July 6, 1943. P. H. WILLIAMS 2,323,637

CENTRIFUGAL PUMP IMPELLER BALANCING PROCESS

Filed Aug. 4, 1940

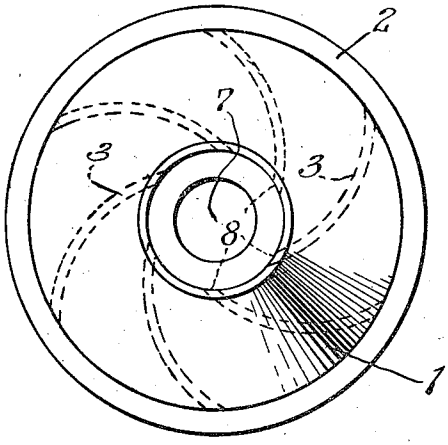


Fig. 1.

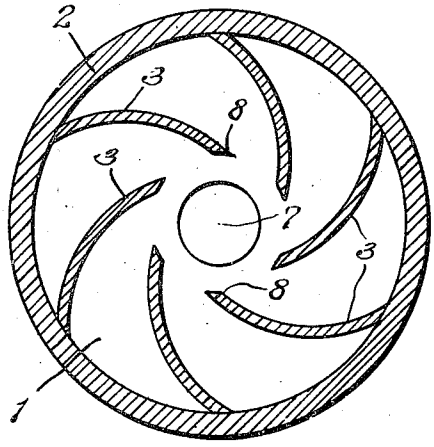


Fig. 2.

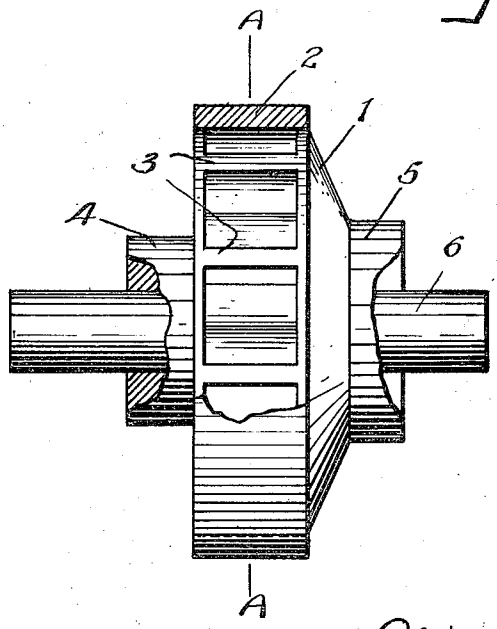


Fig. 3.

Philip H. Williams.
INVENTOR

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CENTRIFUGAL PUMP IMPELLER BALANCING PROCESS

Philip H. Williams, San Jose, Calif.

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2 Claims. (Cl. 103—115)

In the design and construction of high speed rotative machines, specifically centrifugal pumps, it is imperative that rotating parts be accurately balanced to eliminate vibration, friction, excessive power consumption and rapid wear on packings and bearings. Quiet operation is often of extreme importance in the operation of pumps, and this is impossible without accurate balance of the rotating parts.

The usual practice in balancing centrifugal pump impellers is to balance the finished impeller for either static or dynamic balance, treating it simply as a piece of metal. Were it in truth simply a piece of turned metal this process would be fairly accurate. But the process in use today is inaccurate and inadequate in the balancing of centrifugal pump impellers for the following reasons:

A centrifugal pump impeller, as usually constructed, is not a solid piece of metal but a series of curved metal vanes separated by water channels or passages, and shrouded on each side by a thin metal wall.

As the interior of the impeller is cast from sand molds or cores, which in turn are supported during the casting process in an outer sand mold, it will be evident that such inner cores or moulds may shift, deform, or distort under the action of the heated metal and accumulated gases. Even if accurately made patterns and core boxes are used and the utmost care exercised, some distortion takes place from uneven cooling, uneven tamping of the sand, uneven density of the cores and uneven shrinkage during cooling of the castings.

After the castings reach the machine shop it becomes all but impossible, and definitely impractical, for the machinist to determine the exact symmetrical center of the rough casting. The result is that when the impeller is finished and comes from the lathe it is certain that the vanes and water channels are not symmetrically disposed about the true center of the impeller as it was laid out on the drafting board.

Again, the wall thickness of the shrouds will vary at several points from reasons stated above, and the metal of the finished impeller will be lighter or denser at various points.

From what has been written it will appear that the present method of balancing an impeller ignores the symmetry of the design and proceeds as with solid metal. In other words the balancing is done without regard to the weight of the liquid to be pumped or the relation of such weight to the design center of the impeller.

From what has been written it will appear that when actually pumping water the weight of the water or liquid in the impeller will not be symmetrically disposed about the axis of rotation of finished impeller. To state the result in plain language, there will be more water on one side of the shaft of the impeller than on the other, due to the displacement of the axis of rotation from the true center of the design. This condition is still further complicated by the inaccuracies and varying thickness and density of the cast metal. My invention is designed to make possible an accurate balance of pump impellers under the conditions described.

This invention relates to the balancing of centrifugal pump impellers and the like, and more specifically, to the balancing of cast impellers to insure accurate balancing under actual operating conditions.

An object of the invention is to provide a process and a means of balancing a centrifugal pump impeller so that when filled with the liquid it is designed to pump, it will be in accurate balance regardless of inaccuracies of construction and lack of symmetry in the vanes and channels of the impeller.

Another object of the invention is to provide a process and a means of balancing such impellers for the various liquids handled in industry and to adapt the balance of the impeller to the specific liquid to be pumped.

