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Foster

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[54] **WASHING MACHINE PUMP**

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[52] **U.S. Cl.** ..... **415/53**, 415/152 A, 415/214

[51] **Int. Cl.** **F04d 5/00**

[58] **Field of Search** ..... 415/152 A, 53 T, 214

[56] **References Cited**

UNITED STATES PATENTS

2,417,627	3/1947	Brady, Jr.	415/53 T
2,672,822	3/1954	Smith	415/213 R
3,136,254	6/1964	Douglas	415/152 A
3,335,668	8/1967	Thon	415/214
3,751,179	8/1973	Wassmann	415/152 A
3,752,603	8/1973	Bunch	415/214

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[57] **ABSTRACT**

A reversible dual function pump for a laundry appliance which recirculates detergent water in a tub at a moderate rate when driven in a first rotary direction and which removes such water from the tube at a greater rate when driven in the opposite direction. An impeller and a volute cavity of the pump are arranged to produce a positive displacement pumping action which provides sufficient reserve pumping capacity to allow exceptional dimensional latitude in the pump construction and an internal by pass circuit for regulating internal pressure in the pump. Wide dimensional latitude in the pump components allows them to be formed of plastic materials and allows the pump to be mounted on and driven directly by a motor. Pressure regulation by the internal by pass avoids the risk of pump out in an improper operational mode and the possibility of producing suds from an excessive vacuum condition.

