

March 8, 1966

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3,238,604

METHOD OF FABRICATING SLUSH PUMP FLUID END HOUSINGS

Filed Jan. 7, 1963

4 Sheets-Sheet 1

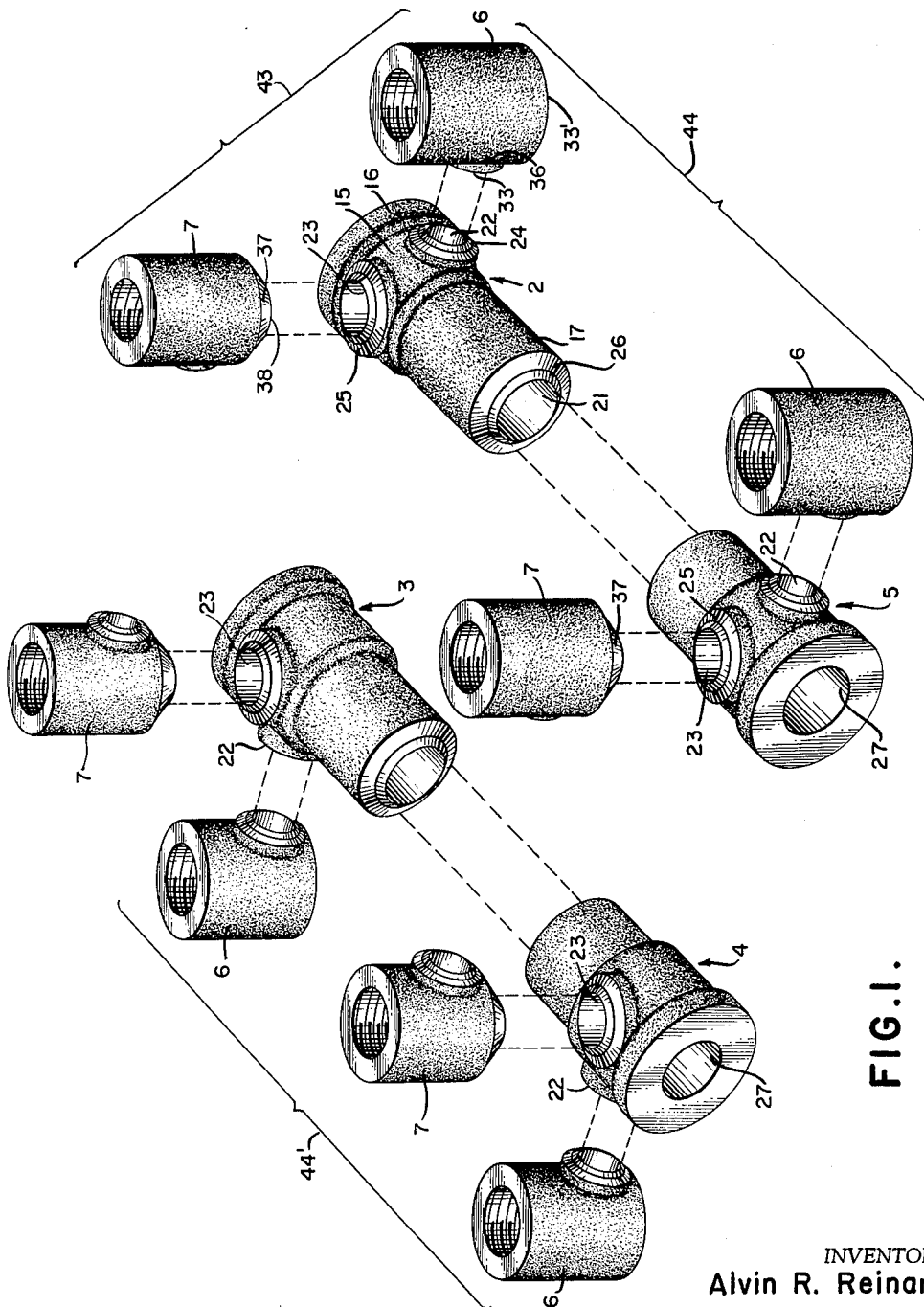


FIG. 1.

