July 23, 1963 R. H. HILL 3,098,449

SLUSH PUMP

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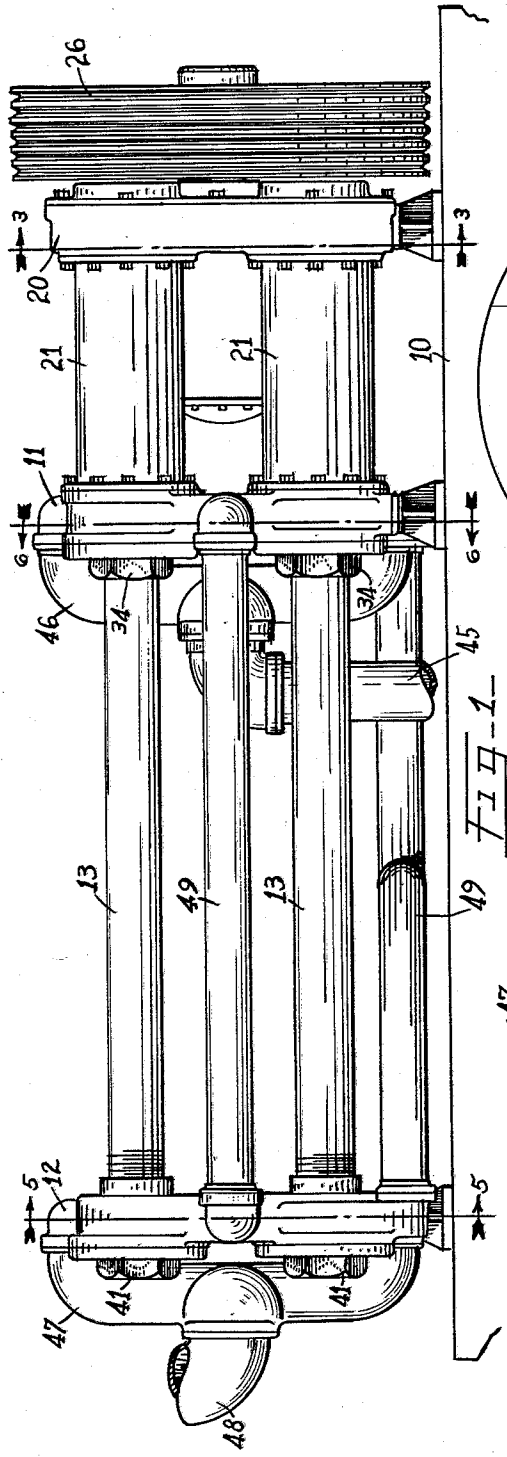


