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CENTRIFUGAL PUMP WITH SPHERICAL-SHAPED CASING
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ABSTRACT OF THE DISCLOSURE
A direct-driven centrifugal pump having a high-pressure, thin-walled casing in the shape of a hollow spherical segment. The centrifugal pump is of the double intake type having a splitter vane formed of one piece with the casing.

Prior art
The present invention relates principally to centrifugal pumps of the kind that are used for pumping high-pressure, high-temperature liquids. Pumps of this kind usually are close-coupled to a source of mechanical power, as a wet or sealed electric motor, that is to say, the external casing of the pump and the frame of the driving machine are structurally unified, often times directly by means of complementary flanges. The result is a direct-driven pump that is also called a motor-pump combination.

Pumps of the foregoing kind have heretofore been constructed with an external casing that is generally in the form of a hollow cylinder closed at one end, and typically including an intermediate bulge, or section of increased diameter, to accommodate outlet diffusers and/or inlet nozzles and other flow-directing means. The casing is characterized by very thick walls to accommodate the bending stresses present which are attributable to the high liquid pressure involved. These thick walls cause high thermal stresses to be present because their insufficient flexibility, particularly when the operating temperature of the pump casing is in the order of from 550° F. to 750° F., for example, and the maximum operating temperature of the motor shell to which it is rigidly secured is typically in the order of 300° F. Thus, in the interest of meeting the requirement for high temperature and pressure, a new kind of pump casing is needed.

Objects
It is a principal object of this invention to provide a new and improved kind of centrifugal pump casing for high-temperature applications.

It is a more specific object of this invention to provide a thin-walled centrifugal pump casing suitable for high-temperature high-pressure applications. Another object is to provide a thin-walled, high-temperature pump casing, for close-coupling to an electric drive motor, having greater flexibility and lower weight.

Brief description
The walls of the pump casing, in a preferred embodiment, are spherical except where the requirements for fluid flow or fastening demand other configurations. In these expected portions, the walls continue to maintain membrane support, as opposed to support characterized by bending stresses. More particularly, in the scroll portion at the central, or belt line, portion of the pump casing, the splitter vane is increased in cross-sectional area, preferably progressively as the corresponding scroll wall departs an increasing extent from the spherical shape, moving circumferentially around the scroll toward the outlet. In this way, a thin-walled casing is provided having the necessary strength heretofore achievable only with thick walls, because the splitter vane becomes a principal structural member adjacent the outlet region.

Detailed description
The pump casing of FIGURE 1 includes an annular flange 10, adapted to be bolted or otherwise directly connected to a driving machine (not shown) that can be of the general kind described in U.S. Patent 3,218,490, for example. In accord with the invention, a first portion 12 of the casing extends radially outwardly from flange 30 and features a substantially constant radius of curvature. Portion 12 can be likened in shape to a thin-walled, truncated, hollow spherical segment. The second, or central, portion 16 of the casing comprises a continuously curved scroll wall 17, having a radius of curvature in the direction of extension from portion 12 equal to or less than that of portion 12. A splitter vane 18 spans wall 17 and defines therewith a fluid discharge passageway, or conduit 19. The third and final principal portion 20 of the integral casing extends radially inwardly from the second portion and provides an end closure in the form of a hollow spherical cap having a substantially continuously curved thin wall with a radius of curvature approximately equal to the radius of curvature of first portion 12.

Inside the pump casing there is an integral annular boss 22 projecting from portion 20 and to which an annular flow-directing baffle 24 is secured. A centrifugal impeller 26 is centrally positioned within the casing and is fixed to a rotatable shaft 28. The axis of rotation of shaft 28 is taken for descriptive purposes as the pump axis and the center of rotation 30 of impeller 26 on this axis is preferably equidistant from the walls of spherical portions 12 and 20 of the casing, that is to say, the impeller 26 is essentially at the center of the sphere of which portions 12 and 20 are segments.

On the described right-hand side of FIGURE 1, it will be noted that the radial thickness of splitter vane 18 has increased to be substantially commensurate in thickness with wall portions 12 and 20. Also, at this circumferential position around the belt line, or central portion 16 of the casing, scroll wall 17 has a radius of curvature substantially less than that of spherical portions 12 and 20. Accordingly, vane 18, in addition to its flow-directing role, is the major structural component of the casing in this region and cooperates with scroll wall 17 to maintain membrane, or essentially tensile, support in both members counteracting internal pressure within the casing. On the opposite side of FIGURE 1, the scroll wall at 32 is essentially a continuation of spherical portions 12 and 20, and the splitter vane at 34 is of reduced radial thickness to the point where it essentially takes on only a flow-directing role without significant contribution to the structural support of the wall.

FIGURE 2 illustrates more clearly how the splitter vane 18 is of substantially reduced radial thickness at 34, relative to the radial thickness of the external casing wall, as at 32, for example, in the radially inner portion of the vane 18. Vane 18 is of progressively increasing radial thickness over most of its circumferential length and the change in radial thickness is in the same direction as...
changes in the radial distance of vane 18 from the center 30 of the impeller and pump casing. The radial thickness of vane 18 adjacent the outlet nozzle, as illustrated in FIGURE 2, is preferably at least as thick as walls 12 and 20. In this way, vane 18 serves a progressively increasing role as a structural component of the pump casing as scroll wall 17 becomes correspondingly less suited for this role as its departure from the desired spheric shape becomes greater, i.e., as the radial distance of scroll wall 17 increases from center point 30, and the discharge nozzle, defined by walls 36 and 38, the vane 18 can taper down in radial thickness, as shown, for fluid dynamic purposes, as walls 36 and 38 provide a substantial portion of the required support in this region.

FIGURE 3 illustrates a second flow-directing vane 40, opposite splitter vane 18, that can be an insert that need not form part of the pressure-supporting casing because the corresponding central wall portion at 42 is essentially a continuation of the spheric outer wall. Alternatively, vane 40 can be formed as part of the wall at 42, with no separating void, as where casting or assembly is thereby facilitated, for examples.

While the invention has been described in connection with a double-inlet, double-discharge centrifugal pump, it will be apparent that the teaching herein extends equally to other types of pumps as those featuring a single discharge and/or single inlet, as axially upwardly from the bottom, for examples.

The foregoing is a description of an illustrative embodiment of the invention, and it is applicants' intention in the appended claims to cover all forms which fall within the scope of the invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. A centrifugal pump comprising: (a) an annular flange for attachment to the stationary structure of a pump-driving machine; (b) a thin-walled first portion extending radially outwardly from said flange and having the shape of a hollow truncated spheric segment; (c) a second portion extending from said first portion and including a scroll wall and a splitter vane defining a liquid outlet flow passage therebetween; and (d) a third portion extending radially inwardly from said second portion and providing an end closure in the shape of a hollow spheric segment with a substantially continuously curved thin wall.

2. The pump of claim 1 wherein the centers of curvature of said first and third portions are essentially coincident.

3. The pump of claim 1 wherein the radius of curvature of said scroll wall decreases in the circumferential direction toward said outlet and the radial thickness of said splitter vane correspondingly increases in the same direction.

4. The pump of claim 1 wherein said vane is characterized by having an essentially rectangular vertical cross section.

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