15 Claims, 7 Drawing Figures

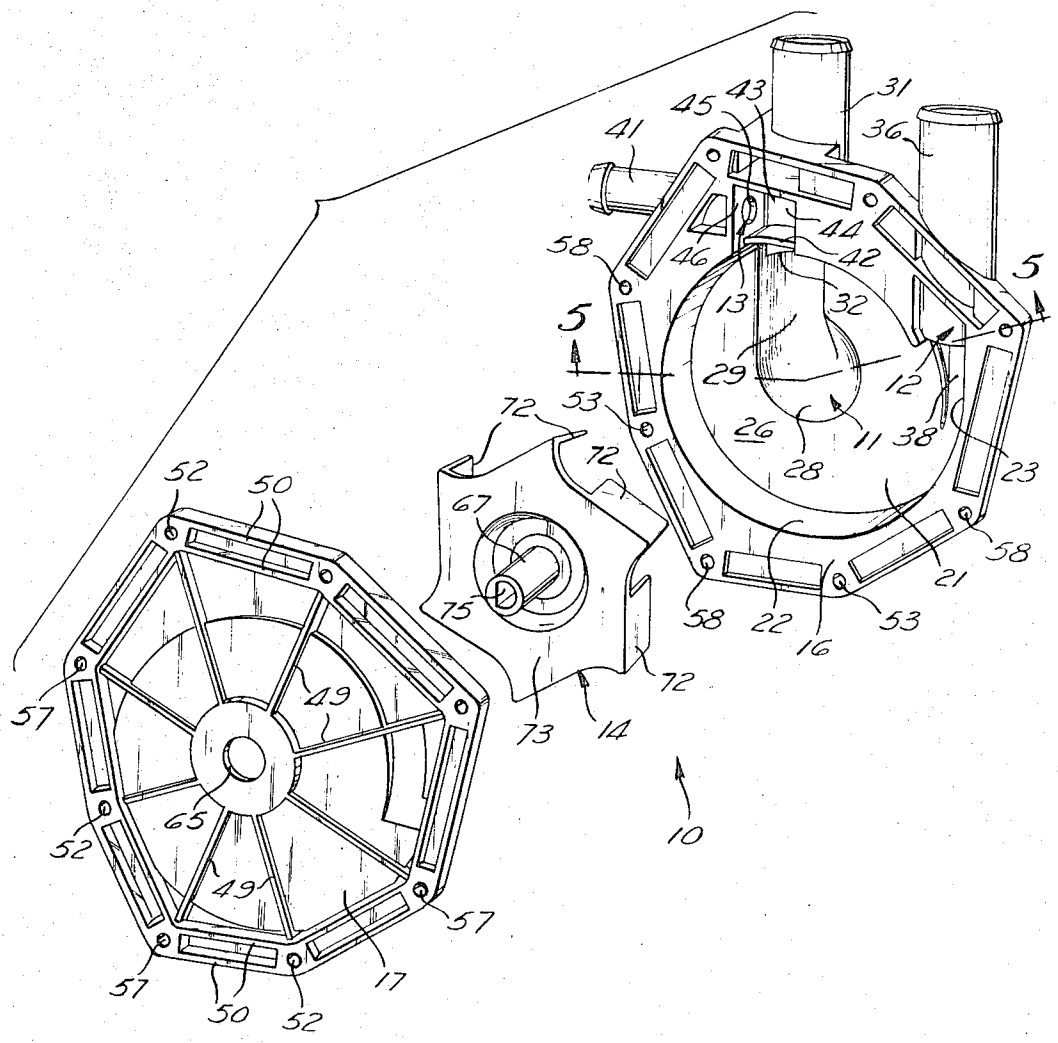


Fig. 1