FIG. 1

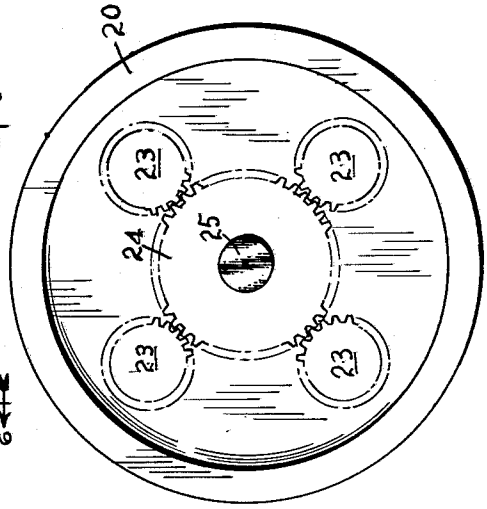


FIG. 3

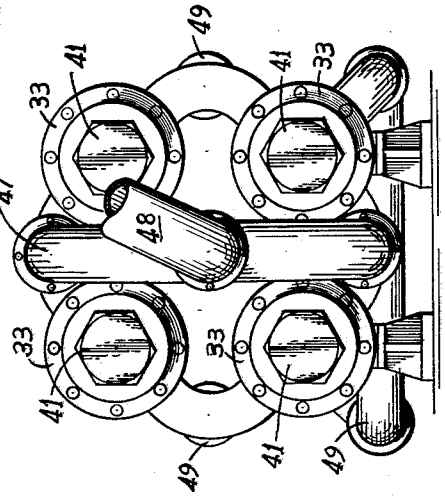


FIG. 2

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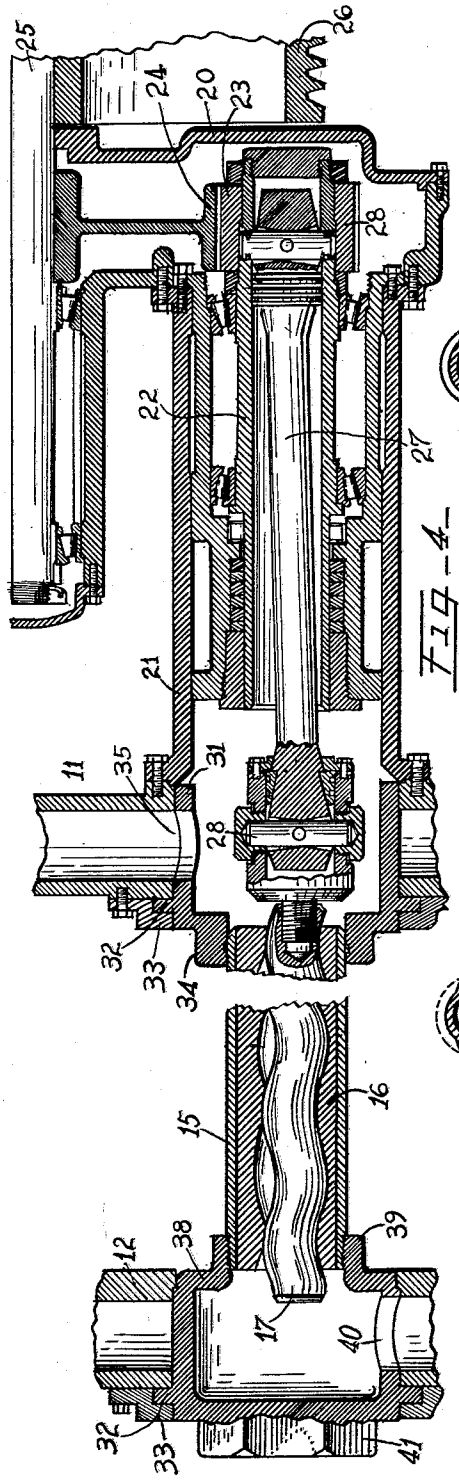


FIG-4

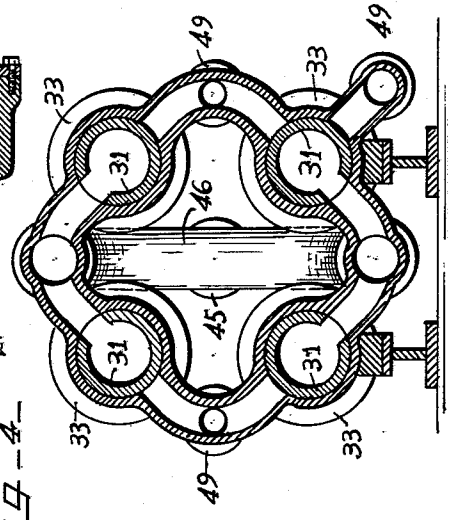


FIG-6

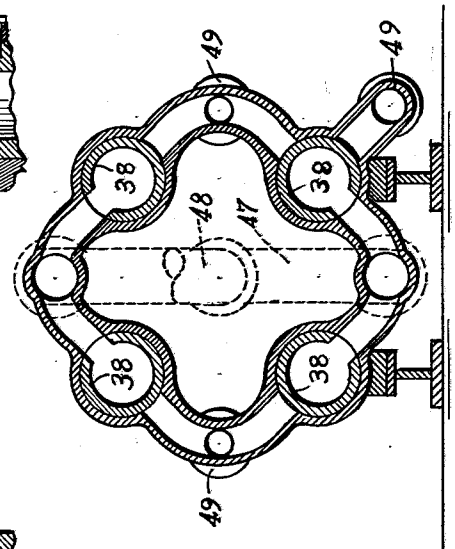


FIG-5

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FIG. 9.