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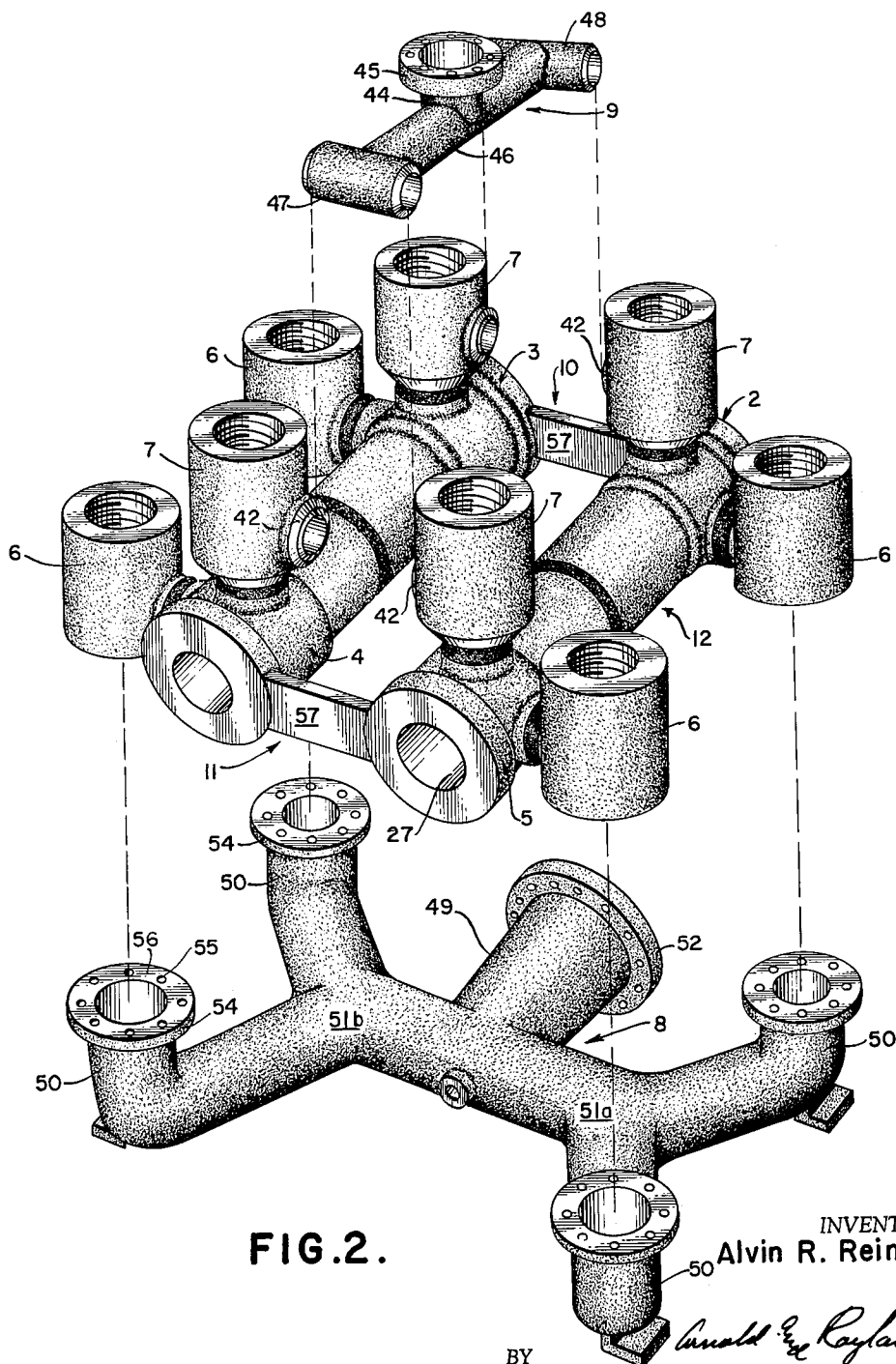
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4 Sheets-Sheet 2



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4 Sheets-Sheet 3

FIG. 3.

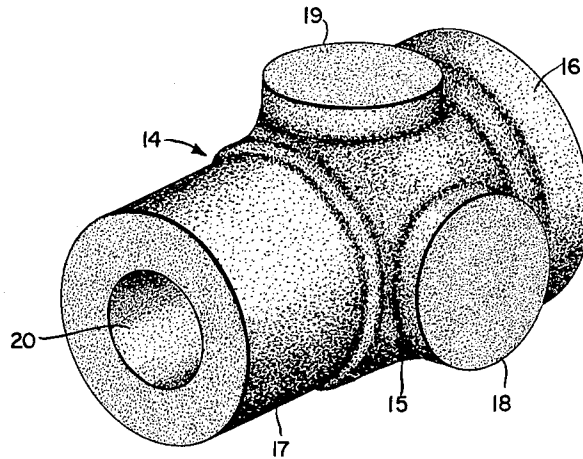


FIG. 4.

