

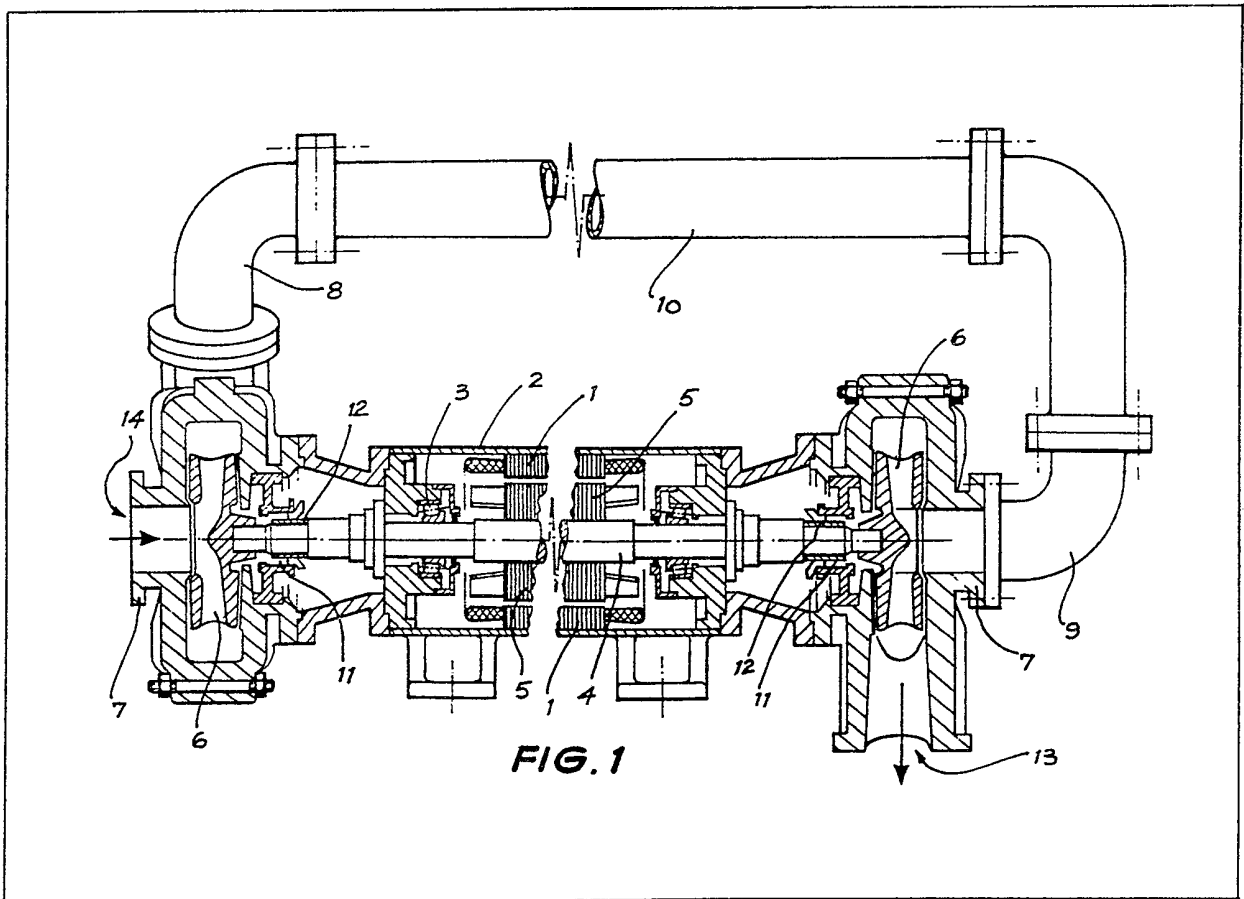
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GBA 2036869
GB 1538095
GB 1127299
GB 1009823
GB 0773827
GB 0535061
GB 0378615
GB 0371819
GB 0279065
EPA 0009449
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(54) Multistage centrifugal pumps

(57) The pump comprises a motor having a shaft (4) supported by bearings (3) and having an impeller (6) mounted at each end of the shaft. Conduit means (10) connect the discharge branch (8) of one pump casing (7) to the suction branch (9) of the other pump casing (7). In use, a number of the pump units can operate in series by connecting an outlet (13) of one unit to an inlet (14) of the next unit. The pump can be used to pump slurry, acid or air and may be driven electrically, hydraulically or by a turbine. By mounting the impellers at each end of the shaft, axial thrust loads are balanced.