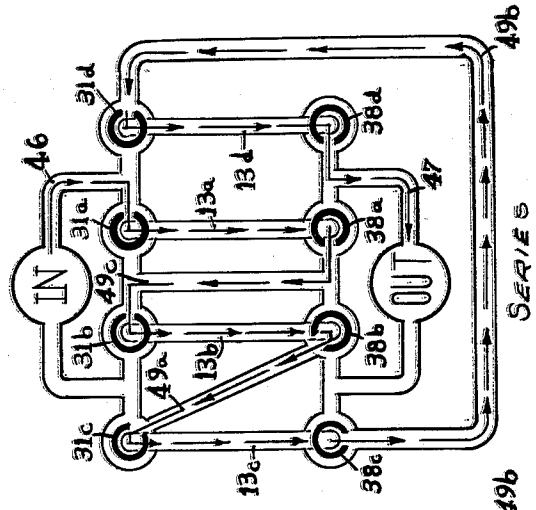


FIG. 8.

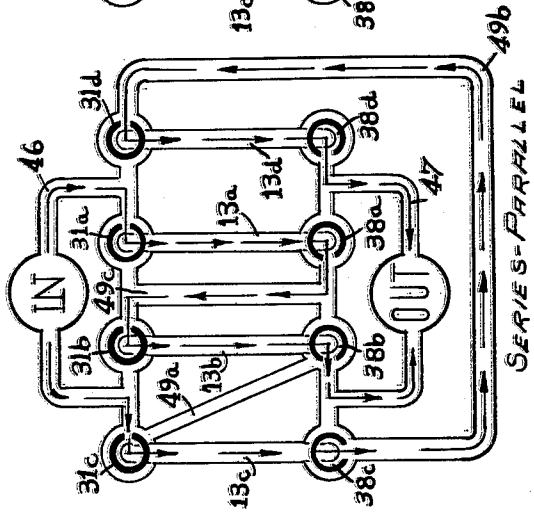
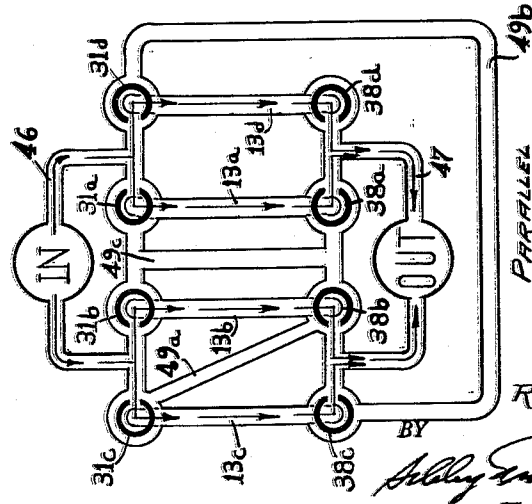


FIG. 7.



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United States Patent Office 3,098,449 Patented July 23, 1963

3,098,449

SLUSH PUMP

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Filed Dec. 7, 1959, Ser. No. 857,761
7 Claims. (Cl. 103—4)

This invention relates to slush pumps of the type used in circulating the mud employed in well-drilling operations. Among the objects of the invention are to produce a pump which can readily be converted from high-capacity low-pressure operation to low-capacity high-pressure operation, which will be relatively inexpensive and light in weight, and the principal components of which can be readily disassembled and assembled to facilitate its transportation and re-erection. A further object of the invention is to produce such a pump which will embody a number of interchangeable parts that can readily be removed and replaced, thus facilitating service and repairs in the field.

In its preferred form, a pump embodying my invention comprises a plurality of individuals pumps of the "Moyno" type. Such pumps extend in parallel disposition between generally annular inlet and outlet headers which are interconnected with each other not only through the individual pumps but also through auxiliary conduits. Each pump has associated with it at each end a valve controlling its connection to passages of the associated manifold, and by appropriate adjustment of such valves the pumps can be connected in parallel for high-capacity low-pressure operation, in series for low-capacity high-pressure operation, or in series-parallel for operation at intermediate pressure and intermediate delivery. The pumps are driven at different speeds; and the arrangement of the manifold, auxiliary conduits, and valves is such that when any two pumps are connected in series the pump of higher speed delivers to the pump of lower speed.

