 of the rotor is then mounted on the reduced portion 52, and a cap nut 54 is then screwed down against the central portion 50 of the rotor. To prevent any accidental movement of the rotor relative to the shaft, and to prevent the cap nut from inadvertently backing away from engagement with the central portion 50 of the rotor, set screws 55 connecting the collar nut 53 and the cap nut 54 may be employed.

In Fig. 5 is shown an alternative method of mounting in which the central portion of the rotor is drilled and the side walls 56 of the opening thus formed are turned in, funnel shaped. The reduced end 58 of the shaft is threaded and a collar nut 60 is screwed thereon. The rotor is then mounted upon the reduced end 58 of the shaft in such a manner that the funnel shaped part of the rotor bears against the side walls 61 of a recess provided in the collar nut 60. A cap nut 62 is screwed on to clamp the rotor against the collar nut 60, and a set screw 62' may be employed to prevent the cap screw from backing away from its operative position.

A second alternative method of mounting the rotor upon the shaft is shown in Fig. 6 wherein the walls 63 of the center opening in the rotor are bent in such a manner as to extend outwardly away from the rotor shaft 64. The end portion 65 of the shaft is reduced and threaded, and a collar nut 66 is screwed thereon. The rotor is mounted about the reduced end portion 65 of the shaft, and a cap nut 67 is then screwed thereon in such a manner that the side walls 68 of a recess provided in the cap nut engage the outwardly extending walls 63 of the center opening of the rotor, thereby to clamp the rotor between the collar nut 66 and the cap nut 67. A set screw 70 may be employed to keep the cap nut from getting loose, the engaging surfaces of the cap nut 67 and the collar nut 66 being given a curve to correspond with the curve of the funnel shaped opening in the rotor, thus assuring a firm joint.

In pumps of the type specifically described herein, there is a thrust on the rotor in the direction of the inlet opening, owing to the relatively low pressure in the inlet. The design of the rotor may be such that this thrust is counteracted. In forming the rotor from the sheet metal rotor blank of Fig. 3, the portion of the blade that is twisted assumes substantially the form of a screw propeller blade causing an axial flow of the liquid. By noting the direction of twist, it is possible to produce a rotor such that the screw acting portion of the rotor tends to draw liquid from the packing-gland side of the rotor and thus relieve the higher pressure on that side, thereby tending to equalize the axial forces. This effect may be accentuated by forming suitable wings 71 on the collar nut 53. The wings 71 are so configured as to cooperate with the screw-acting portion of the rotor in tending to force liquid from the packing gland side of the rotor. Reduction of the pressure exerted internally on the packing gland is also advantageous in that it reduces the likelihood of liquid leaking through the gland. This is of considerable importance when handling liquids of a corrosive or toxic nature. To produce a suction on the packing gland the direction of twist of the rotor blades, looking from the tips to the hub or center portion, should be the same as the contemplated direction of rotation of the impeller, viewed from the packing gland side.

A modified form of apparatus made according to the invention is shown in Figs. 7 to 11. A pump casing comprising opposing casing halves 80 and 81 is made of sheet metal substantially in the manner described above, so far as concerns the side walls of the casing and the central necks to which the nipples are joined.

The major difference is in the construction of the splitter. The splitter 88 (Fig. 7 and Fig. 8) instead of being formed of parts integral with the casing sections, comprises a separate piece suitably shaped from sheet metal and firmly mounted in position within the casing adjacent the discharge conduit 93 thereof. The splitter 88 is preferably attached to only one half of the casing, so that there will be no difficulty in separating the casing halves when dismantling the pump. A tapered discharge nipple 90 is clamped to the walls 91 and 92 of the discharge conduit 93 by means of clamp members 94 and 95 substantially as described above in conjunction with Fig. 2.

In making the modified rotor shown in Figs. 7 to 11 a rotor blank (Fig. 9) having a central portion 96 and a number of radial blade portions 97 is cut from sheet metal and a notch 98 is cut at the base of each blade portion. On the opposite side of each blade, near the base, some metal is left, as at 99, so that the notch may underlie the entire width of the blade. Each blade portion is then bent through about ninety degrees along a line (shown in Fig. 9 as the dotted line 100) substantially parallel to the radial axis of the blade portion and in line with one edge thereof. The blades are then bent (Fig. 10) toward the rotor axis as before to the curve necessary to form efficient impeller blades. The blades may of course be first bent toward the rotor axis and then twisted on their own radial axes, but the twisting first is better. If desired, the blades may be stiffened by imparting to them a slight transverse curvature.

The finished rotor may be mounted upon a shaft 101 as follows: The end portion 102 of the shaft is reduced and threaded as before, but back of this is a tapered portion 103. A collar 104, provided with a corresponding internal taper, is put on the taper 103, the rotor is then

mounted on the reduced end portion of the shaft, and a cap nut 105 is screwed on the reduced end of the shaft to clamp the rotor firmly against the collar 104 and to clamp the collar 104 firmly against the tapered portion 103 of the shaft. A set screw 106 may be employed to lock the cap nut 105 to the shaft.

To prevent rotary movement of the rotor relative to the shaft, the central portion 96 of the rotor may be provided with outwardly extending lugs 107 adapted to engage corresponding recesses 108 in the collar 104. The collar 104 may be keyed to the shaft, or friction may be relied upon to hold it in non-rotatable relationship with the shaft.