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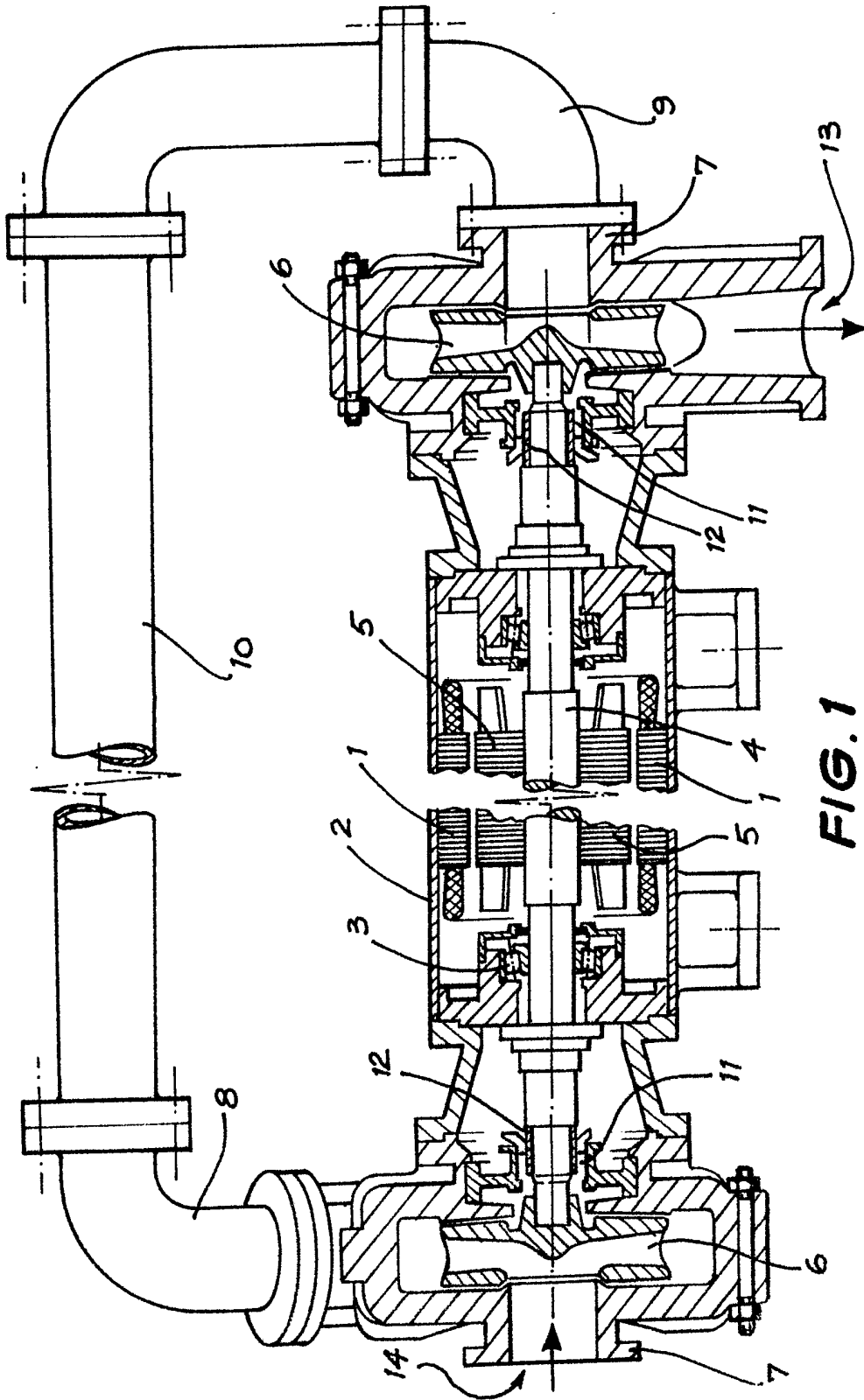