Further objects and features of the invention will become apparent from the following more detailed description and from the accompanying drawings in which:

FIG. 1 is a side elevation of the complete pumps;

FIG. 2 is an elevational view illustrating the discharge end of the pump;

FIG. 3 is a vertical transverse section on the line 3—3 of FIG. 1;

FIG. 4 is a fragmental section longitudinally through one of the individual pumps and its drive;

FIG. 5 is a transverse vertical section on the line 5—5 of FIG. 1;

FIG. 6 is a transverse vertical section on the line 6—6 of FIG. 1;

FIG. 7 is a diagrammatic view illustrating the setting of the valves which provide parallel operation of the individual pumps;

FIG. 8 is a view similar to FIG. 7 illustrating the valves as set to provide series-parallel operation of the individual pumps; and

FIG. 9 is a view similar to FIGS. 7 and 8 illustrating the valve setting which provides series operation of the pumps.

The pump shown in the drawings comprises a base 10 from which there are supported generally annular inlet and outlet manifolds 11 and 12. Extending between the two manifolds 11 and 12 are a plurality of pumps 13 of the aforesaid "Moyno" type. Each of such pumps embodies, as shown in FIG. 4, a barrel 15, a helically grooved liner 16 of resilient material, and a helically formed rotor 17. As pumps of this type are well known, it is believed that no further description of them is necessary, although it may be noted that as the rotor rotates liquid supplied to the inlet end of the pump (the right-hand end in FIGS. 1 and 4) will be forced by rotation of the rotor 17 leftwardly through the pump.

Mounted on the base 10 on the opposite side of the inlet manifold 11 from the outlet manifold 12 is a gear housing 20, and between such gear housing and the inlet manifold 11 there extend a plurality of shaft-housings 21 which are coaxial respectively with the pumps 13. Within each of the shaft housings 21 there is rotatably supported a hollow shaft 22 which extends into the gear housing 20 and has affixed to it a pinion 23. The several pinions 23 are coplanar with each other and mesh with a common drive gear 24 carried by a shaft 25 which extends outwardly beyond the gear housing 20 and has affixed to its projecting end a drive pulley 26. A pump drive shaft 27 is located within each of the hollow shafts 22 and has its opposite ends connected respectively to such hollow shaft and to the associated pump rotor 17 through universal joints 28.

Coaxially with each of the pumps 13, the inlet manifold 11 is provided with a cylindrical valve chamber rotatably receiving a hollow valve member 31 which in turn rotatably receives the adjacent end of the barrel 15 of the associated pump 13. Exteriorly of the manifold 11 each valve member 31 has an annular flange 32 overlapped by an annular flange-clamping collar 33 bolted to the face of the manifold 11. Each inlet valve member 31 has a hub 34 which projects outwardly beyond the clamp-collar 33 and, exteriorly, is of hexagonal or other polygonal shape to permit the application of a wrench by which the valve member may be adjusted. Within the inlet manifold 11 the wall of the hollow valve member 31 has a port 35 through which, by rotation of the valve member, the associated pump can be selectively connected to passages of the inlet manifold.

Like the inlet manifold 11, the outlet manifold 12 is provided in alignment with each pump with a cylindrical valve chamber rotatably receiving an outlet valve 38 having a hub 39 into which the adjacent end of the barrel 15 of the associated pump is screw-threaded. To retain each valve 38 in position I may employ an annular flange 32 and an annular clamp-collar 33 similar to the flange and collar associated with each of the inlet valves. Each outlet valve has a port 40 through which, by rotation of the valve, the adjacent end of the associated pump can be selectively connected to passages of the outlet manifold. Exteriorly of the manifold 12 the outlet valve 38 is respectively provided with wrench-receiving heads 41 of hexagonal or other polygonal shape.

The material to be pumped is supplied to the inlet manifold 11 through a supply pipe 45 connected to the midpoint of a header 46 which communicates at its ends with diametrically opposite points of the header 11 between adjacent valve chambers thereof. Material leaving the pump is discharged from the outlet manifold 12 at diametrically opposite points into the ends of a header 47 communicating with an outlet pipe 48. Auxiliary conduits 49 extend between the manifolds 11 and 12 to provide for return flow of mud when the pumps are operated in series or in series-parallel, as hereinafter described.