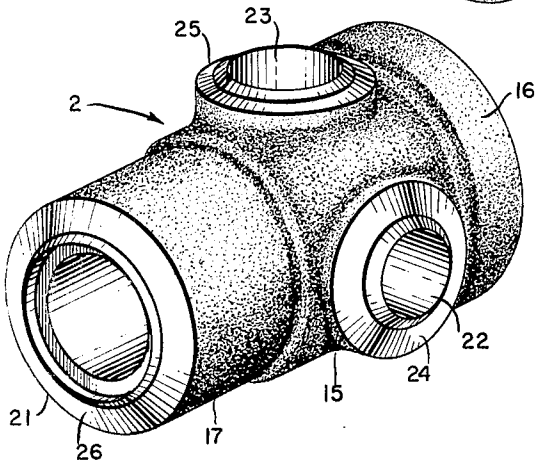
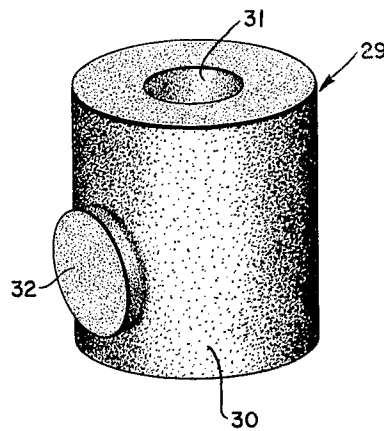


FIG. 5.

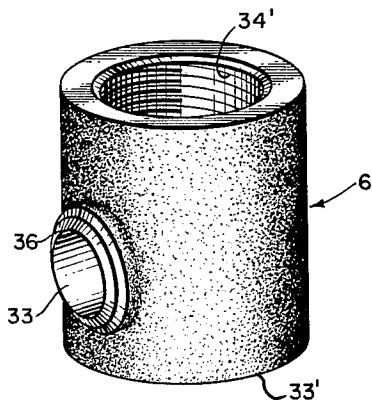


FIG. 6.

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4 Sheets-Sheet 4

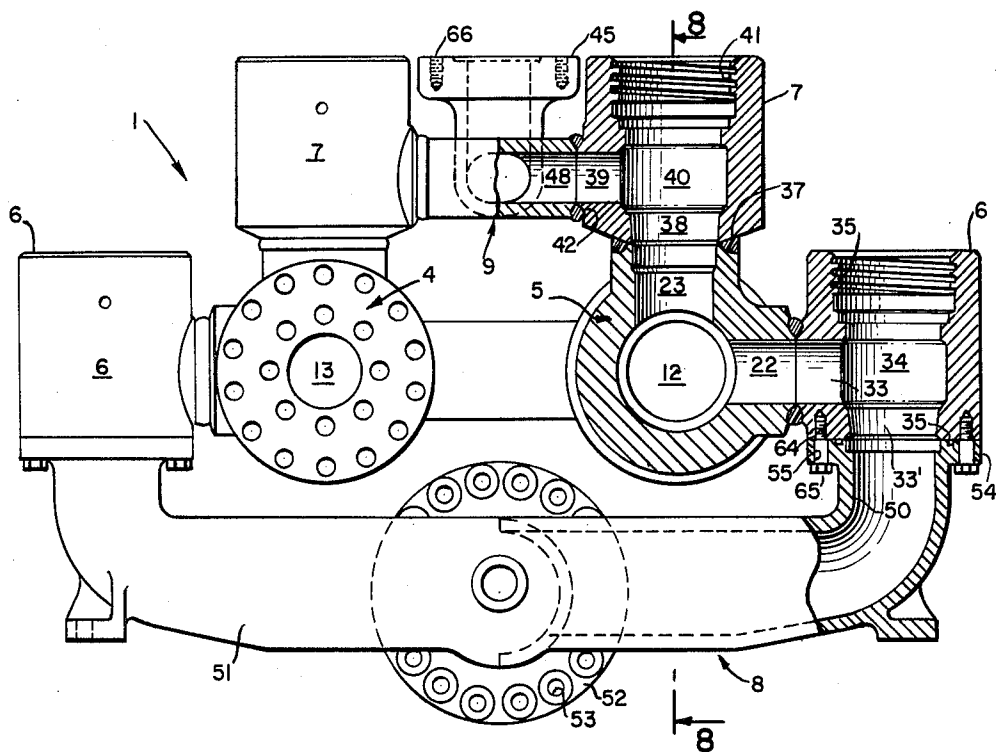


FIG. 7.