Still another object of the invention is to provide such means for the purposes named as shall be low in cost, simple in operation and of practical application to the problems of balancing centrifugal pumps in a pump manufacturing plant.

I attain these objects by use of the process described in the accompanying specification and illustrated and made clear by reference to the annexed drawing, in which

Figure 1 is a side view of an impeller from the suction side and showing a balancing ring in place.

Figure 2 is a section through such impeller and balancing ring on the section A—A indicated in Figure 3.

Figure 3 is a conventional centrifugal pump impeller mounted on a balancing arbor with balancing ring cut away to show vane tips and water channels of the impeller.

Similar numerals refer to similar parts throughout all the figures of the drawing.

Referring to the accompanying drawing,

1 is a shroud or side plate of the impeller.

2 is a balancing ring used as hereinafter described.

3, 3, 3 are impeller vanes, shown in section in Figure 2.

4 is the hub of a single suction impeller.

5 is the suction nozzle of a single suction impeller.

6 is a balancing arbor or the shaft of the impeller.

7 is the mechanical center of the finished impeller.

8, 8, 8 are the inner edges of the impeller vanes.

By reference to the preceding discussion it will be clear that the points of the vanes, 8, 8, 8, may not, and usually will not, be symmetrically disposed with reference to the mechanical center 7 of the impellers as it comes from the lathe. It will also be clear as to what is meant in the statement that the water passages between vanes 3, 3, 3, may not, and usually will not, be of an exact size or symmetry or symmetrically disposed about the mechanical center 7.

With these details clearly in mind it will appear that if, the impeller could be filled with the liquid to be pumped, and the liquid retained in place during the balancing process, then in that event the impeller would be in balance when actually pumping the liquid. It will also be evident that the same results would be attained could we use some substance of equal weight that would retain its position during the balancing process.

I have discovered that there are certain waxes, or that certain waxes can be produced, that will have the same specific gravity of the liquid to be pumped, be that liquid water, milk, brine, oil, etc.

Referring to the drawing, I press a balancing arbor 6, through the impeller as in conventional balancing arrangement, then a metal ring with a light push fit and wide enough to close the outer ports of the impeller, is pressed by hand over the outer circumference of the impeller closing the outer ports. It will be evident that the ring in itself is in balance, being turned inside and outside from solid metal. The impeller is now placed with the balancing arbor 6 vertical and with the suction nozzle 5 up and the heated balancing wax is poured into the nozzle until the channels and openings in the impeller are completely filled.

The wax, being heated only to melting temperature rapidly solidifies and the impeller may be balanced either statically or dynamically without displacing the wax. The balancing ring 2 securely holds the balancing medium against displacement by centrifugal force under high rotative speed for dynamic balancing.

Two methods, hereafter termed "the conventional manner" are common in impeller balancing, either of which is applicable to the process described herein.

1. *Dynamic balancing.*—The impeller after being filled with the balancing medium is mounted on the spindle of a dynamic balancing machine and rotated at high speed. The balancing machine registers the amount of unbalance and at the same time indicates where metal is to be removed to restore balance. Metal is removed by grinding or drilling until the desired balance is attained.

2. *Static balance.*—The impeller is mounted on a balancing arbor or shaft, filled with the balancing medium and the ends of the shaft supported upon parallel ways or knife edges. The heavy side of the impeller will rotate the impeller upon its supports until it comes to rest with the unbalance down. By a trial and error method enough metal is removed from the heavy side of the impeller to allow the impeller to remain at rest in any position.

When the balancing is completed and the impeller ready for assembly, it is only necessary to warm the impeller to the melting point of the wax when the balancing medium will run out into any convenient receptacle and be ready to use again. The usual practice is to press out the balancing arbor, 6 remove the balancing ring 2 and place the balanced impeller on a drain rack over a receptacle in a low temperatured oven. In a few minutes the impeller will be completely drained and the balancing medium all recovered to be used again.

As a balancing medium I use commercial waxes of either vegetable, animal or mineral composition as best suit the problems in hand. Beef or mutton tallow with a specific gravity ranging from 0.895 to 0.953; beeswax with a specific gravity of 0.961 to 0.968; carnauba wax with a specific gravity of 0.995 to 0.999 may be used when their specific gravity corresponds with the liquid to be pumped. The carnauba wax at highest specific gravity of 0.999 is but one tenth of one percent below the weight of water, which renders it accurate enough for practical purposes. I have found, however, that reheating and heating to high temperatures tends to increase the specific gravity of carnauba wax until it is possible to approximate the exact weight of the liquid to be pumped.

In special cases I have used successfully beef tallow warmed to working consistency and enough finely divided graphite stirred in to give the exact specific gravity desired. This process is practical and there are a number of combinations possible to increase the specific gravity of the balancing medium. Certain commercial resins have a specific gravity greater than unity and are used to mix with waxes as, for example, shoemaker's wax is a mixture of beeswax and resin.

From what has been written it will appear that I have provided a low cost, practical and efficient process for the purposes named, and that the balancing medium is low in cost and easily obtainable. It will further appear that the balancing process set forth above is new, novel, and solves a serious problem in the industrial and manufacturing world.

Having thus described my invention, I claim:

1. The process of balancing a centrifugal pump impeller and the like, consisting in filling the impeller passages completely full of a medium of a specific gravity approximating that of the liquid to be pumped, retaining such medium by suitable means, balancing the impeller in the conventional manner while filled with such medium, and removing such medium by the application of heat.

2. The process of balancing a centrifugal pump impeller or the like, consisting in filling such impeller or the like with a medium approximating the specific gravity of the liquid to be pumped, balancing the impeller or the like in the conventional manner and removing the balancing medium by suitable means.

PHILIP H. WILLIAMS.