FIG. 1

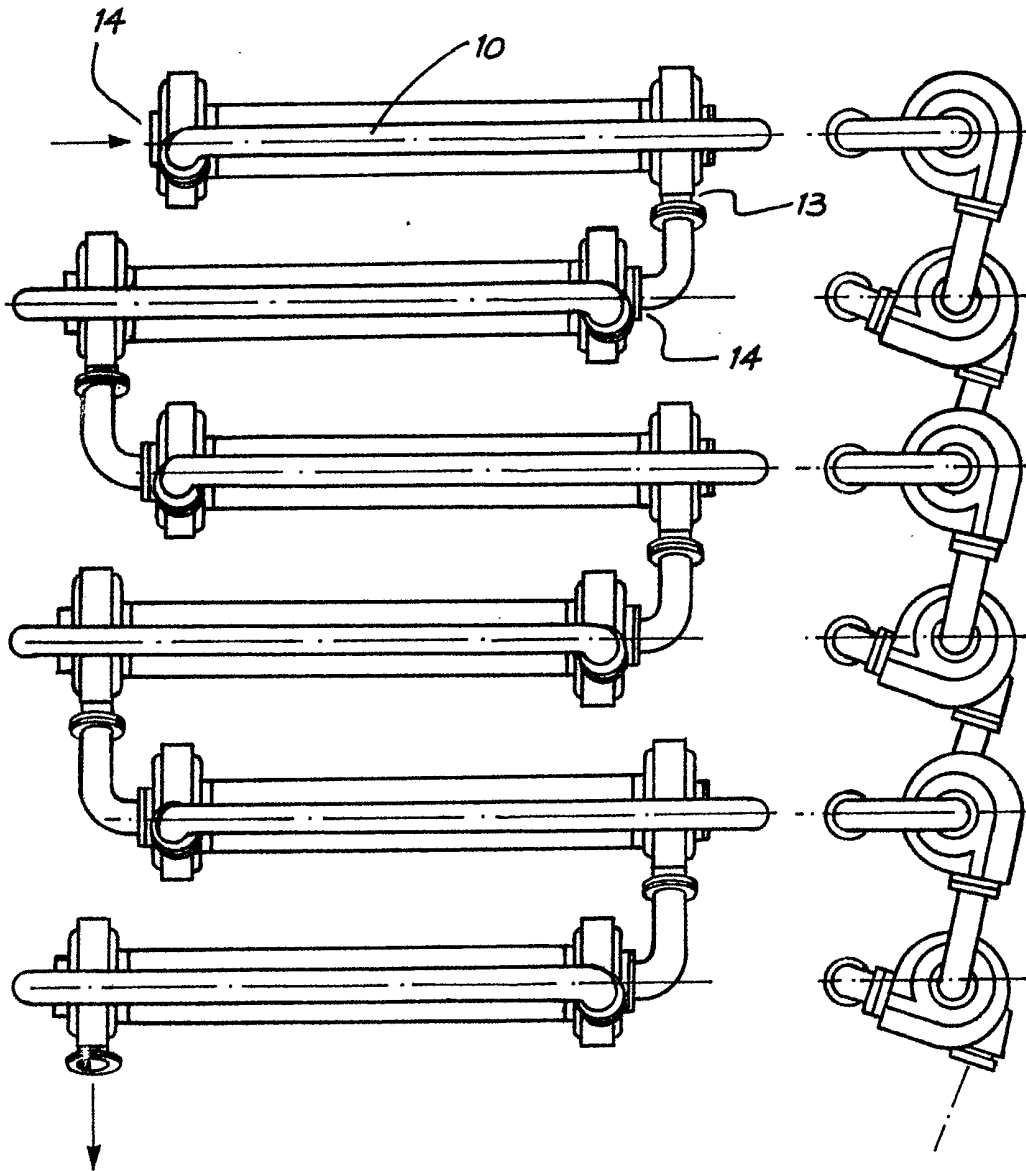


FIG. 2

SPECIFICATION
Improvements in or relating to centrifugal pumps

5 This invention relates to improvements in or relating to centrifugal pumps and, in particular, to a centrifugal pump which is suitable for operation at high pressures and has particular application when it is required to operate a number of pumps in series.

10 For pumping clean fluids at high pressure, a multi-stage pump may be used wherein a number of impellers are mounted on a common shaft arranged to operate within a compartmented single casing. Each impeller operates within its
 15 own compartment to restrict short circuiting flow of fluid and to maintain the pressure within the compartment. However, satisfactory multistage slurry pumps have not been developed because of difficulties in constructing the complex shapes in
 20 abrasion resistant material and difficulties in providing sealing means between stages to resist the abrasive action of slurry.

The most satisfactory of the previously proposed centrifugal slurry pumps are single stage
 25 single suction (end suction) type. When slurry pressures higher than the capacity of a single stage slurry pump are required it is known to use a number of single stage slurry pumps arranged to operate in series, each pump being driven by a
 30 separate motor. Each motor requires separate starting, control and protection equipment and for automatic operation all starters and controls must be interlocked.

Another problem caused by use of a large
 35 number of single stage pumps coupled in series is the high axial thrust loads caused by high intake pressures operating on single suction single stage pumps. The number of single stage centrifugal
 40 slurry pumps which can be operated in a single pump station is often limited by the capacity of bearings to carry thrust loads induced by the intake pressure on the final stage impeller. Pumps for clean fluids accommodate high intake
 45 pressures, and the resultant high axial loads, by using double suction impellers, multistaged pumps or hydraulic balance pistons. Such means are not practical for slurry pumps handling abrasive mixtures of solids and liquid.

50 It is an object of the present invention to enable the provision of a centrifugal pump whereby the above disadvantages may be overcome, or at least mitigated.

Accordingly, a first aspect of the present invention provides a centrifugal pump, which
 55 comprises two single stage pump heads, each of which is mounted on a respective end of the shaft of a double ended motor, and conduit means for connecting the discharge outlet of one pump head to the suction inlet of the other pump head to provide a two stage centrifugal pump.

60 In one embodiment of the present invention two single stage slurry pump heads are mounted to either end of a double ended electric motor, with impellers of the pump stages fixed to

65 respective ends of the motor shaft. Thus, this invention reduces by half the number of drive motors and their associated equipment which would otherwise be required. By providing suitable conduit means to connect the discharge outlet of the pump head at one end of the motor to the
 70 suction inlet of the other pump head, an effective two stage centrifugal slurry pump is provided.