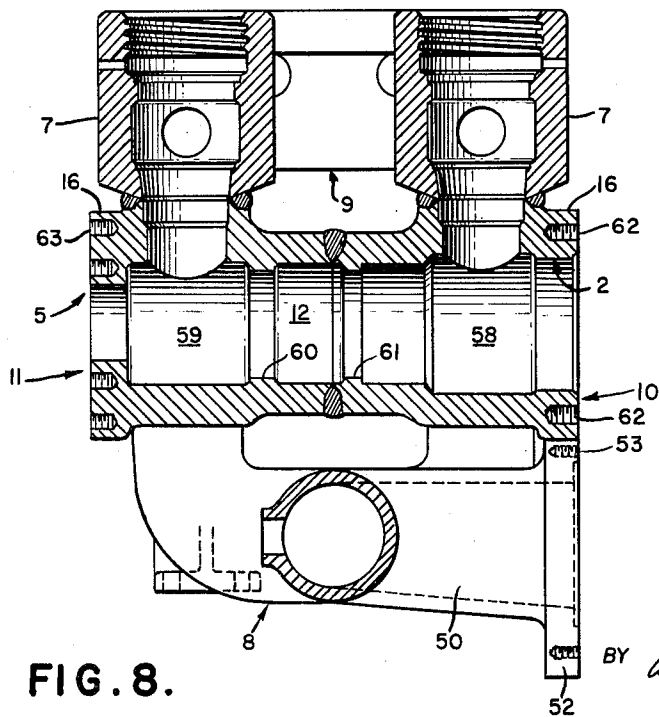


FIG. 8.

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3,238,604

METHOD OF FABRICATING SLUSH PUMP FLUID END HOUSINGS

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11 Claims. (Cl. 29—156.4)

This invention relates to the fluid end of a slush pump adapted for use in the oil industry, and more particularly to a method of fabricating the fluid end housing for such a slush pump.

It is common practice in drilling oil wells to utilize a drill bit connected to the lower end of a drill pipe which extends from the surface of the earth down to the bottom of the well. The drill bit and drill pipe are rotated by suitable equipment above ground. Also located above ground is a slush pump connected to pump drilling fluid into the upper end of the drill pipe. The slush pump forces the drilling fluid down to the bottom of the well through the drill pipe, through the drill bit, and then back up to the surface of the earth in the space outside the drill pipe.

As the sources of oil closer to the surface of the earth become depleted, it becomes necessary to drill deeper wells which, in turn, require slush pumps capable of delivering drilling fluid at higher pressures. Further demands for increased drilling fluid pressures are brought about by the trend toward jet drill bits which direct the drilling fluid through relatively small high pressure nozzles. The fluid end housing of a slush pump must be constructed to withstand these increased pressures. In the smaller slush pumps, the housing can easily be fabricated from a casting, but as the pressure requirements increase, it becomes increasingly difficult to use castings because of the increased physical size and the inherent poor metallurgical characteristics. Forged housings, on the other hand, have much better metallurgical properties and reduce the physical size of the housing for comparable specifications. Forged housings, however, are considerably more expensive than cast housings and, hence, are difficult to market at competitive prices.

Thus, an object of the invention is to provide a method of fabricating a fluid end housing for a slush pump from forged components while minimizing the cost increase over comparable cast housings.

Another object is to provide a method of fabricating a fluid end housing using pluralities of identical forged blanks so as to minimize the number of different required forging operations, and to minimize the number of different component parts stocked in inventory.

Still another object is to provide a method of fabricating a fluid end housing using pluralities of identically forged blanks which are subsequently machined to different dimensions so that an identical forging can be utilized in the plurality of different positions.

Yet another object is to provide a method of fabricating a fluid end housing by assembling a relatively large number of individual components and yet achieving accurate internal dimensions extending through more than a single one of these components.

The invention is specifically illustrated with respect to the fluid end for a dual cylinder, double acting type slush pump, but the invention is not limited to any particular type of pump construction. In accordance with this invention, the housing for such a fluid end is fabricated from four identical forged cylinder barrel half blanks, eight identical forged valve pot blanks, a cast suction manifold and a cast discharge manifold. Each of the barrel half blanks are machined to somewhat different di-

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mensions to form four different barrel halves which, when assembled, will form the two fluid cylinders of the fluid end. During the machining operation, a suction port and a discharge port are provided in each of the barrel halves. Half of the valve pot blanks are machined to form suction valve pots, and the other half are machined to form the discharge valve pots. At this point, it should be noted that the two basic types of forgings have now been machined and form six different component parts.

A suction valve pot and a discharge valve pot are securely welded to each of the barrel halves so as to properly communicate with the suction and discharge ports respectively, thus forming quarter sub-assemblies. The barrel halves are then welded together to form two half sub-assemblies, each half sub-assembly including a complete fluid cylinder. Next, the suction and discharge manifolds are secured in position to complete the assembly. After all welding operations are completed, the entire unit is stress relieved, and finally the fluid cylinders are machined to their final and precise internal dimensions.