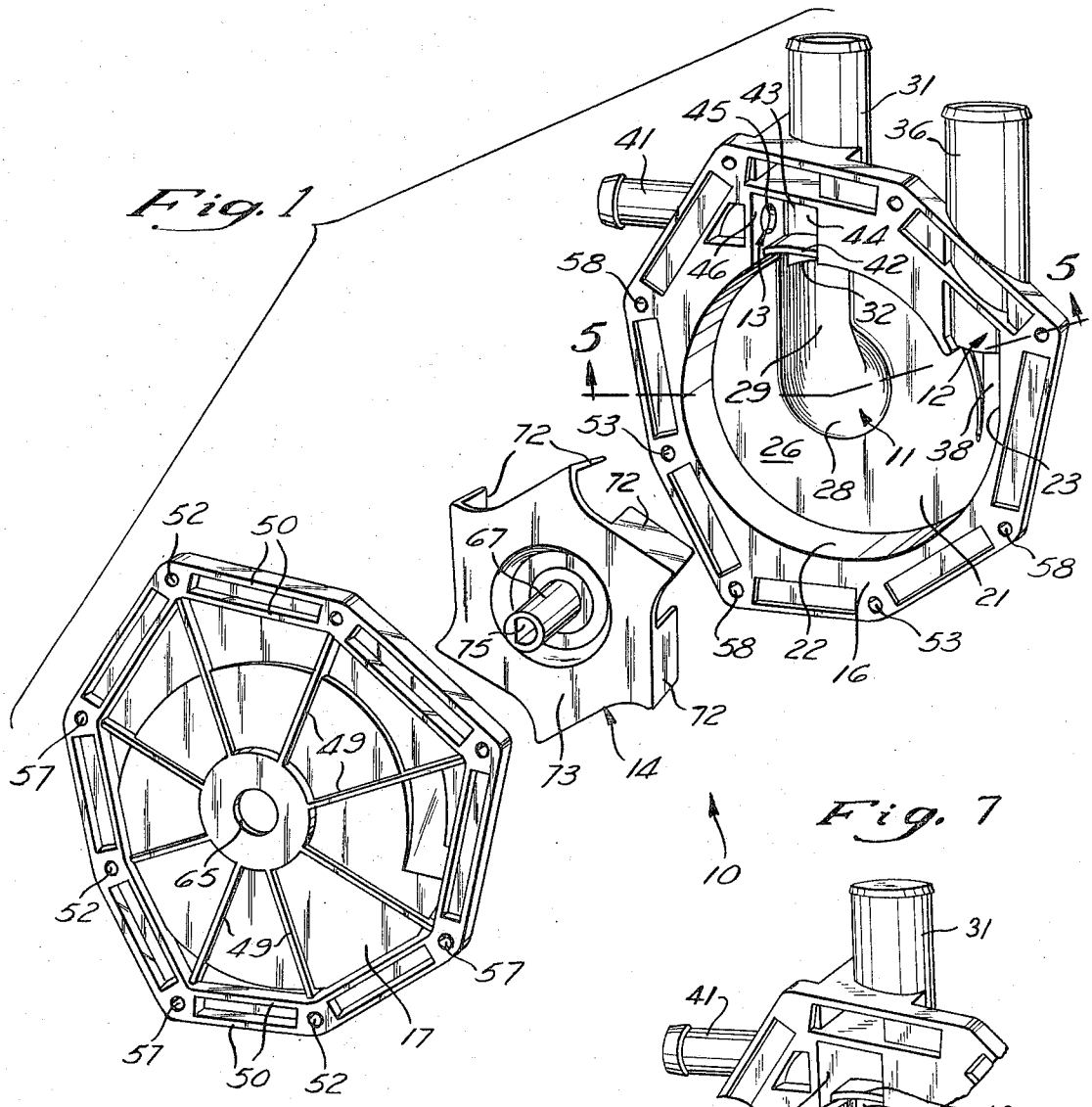
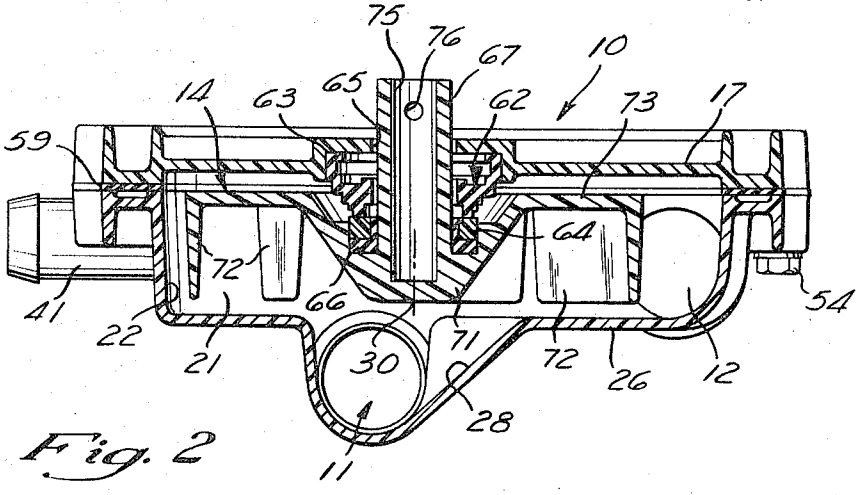