To facilitate description of the manner in which the several valves may be adjusted selectively to provide parallel, series-parallel, or series operation of the several pumps, the pumps 13, the valves 31 and 38, and the return conduits 49 will hereinafter be distinguished from each other by subscripts. Thus, referring to FIGS. 7, 8, and 9, it will be noted that the pumps are designated 13*a*, 13*b*, 13*c*, and 13*d*. One end of the inlet header 46 communicates with the inlet manifold 11 at a point between the two chambers which receive the inlet valves 31*b* and 31*c* respectively associated with the pumps 13*b* and 13*c*. The opposite end of the header 46 communicates with

the manifold 11 at a point between the chambers which receive the inlet valves 31*a* and 31*d* respectively associated with the pumps 13*a* and 13*d*. At the opposite end of the pump, one end of the outlet header 47 communicates with the outlet manifold 12 between the chambers receiving the outlet valves 38*b* and 38*c* respectively associated with the pumps 13*b* and 13*c*. The opposite end of the outlet header 47 communicates with the outlet manifold at a point between the chambers receiving the outlet valves 38*a* and 38*d* of the respective pumps 13*a* and 13*d*. The manifold chambers respectively receiving the inlet valve 31*c* and the outlet valve 38*b* are interconnected by a return conduit 49*a*. In similar fashion, the manifold chambers receiving the inlet valve 31*d* and the outlet valve 38*c* are interconnected through a return conduit 49*b*. A third return conduit 49*c* extends from a point in inlet manifold 11 between the chambers of inlet valves 31*a* and 31*b* to a point in the outlet manifold between the chambers of valves 38*a* and 38*b*.

For parallel operation of all four pumps, the valves are adjusted, as indicated in FIG. 7, so that all the intake valves communicate with the inlet header 46 and all the outlet valves communicate with the outlet header 47. The material entering the header 46 will divide therein, and the material discharged from each end of the header 46 will be in turn divided between two of the pumps. At the outlet ends of the individual pumps, the material discharged therefrom is collected into opposite ends of the header 47 and combined for discharge through the discharge conduit 48.

For series-parallel operation, the several valves are adjusted as indicated in FIG. 8. Specifically, the inlet valves 31*a* and 31*c* are left in the positions of FIG. 7 to communicate with the inlet header, but the valve 31*b* is adjusted to communicate with the return conduit 49*c* while the inlet valve 31*d* is adjusted to communicate with the return passage 49*b*. The outlet valves 38*b* and 38*d* are left, as in FIG. 7, in communication with the outlet header 47, but the outlet valve 38*c* is adjusted to communicate with the return conduit 49*b* and the outlet valve 38*a* is adjusted to communicate with the return conduit 49*c*. With the valves so adjusted all material supplied to the inlet manifold from the right-hand end of the inlet header 46 is directed through the pump 13*a*, return conduit 49*c*, and the pump 13*b* to the left-hand end of the outlet header 47, while all material supplied to the inlet manifold through the left-hand end of the inlet header 46 is directed through the pump 13*c*, return conduit 49*b*, and pump 13*d* to the left-hand end of the outlet header 47.

For series operation, the valves are adjusted as shown in FIG. 9. Here, the inlet valves 13*a*, 13*b*, and 13*d* are left as in FIG. 8, but the inlet valve 13*c* is adjusted to communicate with the return conduit 49*a*. The outlet valves 38*a*, 38*c*, and 38*d* are left as in FIG. 8, but the outlet valve 38*b* is adjusted to communicate with the return conduit 49*a*. As a result of such valve adjustments, all material supplied to the inlet header is directed into the valve 31*a* and flows to the outlet header 47 by way of pump 13*a*, return conduit 49*c*, pump 13*b*, return conduit 49*a*, pump 13*c*, return conduit 49*b*, and pump 13*d*.