Although a similar effect could be produced by coupling two single stage slurry pumps to a
 75 double ended motor by way of couplings or belts, an important effect of this invention would not be achieved in that the bearings of each pump would be required to withstand the respective axial thrusts from their impellers. In single stage pumps the axial thrust load on the bearing is determined by the intake pressure of the fluid. Therefore with a number of single stage pumps in series the axial thrust pressure on the bearings of each pump increases from pump to pump along the series, as
 80 the respective intake pressures increase. In a pump in accordance with the invention the axial loads from the two impellers balance each other due to their opposed disposition and the only axial load to be carried by the bearings is that due to the difference in inlet pressure between the two stages. Thus, the present invention enables the provision of a centrifugal pump, and in particular a slurry pump, in which axial thrust loads are hydraulically balanced as far as possible, thereby
 85 reducing axial loads which must be mechanically supported by bearings on the pump shaft. Any number of such two stage units can therefore be arranged to operate in series and the thrust load on the bearings is independent of the number of
 90 two stage units which are installed. Therefore for any given series of pumps only bearings of a single rating are required. For example, if a slurry pressure is required equivalent to 12 stages each developing a head of 150 metres of water and
 100 pump shaft sleeve diameters are of 190 mm through the shaft seal, the axial thrust due to inlet pressure on the bearings of the twelfth stage at 12 single stage units would be equivalent to a force of 46,000 N. If, however, six two stage units
 105 according to this invention are employed to develop the same pressure the axial thrust to be carried by the bearings of each two stage unit would only be 4245 N.

115 A centrifugal pump unit in accordance with the present invention may produce substantially higher head than can be achieved from a single stage pump.

For a better understanding of the present invention, and to show how the same may be put
 120 into effect, reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 shows a part sectional view of a centrifugal pump embodying the present invention, and

125 Figure 2 shows a perspective view of a multistage pump arrangement comprising six of the pumps shown in Figure 1.

Referring now to Figure 1, a centrifugal pump comprises an electric motor having a stator 1

supported in a frame 2. The frame 2 accommodates bearings 3 which support a shaft 4 on which are mounted a rotor 5 and pump impellers 6. Pump casings 7 are fixed to each end of the motor frame 2.

5 The discharge branch 8 of one pump casing 7 is connected to the suction branch 9 of the other pump casing by connecting pipework 10. Water flushed stuffing box seals 11 are provided where
10 the motor shaft 4 passes through the pump casings 7. The shaft is protected in the stuffing box area by abrasion resistant renewable shaft sleeves 12.

15 A suitable arrangement for a twelve stage slurry pump arrangement is shown in Figure 2, wherein six of the units shown in Figure 1 are connected in series, the outlet 13 of one unit being connected to the inlet 14 of the next unit. This arrangement, as mentioned previously,
20 reduces by half the number of drive motors and starters necessary (although each motor will be double the power of individually mounted units) but is more efficient than two single smaller motors and also greatly reduces the axial thrust to
25 be carried by the bearings of the two-stage units.

The pump of the present invention may be driven electrically, hydraulically, by turbines or by any other suitable means. The pump of the present invention can be used to pump slurry and
30 liquids such as acids, or to blow air. Conversely the unit of the present invention could be used as a turbine.

35 Axial adjustment of running clearances between impellers and adjacent liners may be achieved by using shims at the impeller boss or at a flange between the motor and pump casing

flanges.

CLAIMS

40 1. A centrifugal pump, which comprises two single stage pump heads, each of which is mounted on a respective end of the shaft of a double ended motor, and conduit means for connecting the discharge outlet of one pump head to the suction inlet of the other pump head to
45 provide a two stage centrifugal pump.

50 2. A centrifugal pump, which pump comprises a double ended motor, the motor comprising a frame and a shaft rotatable with respect to the frame, two pump casings, each of which is fixed to a respective end of the frame, impeller means housed within each pump casing and fixed to
55 respective ends of the shaft and conduit means for connecting a discharge outlet of one pump casing to a suction inlet of the other pump casing to provide a two stage centrifugal pump.

3. A centrifugal pump according to Claim 1 or 2 wherein the motor is an electric motor.

60 4. A centrifugal pump according to Claim 1, 2 or 3, wherein the axial clearance between impellers and adjacent liners is achieved, in use, by using shims at the impeller boss or at a flange between the motor and pump carrying flanges.

65 5. A centrifugal pump, substantially as hereinbefore described with reference to, and as shown in, Figure 1 of the accompanying drawings.

6. A multistage centrifugal pump arrangement, substantially as hereinbefore described with reference to, and as shown in Figures 1 and 2 of the accompanying drawings.

70 7. Any novel feature or combination of features described herein.