Fig. 7

Fig. 2



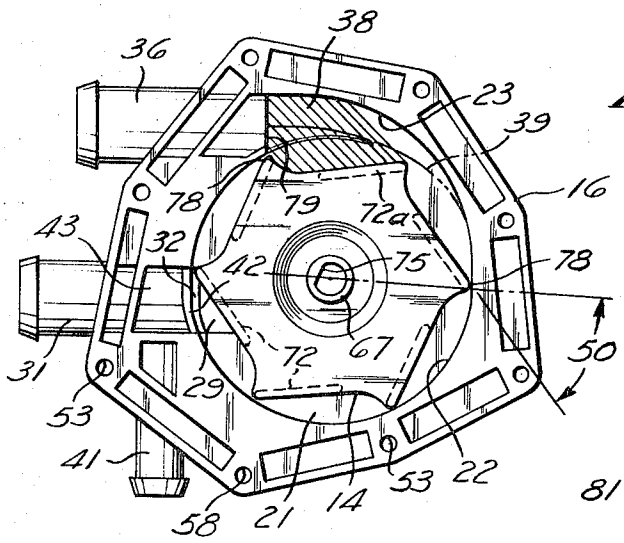


Fig. 3

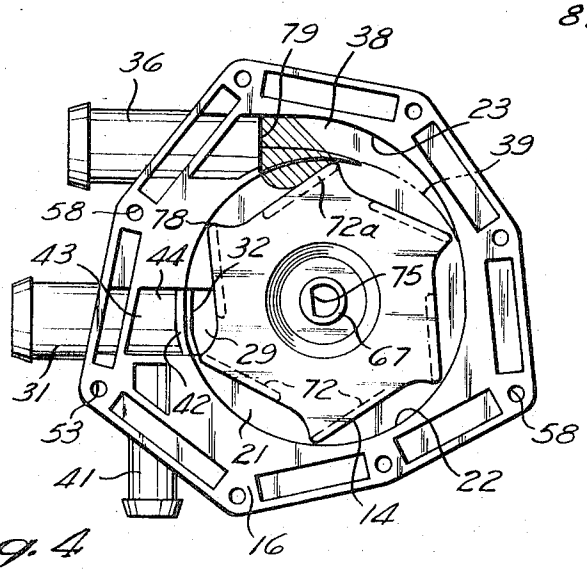


Fig. 4

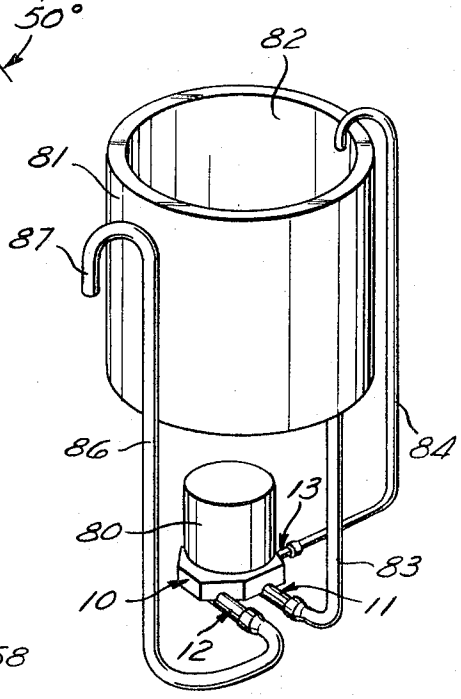


Fig. 6

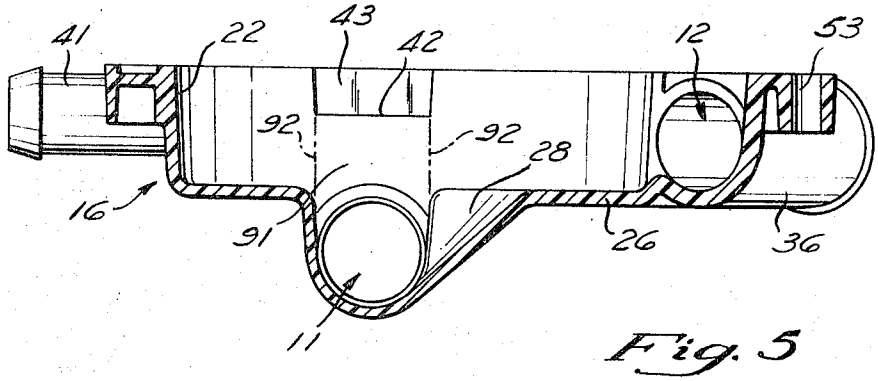


Fig. 5

WASHING MACHINE PUMP

BACKGROUND OF THE INVENTION

The invention relates to reversible pumps and in particular to pumps having distinct operational modes selected by changing direction of the pump rotation.

PRIOR ART

The present invention is particularly suited for use in the field of laundry appliances. In such appliances it is often desirable to recirculate detergent water during a wash cycle and subsequently drain the water from the washing tub after the wash cycle has been completed. In automatic clothes washers, for instance, it is generally convenient to provide a single pump for performing both of these operations and it is generally advantageous for the pump mode of operation to be selected by driving it in one or the other rotary direction.

Prior to the present invention, bi-directional dual function pumps for this service have generally had characteristic deficiencies which limited their performance and, consequently, their acceptance. Among the common problems associated with earlier pumps has been a requirement of close dimensional tolerances in manufacture and assembly to approach satisfactory performance. These previously required dimensional tolerances have necessitated the use of metal components for dimensional stability and have limited the realization of economy associated with the use of plastic materials. An undesirable trait of certain prior pump designs is the development of excessive vacuum in the recirculation mode resulting in the production of suds and a consequent loss of washing efficiency. Another disadvantage of certain reversible pumps is a tendency to drain the tub during operation in the recirculation mode causing a loss of detergent water during a wash cycle in the event the recirculation circuit becomes plugged. Typically, output volume of earlier pumps varied with the square of pump speed, as in most centrifugal pumps, such that it was difficult to reach a satisfactory design compromise between flow rates at high and low speeds.

SUMMARY OF THE INVENTION

The invention provides an improved impeller and housing arrangement for a reversible pump wherein balanced bidirectional pump performance is achieved. Positive displacement pump action at a main pump outlet produces sufficient capacity to permit successful use of a bypass circuit at an auxiliary recirculation pump outlet to limit internal pressure in the pump. This self regulating effect of the bypass prevents objectionable pump out and loss of water in the event that the recirculation circuit is fouled.

The positive displacement pump action further provides sufficient reserve pumping capacity to allow unusual latitude in dimensional tolerances in the components and the assembly of the pump. This flexibility permits the pump to be constructed of plastic materials with attendant savings in manufacturing costs and elimination of corrosion problems. Further, relatively large workable clearances in the improved pump allow the impeller to be supported directly on a motor shaft and the housing to be mounted on the motor or an adjacent bracket with minimum concern of dimensional variations in the motor construction or positioning of the pump relative to the motor.

Additionally, the pump arrangement has been found to produce a recirculation flow which is approximately proportional to motor speed, a characteristic of positive displacement pumps, so that the difference in recirculation flow between high and low motor speed is at an acceptable minimum. Moreover, the present pump avoids sudsing of the wash water resulting from excessive suction at the main outlet during operation in the recirculation mode.

In the disclosed embodiment, the impeller blade configuration and the geometry of the impeller cavity adjacent the main outlet produces a variable volume chamber effect when a blade sweeps by the outlet. This effect provides positive pressure at the outlet in the pump out mode and a normally negative pressure during the washing or recirculation mode. A bypass circuit between the recirculation outlet and the pump inlet moderates internal pump pressure to insure that pressure in the main outlet cannot become positive enough to pump out water when the recirculation outlet is blocked. The bypass circuit preferably includes an integral open faced channel forming a portion of the inlet and extending radially between the axis of the impeller and the recirculation outlet.