A better understanding of the invention, with respect to the foregoing and other objects, can be achieved by referring to the following specification and drawings, the drawings forming a portion of the specification and wherein:

FIG. 1 is a view in exploded perspective showing the forming of quarter sub-assemblies and half sub-assemblies in accordance with the method of the present invention;

FIG. 2 is a view in partial exploded perspective showing the relative positions of components forming the completed half sub-assemblies and the manner in which the manifolds are added to complete the assembly of the fluid end housing;

FIG. 3 is a view in perspective of a forged cylinder barrel half blank;

FIG. 4 is a view in perspective of a rough machined cylinder barrel half;

FIG. 5 is a view in perspective of a forged valve pot blank;

FIG. 6 is a view in perspective of a machined suction valve pot;

FIG. 7 is an end elevational view, partly in section, of a completed fluid end housing fabricated in accordance with the method of the present invention; and

FIG. 8 is a sectional view looking along lines 8—8 of FIG. 7.

As shown in FIGS. 1, 2, 7 and 8, a fluid end housing 1 fabricated by the method of the present invention includes four different cylinder barrel halves 2, 3, 4 and 5; four identical suction valve pots 6; four identical discharge valve pots 7; a suction manifold 8; and a discharge manifold 9. The fluid end housing illustrated is for a duplex, double acting slush pump and has a head end 10 and a rod end 11. As viewed from the rod end, cylinder barrel halves 2 and 5, when assembled, form a right-hand fluid cylinder 12, and cylinder barrel halves 3 and 4 similarly form a left-hand fluid cylinder 13.

An initial step in fabricating fluid end assembly 1 is forging four identical cylinder barrel half blanks 14 (FIG. 3) from a suitable steel ingot. Each cylinder barrel half blank is generally cylindrical, having a center body portion 15, a larger diameter flange 16 at one end of the blank, and a smaller diameter elongated cylindrical portion 17 at the other end. Projecting radially from the same point along the longitudinal axis of center body portion 15 are two identical, generally cylindrical bosses 18 and 19 which are at right angles to one another. The cylinder barrel half blanks are provided with longitudinally extending circular openings 20 to reduce subsequent machining.

One of the forged steel cylinder barrel half blanks is subsequently machined to form cylinder barrel half

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2 (FIG. 1). A barrel half blank 14 is bored longitudinally to enlarge circular opening 20 and form a rough machined bore 21 having a configuration as can be seen in FIG. 8. Boss 18 is drilled to form a radially extending suction port 22 communicating with bore 21, and boss 19 is drilled to form a radially extending discharge port 23 which also communicates with bore 21. Discharge port 23 has a larger diameter than suction port 22 and extends at right angles thereto. The plane surfaces of bosses 18 and 19 are machined to provide beveled surfaces 24 and 25 which, when assembled, will form an annular V-shaped groove with an adjacent component. The groove so formed is adapted to receive a weld fillet, as will be subsequently described. The plane end surface of elongated portion 17 is similarly machined to provide a bevel surface 26 around bore 21. The flat end face of flange 16 is face machined to form a plane surface perpendicular to the axis of cylinder barrel half 2.

As best seen in FIG. 1, cylinder barrel half 2 forms the right-hand, head end, cylinder barrel half of fluid end housing 1. Another of the forged cylinder barrel half blanks is similarly machined to form the left-hand, head end, cylinder barrel half 3. The essential difference in machining is that the smaller diameter suction port is drilled through boss 19, and the larger diameter discharge port is drilled through boss 18 so that, when cylinder barrel half 3 is properly oriented, suction port 22 faces upwardly and discharge port 23 faces to the left (FIG. 1). It should be noted that bosses 18 and 19 on the forged cylinder barrel half blanks are both sufficiently large to permit the larger diameter discharge port to be drilled in either boss.

The right-hand, rod end, cylinder barrel half 5 of fluid end housing 1 is also machined from a forged cylinder barrel half blank 14. In this case, the flange end of the blank is drilled to form a bore 27 at the rod end of housing which is of smaller diameter than a similar bore at the head end of the assembly. The interior of the blank is rough machined to conform generally to the configuration shown in FIG. 8. Boss 22 is drilled to form a suction port and boss 23 is drilled to form a discharge port and the plane surfaces of the bosses are machined to provide beveled surfaces. The right-hand, rod end, cylinder barrel half 4 of the housing is machined similar to cylinder barrel 5 except that boss 23 is drilled to form the suction port and boss 22 is drilled to form the discharge port. When cylinder barrel halves 4 and 5 are properly oriented, as shown in FIG. 1, the discharge ports extend vertically and the suction ports extend horizontally away from one another.