The use of sheet metal or other sheet material in the construction of rotary impeller pumps presents a number of advantages not heretofore attainable. For example, it is a comparatively simple task to make the rotor or casing from sheet metal in accordance with any of the usual methods of mechanically working sheet material. Once the dies have been set up, economy almost demands that a considerable number of pieces be struck from them, whereas if the parts are cast, as has heretofore been customary, a separate mold is required for each casting, and so volume production of parts is little, if any, more economical than piece work. For these reasons, a manufacturer is more likely to carry in stock spare parts of sheet metal than of cast metal, and as a result delay and attendant expense in obtaining replacements for pumps made in accordance with the invention will be largely eliminated.

A further advantage of the invention resides in the fact that expensive alloys, such as stainless steel, "Monel" etc., may be more economically employed in the construction of pumps than has been possible heretofore. Practically all desirable alloys may easily be obtained upon the market in sheet form, whereas casting of certain alloys is difficult because of changes in the character of the alloy when improperly melted and cast, or because of the difficulties manifested by blow holes, hard spots, or excessive shrinkage in the casting. By employing sheet metal, it is possible to eliminate the difficulties inherent in the process of casting, and it is possible to effect a reduction in the weight of metal necessary to form the individual parts.

By making all parts of the pump with which the liquid comes in contact of sheet metal, rough surfaces over which liquid passes at high velocity are eliminated, resulting in lower internal friction losses. The rolled sheet metal surfaces are compact and do not contain pores in which bacteria might lodge, and so pumps made from such sheet metal may be employed in handling food products without fear of contaminating them.

Pumps made in accordance with the invention may be constructed sufficiently strong to deliver pressures as high as those delivered by cast pumps, and they possess the added advantage that when inadvertently overloaded, the sheet metal rotor blades, being somewhat flexible, will bend slightly without breaking, thereby automatically compensating for the overload. Notwithstanding this flexibility of the sheet metal parts, however, they are amply stiff, especially if curved longitudinally or transversely.

Pumps may be constructed in accordance with my invention wherein no welds are exposed to the liquid being pumped. Some alloys, among them several varieties of stainless steel, are difficult to weld, and the welded portions, due to improper heating, may be much less resistant to corrosion than the original material. In some instances the corrosion resistance of the welded portions may be increased by subsequent heat treatment but this expedient is costly, and relatively uncertain. By avoiding welds, my invention presents advantages of simple construction, and when it is necessary to employ materials with which corrosion resistant welds are difficult or impossible to obtain a further advantage accrues.

I claim:

1. A centrifugal pump which comprises a casing having two opposed halves each made integrally of sheet material and fastened together at their peripheries and having outwardly extending integrally formed tubular necks near the centers of the respective casing halves, an inlet nipple abutting one casing half and fastened to the respective tubular neck by a friction joint, a packing gland attached to the other casing half by a friction joint, a rotatable shaft extending through said packing gland, a sheet metal rotor rigidly attached to said shaft by a friction joint and disposed within the casing halves, a tapered outlet nipple attached to both casing halves adjacent their peripheries by a driven joint, and a sheet metal splitter disposed within the casing halves adjacent the outlet nipple and rigidly attached to one casing half.

2. Apparatus according to claim 1 wherein the tubular necks are upset into grooves within the inlet nipple and the packing gland.

3. A centrifugal pump comprising a rotor rigidly mounted on a rotatable shaft, a sheet metal casing enclosing said rotor and having two opposed sheet metal casing halves, each half being integrally formed with a tubular neck extending outwardly along the axis of the shaft, a packing gland assembly disposed on the outside of the tubular neck of one casing half and rigidly attached thereto by a rolled joint, a nipple disposed on the outside of the tubular neck of the other casing half and rigidly attached thereto by a rolled joint, a tapered nipple disposed at the periphery of the casing and fastened between the opposed casing halves by a driven joint, and a reinforcing member disposed outside the casing halves adjacent the point at which the tapered nipple is joined to the casing halves.

4. A centrifugal pump comprising an impeller rigidly mounted on a rotatable shaft, a relatively thin sheet metal casing enclosing the impeller, said casing being divided into two integrally formed outwardly concave casing halves having tubular neck portions formed integrally therewith and extending outwardly from the pump casing along the axis of the shaft, a packing gland abutting one casing half and rigidly attached to the tubular neck portion of this casing half, a nipple rigidly attached to the tubular neck portion of the other casing half, and a pair of relatively thick reinforcing members, one of which is placed against the exterior face of one casing half and against the adjoining nipple, the other being placed against the exterior face of the other casing half and against the adjoining packing gland.

5. In a centrifugal pump having opposed casing halves of relatively thin sheet material fastened together at their peripheries, the combination which comprises a peripheral nipple formed by abutting sections formed integrally with the respective casing halves, a conduit projecting into said nipple and attached thereto by a driven

joint, a second conduit having a wall substantially thicker than the sheet material abutting the outside of a casing half near its center and having an internal annular groove, and a tubular neck formed integrally with the casing half and projecting into the second conduit, said tubular neck having an expanded portion fitting tightly into the groove in the second conduit.

6. In a centrifugal pump having opposed casing halves of relatively thin sheet material fastened together at their peripheries, the combination which comprises a peripheral nipple formed by abutting sections formed integrally with the respective casing halves, a conduit projecting into said nipple and attached thereto by a driven joint, a second conduit abutting the outside of a casing half near its center and having an internal annular groove, a tubular neck formed integrally with the casing half and projecting into the second conduit, said tubular neck having an expanded portion fitting tightly into the groove in the second conduit, and a reenforcing member fitted against the outside of the casing half and the abutting second conduit.

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