Recirculation flow is driven through a slot in a circumferential wall of the pump housing. Water passes through the slot into a recess and then to a recirculation port. In accordance with an important feature of the invention, a wall common to portions of both the recess and the main inlet may be perforated when the pump is employed in an appliance not having an external recirculation circuit. By perforation of this wall, an internal recirculation path is created such that the operational characteristics of the pump are not significantly altered. Thus, substantially the same pump and tooling may be used whether or not it is desired to provide recirculation.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an exploded perspective view of a reversible pump constructed in accordance with the invention.

FIG. **2** is an elevational cross-sectional view of the pump assembly.

FIG. **3** is a plan view of the pump with its cover removed to reveal the impeller in a first angular position.

FIG. **4** is a view similar to FIG. **3** illustrating the impeller in a second angular position.

FIG. **5** is an elevational sectional view of the lower portion of the pump housing illustrating spatial relationships between the pump inlet and outlets.

FIG. **6** is a perspective schematic view of the pump and a wash tub of a laundry appliance.

FIG. **7** is a fragmentary, perspective view similar to FIG. **1**, illustrating a modification of the pump housing used when recirculation is not provided.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The drawings disclose a reversible pump **10** wherein water or other liquid is drawn into a central inlet port **11** and expelled from either of two peripheral outlet ports **12** and **13** determined by the direction of rotation of an impeller **14**. A pump housing in which the impeller **14** operates comprises mating body and cover portions **16** and **17** respectively.

Within the housing body **16** is formed an impeller cavity **21.** The impeller cavity **21** is bounded radially by a generally circular or cylindrical wall **22** and a spiral or volute wall extension **23.** The impeller cavity **21** is bounded axially by an end wall **26** integral with the housing body **16** and the cover or opposite end wall **17.** The central inlet, generally indicated at **11,** is integrally formed in the end wall **26** and includes a rounded central chamber or hollow **28,** projecting axially outward of the plane of the end wall **26,** and a rounded channel **29.** The inlet channel **29** is preferably in open communication with the impeller cavity **21** along its full length and extends generally radially to the axis of the pump, i.e. the axis of rotation of the impeller **14.** The channel **29** is slightly eccentric to the impeller axis to provide an efficient flow path to the impeller center, designated **30.** A cylindrical inlet nipple **31,** formed integrally with the housing body **16,** joins the inlet channel **29** at a point **32** slightly within the line of the circular cavity wall **22.**

The main outlet, generally indicated at **12,** is formed by a cylindrical nipple **36** integrally formed with the housing body **16** in a manner similar to the inlet nipple **31.** This outlet nipple or tube **36** is substantially parallel to the inlet nipple **31** extends tangentially into direct communication with a volute zone **38** of the impeller cavity **21.** The volute zone **38** is formed by the spiral wall section **23** and an adjacent section **39** (shown in phantom in FIGS. **3** and **4**) of an imaginary cylinder defined by an extension of the circular wall section **22.**

The auxiliary outlet, indicated generally at **13,** is provided for recirculatory flow and includes an outlet nipple **41** integrally formed in the housing body **16** adjacent the inlet **31.** The auxiliary nipple **41** communicates with the impeller cavity **21** indirectly through a recess **43** peripheral to the cavity. The recirculating flow receiving recess **43** is partially formed by the circular cavity wall **22** and a wall area **44** of the inlet nipple **31.** The nipple **41** communicates with the recess **43** through an aperture **45** in an associated housing wall portion **46.** An elongated slot or aperture **42** is formed in the cavity wall **22** for passage of water or other liquid into the recess **43.** The slot **42** is aligned lengthwise with the circumference of wall **22** and is arranged on the wall in angular alignment with the inlet channel **29** (FIG. **5**). The slot is adjacent the housing end wall formed by the cover **17** and is axially displaced from the opposite end wall **26** and the channel **29.**

The housing cover **17** which closes the impeller cavity **21** is a generally planar element having integrally formed reinforcing ribs **49** and **50.** A series of alternating holes **52** in the cover **17** register with corresponding holes **53** in the body **16** and receive screws **54** (one is shown in FIG. **2**) to secure the cover to the body. Intervening holes **57** and aligned holes **58** are formed in the cover and body **17** and **16** respectively for receiving screws (not shown) for securing the pump **10** relative to a motor **80** schematically illustrated in FIG. **6.** As shown in FIG. **2,** a suitable gasket **59** is used to seal the body **16** and cover **17.** A seal assembly of conventional design is indicated generally at **62** in FIG. **2** and includes an elastomeric element **63** in an associated recess in the cover **17** and a pair of washer-like elements **64** and **66** retained in an annular recess in the impeller **14.**

A hub **67** of the impeller **14** extends through the seal assembly **62** and a clearance hole **65** in the cover **17.** The clearance hole **65** and the abutting faces of the seal elements **63** and **64** accommodate misalignment and eccentricity of the impeller relative to the housing portions **16** and **17.** The housing body **16** and **17** cover are preferably constructed of a plastic material such as polypropylene with 20% talc fill. These members **16** and **17,** ideally, have a substantially uniform wall thickness throughout their various sections for satisfactory molding results and for minimizing the amount of material used in their construction.