All four suction valve pots 6 and all four discharge pots 7 are machined from eight identical forged valve pot blanks 29 (FIG. 3). Valve pot blank 29 has a cylindrical body 30 with a circular opening 31 extending through the body along the longitudinal axis. A cylindrical boss 32 projects radially from body 30 and is located slightly offset toward one end of the cylindrical body.

Four suction valve pots are finish machined from valve pot blanks 29 by boring a cylindrical outlet passage 33 through boss 32 to the center of the blank. The blank is then further machined, enlarging opening 31, to form an inlet passage 33', at the lower end, and a valve chamber 34. The upper end of the blank is internally threaded to provide threads 35 adapted to receive a threaded plug (not shown) for closing the upper end of the valve pot. The bottom end of the valve pot blank is faced to provide a plane surface perpendicular to the axis of cylindrical body 30. The face of boss 32 is machined to provide a beveled surface 36.

Four discharge valve pots are machined from the remaining valve pot blanks in the same manner as described for the suction valve pots, except that the bottom of the discharge valve pot is machined to provide a beveled end surface 37 which when assembled provides a V-shaped annular groove adapted to receive a weld fillet. Inlet

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passage 38, outlet passage 39 and valve chamber 40 of discharge valve pot 7 are substantially identical to the same corresponding portions of the suction valve pot. The upper end of discharge valve pot 7 is internally threaded to provide threads 41 that are adapted to receive a plug for closing the valve chamber. The face of boss 32 is machined to provide a beveled surface 42 surrounding outlet passage 39.

The preferred assembly procedure is to first form quarter sub-assemblies by welding a suction valve pot 6 and a discharge valve pot 7 to each of the machined barrel halves. To form the right-hand, head end, quarter sub-assembly 43 (FIG. 1), outlet passage 33 of a suction valve pot 6 is aligned with suction port 22 of cylinder barrel half 2 and the members are secured to one another by welding together the beveled surfaces 36 and 24. A discharge valve pot 7 is positioned with inlet passage 38 aligned with discharge port 23 and beveled surfaces 25 and 37 are then joined by welding. The additional quarter sub-assemblies are formed in like fashion including, respectively, barrel halves 3, 4 and 5. Half sub-assembly 44 is formed by axially aligning cylinder barrel halves 2 and 5 and by then welding the cylinder barrel halves to one another by filling the V-shaped annular groove formed by adjacent beveled surfaces with a weld fillet. Half sub-assembly 44' is formed in like fashion by similarly joining cylinder barrel halves 3 and 4. The longitudinal opening passing through half sub-assemblies 44 and 44' form, respectively, the right and left fluid cylinders.

Discharge manifold 9 (FIG. 2) is an integrally cast unit cored in a suitably dimensioned core mold. The discharge manifold includes a tubular H-shaped portion formed by a conduit 46 which, in the completed assembly, is adapted to extend along an axis parallel to the fluid cylinders 12 and 13, and a pair of communicating, horizontal cross conduits 47 and 48 at the ends thereof. The internal diameter of the conduits is approximately the same as that of the outlet passages of discharge valve pots 7 and the lengths of the conduits are such that the open ends of cross conduits 47 and 48 will align with these outlet passages in the completed assembly. Preferably, the free ends of the cross conduits are machined to provide a beveled surface which will form an annular V-shaped welding groove with the beveled surfaces 42 of the adjacent valve pot 7. An upwardly extending conduit 44, at one end, is joined to conduit 46 at the midpoint and, at the other end, terminates in a flange 45. Flange 45 is machined to provide a finished plane horizontal surface, and is drilled to provide a circular array of downwardly directed bolt holes.

Suction manifold 8 is also an integral casting formed in a suitably cored mold. The suction manifold includes a header formed by a pair of horizontally disposed Y-shaped conduit portions 51a and 51b, each having a pair of upwardly extending conduit portions 50 at the divergent ends. The base legs of the Y-shaped conduit portions, as viewed in FIG. 2, form a single conduit having a longitudinal axis perpendicular to the fluid cylinders 12 and 13 and having a horizontal, rearwardly extending conduit 49 extending from the midpoint thereof. The free end of conduit 49, and the free ends of conduits 50 terminate in flanged end portions which are machined to provide a finished plane surface and drilled to provide a circular array of bolt holes perpendicular to the plane surfaces. The suction manifold is dimensioned so that the four upwardly extending conduit portions 50 will communicate respectively with the inlet passages 33' of the corresponding suction valve pots 6.