The impeller **14** is, preferably, an integrally formed member which includes a central truncated conical boss **71** facing the inlet hollow **28.** A plurality of substantially flat blades **72** are fixed on the circumference of a web **73** extending radially from the conical boss **71.** The impeller hub **67** includes an axial bore **75** having a D-shaped cross section for mounting the impeller **14** directly on a cylindrical motor shaft having an axially extending flat on its circumference. Preferably, the impeller **14** is retained to the motor shaft by driving a cross pin through a radial hole **76** in the hub **67.** The impeller **14** is, ideally, molded of the same plastic material as the housing body and cover **16** and **17.**

The impeller blades **72** are preferably six in number and are of generally uniform wall thickness except for the allowance of a slight draft angle for molding purposes. As illustrated most clearly in FIGS. **3** and **4,** each of the impeller blades **72** are tangentially oriented such that they each form a substantial angle with a radial line from the axis of the impeller **14** to their radially outermost portion or edge **78.** This angle, preferably, is approximately 50° when six blades are used.

Study of FIGS. **3** and **4** reveals that the tangentially oriented flat blades **72** cooperate with the volute zone **38** to produce positive displacement pumping action. When a blade **72***a* is in a position substantially as shown in FIG. **3** where an outermost edge **78** of an adjacent blade **72** is proximate to an inner end, designated **79,** of the main outlet nipple **36,** the plane of the blade describes with the spiral or volute wall section **23** a volume of maximum value, represented by the cross hatched area in the subject Figure. In contrast to the position of FIG. **3,** the plane of the blade **72***a* in FIG. **4** describes with the volute wall **23** a volume substantially smaller. As the impeller **14** turns counterclockwise, the plane of each blade **72** sweeps across the volute zone **38** diminishing the actual volume in the volute zone ahead of it to cause water or other liquid to be forced out of the outlet **36.** The flat vanes **72** besides providing a positive displacement pumping action are advantageous since their uniform cross section is more readily molded and requires a minimum of material.

Referring to FIG. **6,** there is shown a typical arrangement of the pump **10** with a laundry tub **81** such as provided in a domestic automatic clothes washer. The pump **10** is conveniently mounted on a motor **80** located under the tub **81.** The tub **81** may be a splash tub in which a slightly smaller spin tub **82** is rotatably mounted. The inlet **11** of the pump is connected to a drain flange (not shown) at the bottom of the splash tub **81** by a suitable hose **83.** A hose **84** extends from the pump recirculation outlet **13** to a point over the splash tub **81.** The main outlet **12** of the pump **10** is connected to a discharge hose **86** which extends vertically slightly higher than the expected water level in the tub **81.** An end **87** of the hose **86** may be fitted with an additional line to direct discharged water to a sewer or

a holding tub. As illustrated, the hose circuitry associated with the pump **10** is valveless.

A suitable control system in accordance with principles familiar to those skilled in the art, may be provided to direct detergent water into the tubs **81** and **82** (the inner tub **82** may be perforated). An agitator (not shown) may be driven by the motor **80** through a conventional transmission (not shown) at an appropriate time in a control cycle. The transmission may be conventionally arranged to drive the agitator when driven by the motor **10** in one direction and the spin tub **82** when driven by the motor in the other direction.

In operation, the pump **10** is adapted to remove used detergent water from the tub **81** when the impeller **14** is driven counterclockwise as viewed in FIGS. **1, 3** and **4.** This mode of pump operation may coincide with a spin or centrifugal cycle of the inner tub **82.** During such operation water enters the inlet **11** from the tub **81** and is forced from the central inlet hollow **28** radially outwardly through the main outlet **12** and associated hose **86** by the impeller blades **72.** The disclosed pump **10** is capable of draining a tub of conventional size in approximately two minutes. The pump, moreover, has sufficient reserve pumping capacity to allow an eccentricity as high as .062 inches of the true impeller axis of rotation from the ideal axis defined by the cavity **21** where the outside diameter of the impeller **14** is approximately 3.75 inches.