The half sub-assemblies 44 and 44' (FIG. 1) are secured to one another by means of suitably dimensioned spacers 57 (FIG. 2) welded between the flanged end portions of the cylinder barrel halves. Discharge manifold 9 is then lowered into position with the longitudinal axes of cross conduits 47 and 48 extending through the re-

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spective outlet passages of discharge valve pots 7. The discharge manifold is then welded into position thereby forming a weld fillet in the V-shaped grooves formed by adjacent beveled surfaces.

At this point in the fabrication, it should be noted that all welding operations have been completed. Each of the welds are carefully inspected by suitable nondestructive methods and defective welds repaired if possible. The entire unit is then stress relieved to eliminate stresses caused by the various welding operations. The stress relieving operation entails slowly heating the unit to a suitable stress relieving temperature, maintaining the temperature for a predetermined period of time, and then slowly cooling the unit.

The welding operations and subsequent stress relieving may cause the assembly to warp and therefore the finish machining of the fluid cylinder interiors and of the surfaces which connect to the suction manifold must be deferred until the stress relieving is completed. During the final machining operations of fluid cylinder 12, the annular ribs 60 and 61 (FIG. 8) are precisely machined so that a cylinder liner (not shown) to be supported by these ribs, will be accurately aligned even though these ribs are part of different cylinder barrel halves. The head end of the fluid cylinder 12, including chamber 58, is finished machined and a circumferential array of bolt holes 62 are drilled and tapped in flange 16 so that a head assembly (not shown) can be securely bolted to the head end with the proper alignment. The rod end of the fluid cylinder is also finished machined and a double row of circumferentially arranged bolt holes 63 are drilled and tapped so that a rod end assembly can be securely bolted thereto in a properly aligned relationship. The other fluid cylinder 13 is finish machined in like fashion.

The lower plane surfaces of the four suction valve pots 6 are faced and a circular array of bolt holes 64 are drilled and tapped extending upwardly from the lower surface. The final step in the assembly operation is to move suction manifold 8 (FIG. 2) upwardly against suction valve pots 6 so that the conduits 50 are aligned with the inlet passages of the suction valve pots. The suction manifold is then bolted into position by means of suitable bolts 65.

The fluid end is completed by mounting a pressure actuated check valve in each of the valve pots, and a piston, a cylinder lining, a rod end assembly and head end assembly in each of the fluid cylinders. The pistons are preferably staggered so that there are four power strokes for each cycle of operation. In between the valves, i.e., including the fluid cylinders and a portion of the valve pots, there are violent pressure fluctuations, changing from a high negative pressure during the suction stroke to a high positive pressure during the power stroke. The surrounding portion of the housing must be capable of withstanding these pressure fluctuations and therefore the fluid cylinders and valve pots are made from forged blanks which have much better metallurgical properties than do castings. The pressure fluctuations are substantially less outside the valves since the pressure is either positive or negative, but does not change, and since the staggered four strokes per cycle further decrease the fluctuations. Accordingly, castings suffice for the suction and discharge manifolds.

The method in accordance with this invention permits the entire fluid end housing to be fabricated from two types of relatively simple forgings and two castings, thereby providing a housing better capable of withstanding the high pressures and pressure fluctuation while at the same time minimizing the increase in cost over comparable completely cast housings.

While the invention has been illustrated with respect to a particular type of slush pump fluid end, it should be clear that the invention is applicable to slush pumps generally. Furthermore, there are numerous modifications which can be made in the method without departing

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from the scope of the invention. The scope is more particularly defined in the appended claims.

What is claimed is:

1. The method of fabricating a fluid end housing assembly for a slush pump comprising,
 - 5 forging
 - a plurality of identical valve pot blanks, and
 - a plurality of identical cylinder barrel half blanks;
 - 10 machining
 - said cylinder barrel half blanks to form at least one pair of cylinder barrel halves, which pair can be assembled into a fluid cylinder having at least one suction port and at least one discharge port, and
 - said valve pot blanks to form suction valve pots and discharge valve pots which, when assembled, will communicate with said suction and discharge ports respectively;
 - 15 welding
 - said suction and discharge valve pots to said cylinder barrel halves so as to communicate, respectively, with said suction and discharge ports, and
 - said pair of cylinder barrel halves together to form a fluid cylinder;
 - 20 stress relieving said welded assembly; and
 - 25 then finish machining the interior of said fluid cylinder.
2. The method of fabricating a fluid end housing for a slush pump, comprising
 - 30 forging four identical cylindrical half blanks each having a pair of identical bosses near one end extending radially outwardly from the longitudinal axis of the blank and at right angles to one another;
 - 35 machining said four half blanks so that when assembled they form two substantially parallel fluid cylinders in a horizontal plane, each of said fluid cylinders having
 - a pair of suction ports near the ends thereof extending away from the other fluid cylinder and through bosses on said half blanks, and
 - 40 a pair of discharge ports also near the ends thereof but extending upwardly through the remaining bosses;
 - 45 welding a previously forged and machined suction valve pot to each of said half blanks so as to communicate with each of said suction ports;
 - 50 welding a previously forged and machined discharge valve pot to each of said half blanks so as to communicate with each of said discharge ports;
 - 55 welding said machined half blanks together to form two fluid cylinders;
 - a casting a suction and a discharge manifold and connecting the same to communicate, respectively, with said suction and discharge valve pots.
3. The method of fabricating in accordance with claim 2 wherein the assembled unit is stress relieved after all welding operations are completed and wherein said fluid cylinders are finish machined after said assembled unit is stress relieved.
4. The method of fabricating in accordance with claim 2 wherein said suction valve pots and said discharge valve pots are machined from identical forged blanks.
5. The method of fabricating a fluid end housing for a slush pump, comprising
 - 65 forging four identical cylinder barrel half blanks and eight identical valve pot blanks
 - machining each of said cylinder barrel half blanks to provide a suction port and a discharge port therein
 - 70 machining said valve pot blanks to form suction valve pots and discharge valve pots
 - forming quarter sub-assemblies by welding a suction valve pot and a discharge valve to each of said cylinder barrel halves to communicate with the associated port
 - 75

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forming half sub-assemblies by welding together said cylinder barrel halves to form two fluid cylinders casting a suction manifold and a discharge manifold connecting said suction manifold to communicate with each of said suction valve pots; and connecting said discharge manifold to communicate with each of said discharge valve pots.

6. The method of fabricating in accordance with claim 5 wherein said discharge manifold is welded to said discharge pots and wherein the assembly is stress relieved after all welding operations are completed and said fluid cylinders are finish machined internally after the assembly is stress relieved.

7. The method of fabricating a fluid end housing for a slush pump, comprising
 forging four identical cylinder barrel half blanks;
 forging eight identical valve pot blanks;
 machining said valve pot blanks to form valve pots having an inlet of one diameter and an outlet of another diameter
 welding two valve pots to each of said cylinder barrel halves so that
 the outlet of one of said welded valve pots communicates with the suction port, and
 the inlet of the other welded valve pot communicates with the discharge port;
 welding together said cylinder barrel halves to form two fluid cylinders;
 casting a suction manifold and connecting the same to communicate with the inlets of the valve pots welded to communicate with said suction ports; and
 casting a discharge manifold and connecting the same to communicate with the outlets of said valve pots welded to communicate with said discharge ports.

8. The method in accordance with claim 7 wherein the inlets and outlets of the valve pots which communicate with said discharge ports are machined having beveled surfaces suitable for welding; the outlets of the valve pots which communicate with said suction ports are similarly beveled; said discharge manifold is welded into position; and said suction manifold is bolted into position.

9. The method in accordance with claim 7 wherein the assembly is stress relieved after all welding operations are completed; and said fluid cylinders are thereafter finished machined internally.

10. The method of fabricating a fluid end housing for a slush pump, comprising

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forging four identical cylinder barrel half blanks each having a pair of similarly dimensioned bosses near one end extending radially outwardly from the longitudinal axis of the blank and at right angles with one another;

forging eight identical valve pot blanks each having a boss extending outwardly perpendicular to the longitudinal axis;

machining four of said valve pot blanks to form suction valve pots each having an inlet of one diameter concentric with said longitudinal axis, and an outlet of another diameter extending through the boss thereof, the material surrounding said outlets being beveled to provide a surface suitable for welding;

similarly machining the remaining valve pot blanks to form discharge valve pots and in addition beveling the material surrounding said inlets to provide a surface suitable for welding;

machining said four cylinder barrel half blanks to form cylinder barrel halves so that when assembled they form two substantially parallel fluid cylinders in a horizontal plane, each of said fluid cylinders having a pair of suction ports of said one diameter near the ends thereof extending away from the other fluid cylinder and through bosses on the blanks, and
 a pair of discharge ports of said other diameter also near the ends thereof extending upwardly through the remaining bosses;

welding said discharge pots so that the inlets thereof each communicate with a different discharge port; welding said suction pots so that the outlets thereof each communicate with a different suction port;

casting a discharge and a suction manifold;
 welding said discharge manifold to communicate with the outlet of each of said discharge pots; and
 securing said suction manifold to communicate with the inlet of each of said suction pots.

11. The method in accordance with claim 10 further including the steps of
 stress relieving after all welding operations are completed, and
 thereafter machining said fluid cylinders to precise internal dimensions.

No references cited.

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