When the impeller **14** is driven in a clockwise direction, such as when the motor **80** is driving an agitator, the pump **10** recirculates water through the tubs **81** and **82** to permit such water to be filtered by a lint filter (not shown). In this recirculation mode, liquid is drawn from the central inlet **11** and driven with centrifugal force radially outwardly by the blades **72** through the slot **42** into the recess **43.** From the recess **43** liquid travels outward through the auxiliary or recirculation nipple **41** and the hose **84.** The geometry of the slot **42** and its relationship to the inlet channel **29** in combination with the size of the recirculation aperture **45** is chosen to provide an adequate recirculation flow ranging, for example, between **2** and **4** gallons per minute. Recirculation flow of the pump has been found to be approximately directly related or linear with pump speed. This characteristic is highly desirable where the pump is driven by a multispeed motor since it reduces flow variation from an exponential variation usually produced in a centrifugal pump.

Under normal conditions in the recirculation mode, the pump is arranged to develop a vacuum at the outlet **12.** The vacuum is created by the blades **72** as they sweep in a clockwise direction again in a positive displacement action which may be visualized as blade movement from the position of FIG. **4** to that of FIG. **3.** The internal pressure of the pump is balanced or regulated to maintain this vacuum under normal conditions by a bypass circuit between the recirculation outlet **13** and the inlet **11.** The bypass circuit comprises a zone between the impeller **14** and a cavity wall area **91.** This wall area **91** extends circumferentially between imaginary lines **92** extending from the slot **42** illustrated in FIG. **5** and axially from the slot to the channel **29.**

The pressure modulation produced by the bypass circuit normally maintains the internal pump pressure at a point where the vacuum at the pump outlet **12** is substantial, e.g., 10 inches of water, but not enough to completely drain the associated hose **86** so as to introduce air into the pump and thereby create suds. The bypass circuit by permitting this normally negative or vacuum biasing at the main outlet **12,** further, limits internal pressure in the pump in the event that the recirculation circuit, including the nipple **41** or hose **84,** becomes obstructed by foreign material. Pressure at the main outlet **12** is thus limited during operation in the recirculation mode such that it cannot become positive enough relative to the inlet **11** to pump out laundry water from the tub **81** during the recirculation mode of the pump in the event of blockage of the recirculation circuit.

The pump **10** may be used in systems where a recirculation circuit is not necessary or desirable as when recirculation is only provided as an extra option on a machine. It has been found that the pump maintains substantially all of its desirable characteristics when the recirculation outlet or port **13** is blocked by not providing the hole **45** and where the adjacent wall **44** of the inlet nipple **31** is perforated or removed in the area of the recess **43** (FIG. **7**). This internal alteration of the pump structure in effect changes the recirculation flow path from an external flow to an internal flow but does not substantially change the characteristics of the pump either in the main pumping mode or in the recirculation mode.

The pump arrangement disclosed above is the result of extensive imperical investigation and development to provide a valveless pump circuit in which adequate pumping capacity is achieved independently of wide dimensional variations in the pump components and in which adequate recirculation flow rates are achieved without risking pump out of detergent water in the event the recirculation circuit is obstructed. The interrelationship of the various pump elements, therefore, is not fully understood and the above description is based on observation and present understanding.

Although a preferred embodiment of the invention is illustrated, it is to be understood that various modifications and rearrangements of parts may be resorted to without departing from the scope of the invention disclosed and claimed herein.

What is claimed is:

1. A reversible pump for a laundry appliance having an internal impeller cavity, an inlet and a main outlet communicating separately with said impeller cavity, an impeller rotatable within said cavity, said impeller including means to pump said water from said inlet to said outlet with positive displacement action when driven in a first direction during a pump out mode, a secondary outlet communicating with said impeller cavity, said impeller including means to pump water from said inlet through said secondary outlet port when driven in an opposite direction in a recirculation mode, and bypass means between said inlet means and said auxiliary outlet means to control pressure in said main outlet when said impeller is rotating in said recirculation mode.

2. A pump as set forth in claim **1** wherein said positive displacement means includes means to normally produce a substantial vacuum in said main outlet when said impeller is driven in said recirculation mode.

3. A pump as set forth in claim **2** wherein said impeller includes a plurality of circumferentially spaced blades, said blades each having a substantially flat outer face, said faces having a tangential orientation.

4. A pump as set forth in claim 3 wherein each of said blade faces are oriented at an angle of approximately 50° to a radial line extending from the axis of the impeller to a radially outermost portion of each respective blade.

5. A reversible pump for a laundry appliance comprising a housing having an internal impeller cavity, an inlet and a main outlet communicating separately with said impeller cavity, an auxiliary outlet communicating with said cavity, an impeller rotatable within said cavity, said impeller including means to pump water from said inlet to said main outlet when driven in a pump out mode and to pump water from said inlet through said auxiliary outlet when driven in an opposite recirculation mode, said housing including an end wall, said auxiliary outlet being arranged on said housing adjacent the circumference of said impeller, said inlet being integrally formed in said end wall and extending radially across said end wall in a direction substantially towards said auxiliary outlet, and bypass means between said inlet and said auxiliary outlet to control pressure in said main outlet during operation in said recirculation mode.

6. A pump as set forth in claim 5 wherein said inlet is in open communication with said cavity substantially from the center of said impeller to the circumference of said impeller.

7. A pump as set forth in claim 6 wherein said bypass means includes an aperture in a wall of said housing adjacent a housing end wall opposite said first mentioned end wall.

8. A pump as set forth in claim 7 wherein said aperture comprises an elongated slot extending lengthwise along the circumference of said impeller.

9. A pump as set forth in claim 7 wherein said inlet includes a wall portion radially outward of said aperture, said wall portion forming a section of a recirculating flow receiving recess external of said cavity, said wall portion being adapted to be perforated to provide an alternate flow path within the housing when an external recirculation circuit is not provided.

10. A reversible pump for a laundry appliance comprising a housing having an impeller cavity, said cavity being defined by a circumferential curved housing wall and opposed housing end walls, a rotatable impeller in said cavity, an inlet communicating with the impeller cavity through a plane defined by one of said end walls, a main outlet communicating with said cavity tangentially to said curved wall, and a recirculation outlet communicating with said cavity through an aperture in said curved wall, said aperture being axially displaced from said one end wall and being adjacent the opposite wall.

11. A pump as set forth in claim 10 wherein said inlet comprises an integral channel in said one end wall, said channel extending radially from the rotational axis of said impeller in angular alignment with said auxiliary outlet, a wall portion within said housing forming both a portion of said inlet channel and a zone in direct communication with said recirculation outlet whereby said wall portion may be perforated where external recirculation is not desired.

12. A bi-directional pump for a laundry appliance comprising a housing having an internal impeller cavity, an inlet and an outlet communicating separately with said impeller cavity, a rotatable impeller in said cavity, said impeller including means for pumping water from said inlet to said outlet when driven in one direction, a recess external of said cavity for receiving recirculation flow when said impeller is driven in a direction opposite to said first direction, said recess communicating with said cavity through an aperture in a wall forming said cavity adjacent the periphery of said impeller.

13. A pump as set forth in claim 12 wherein said recess is formed by at least two walls, one of said walls forming a portion of said inlet, the other of said walls forming a portion of a recirculation outlet, said one wall being adapted to be perforated to establish internal recirculation flow in said housing when external recirculation is not provided.

14. A reversible pump for a laundry appliance comprising a plastic housing of generally uniform wall thickness, said housing including an internal volute impeller cavity, an inlet communicating with the center of the cavity, a main outlet and an auxiliary outlet each communicating with the cavity at its periphery, an integrally molded impeller, said impeller including a plurality of flat tangentially oriented blades, an impeller hub including means for mounting the impeller directly on a motor shaft, said impeller including means to pump water from said inlet to said main outlet when driven in one direction and from said inlet to said auxiliary outlet when driven in the opposite direction.

15. A reversible pump for a laundry appliance, comprising a housing having an internal impeller cavity, said impeller cavity being defined by a pair of axially spaced end walls and a circumferential wall, said circumferential wall having a generally circular major portion and a volute minor portion, a main outlet in said volute wall portion and a recirculation outlet adjacent the circular major portion and angularly spaced from said main outlet, an inlet channel integrally formed in one of said end walls, said inlet channel extending in open communication from the center of said impeller cavity along a radial direction in line with said recirculation outlet, said recirculation outlet communicating with said impeller cavity through a recess external of said cavity, an aperture in said circumferential wall adjacent the other of said end walls providing communication between said cavity and said recess, said inlet channel and said recess having a common wall adapted to be perforated to provide a recirculating flow path internal of the housing when external recirculation flow from said recirculation outlet is not provided, an impeller rotatable in said cavity in a first direction to pump fluid from said inlet through said main outlet, and in an opposite direction to pump fluid from said inlet through said aperture, said impeller including a plurality of substantially flat, tangentially oriented blades, a clearance between said impeller and said circumferential wall providing a bypass circuit between said aperture and said inlet to regulate the pressure at said main outlet when said impeller is driven in said recirculation direction.

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