As previously indicated, I prefer to operate the rotors 17 of the several pumps at different speeds in such a manner that the rotor of any pump which, in series or series-parallel operation, discharges into another pump operates at a somewhat higher speed than does the rotor of such other pump. This is easily accomplished by making the pinions 23 of progressively decreasing numbers of teeth from the pinion which drives the pump 13*a* to the pinion which drives the pump 13*d*. The amount by which the pinions 23 differ in diameter may vary as desired, but ordinarily will be relatively slight, for which reason I have not attempted to illustrate the differences in diameter in FIG. 3. The purpose of driving the pumps at different speeds involves the fact that pumps of the type illustrated operate with some slippage, the amount of which depends upon several factors, including the pressure difference across the pump. Since the delivery of each pump is rather closely proportional to its speed of operation, and since the first of any pair of series-connected pumps operates faster than the other pump of the pair, the latter pump is not starved by reason of the slippage existing in the former pump.

It will be noted that in all conditions of valve adjustment shown in FIGS. 7, 8, and 9 the valves 31*a* and 38*d* remain unchanged in position and hence are not required for the purpose of varying the manner in which the pumps are connected. However, I prefer to employ the valves 31*a* and 38*d* as, by so doing, I am enabled to make each pump 13 and its associated valves identical with the other pumps and valves and thus reduce the number of spare parts which must be stocked for replacement purposes.

The construction described provides ready access to working parts for purposes of inspection, repair, or replacement. Thus, by removing from the outlet manifold 12 the clamp collar 33 of any pump, the associated outlet valve 38, together with the pump-barrel 15 attached to it, can be withdrawn axially through the outlet manifold. This exposes the pump rotor, renders accessible the connection between the rotor and its drive shaft, and permits ready removal of the inlet valve 31.

I claim as my invention:

1. A pumping apparatus, comprising a plurality of pumps each having a barrel provided internally with a helical groove and a helical rotor within the barrel, an annular inlet manifold provided with a plurality of angularly spaced valve housings, an annular outlet manifold having a plurality of valve housings respectively aligned with those of said inlet manifold, a valve sleeve mounted in each of said housings, each of said valve sleeves having an axial opening receiving an end of one of said pump barrels and also having a lateral port communicating with the axial opening, each valve sleeve being rotatable about the axis of the associated pump barrel to control communication of the pump barrel with the associated manifold through said lateral port, an annular series of pinions connected respectively to said rotors, a common drive gear meshing with said pinions, each of said valve sleeves being removable from its associated manifold by movement axially of itself, and releasable means for retaining each valve sleeve in fixed axial position in its associated manifold, one of the valve sleeves associated with each pump barrel being releasably secured to such pump barrel whereby it and the barrel can be removed as a unit from the manifold.

2. A pumping apparatus, comprising first and second pumps each having a barrel provided internally with a helical groove and a helical rotor within the barrel, an inlet manifold, an outlet manifold, said pump barrels extending in parallel spaced relation between said manifolds, said outlet manifold having a cylindrical recess coaxial with said first pump, said inlet manifold having a cylindrical recess coaxial with said second pump, a return conduit connecting said recesses, a valve sleeve in each of said recesses, each of said valve sleeves having an axial opening communicating with the coaxial pump and also having a lateral port, each valve sleeve being rotatable to connect said port alternatively to the return conduit or to the associated manifold whereby the pumps may be alternatively connected between said manifolds in series or in parallel, driving means for rotating the pump rotors, one of said valve sleeves being closed at one end and communicating at its other end with the adjacent end of the associated pump barrel, the opposite end of such pump barrel having a sliding connection with the manifold at such end, the closed-end valve being axially removable from its recess, and releasable means for retaining said closed-end valve in its recess.

3. A pumping apparatus as set forth in claim 2 with the

addition that said closed-end valve is releasably connected to the barrel of its associated pump, whereby such valve and barrel can be withdrawn as a unit.

4. A pumping apparatus, comprising a base, annular, substantially coaxial annular inlet and outlet manifolds mounted in spaced relation on said base, said inlet manifold having four angularly spaced sleeve-receiving recesses, said outlet manifold having four sleeve-receiving recesses respectively aligned with the recesses of the inlet manifold, each of said recesses opening in opposite faces of its manifold, sleeves received in said recesses, each pair of aligned sleeves having axial openings in their adjacent ends, a pump barrel received in the axial openings of each pair of aligned sleeves, a rotor within each pump barrel, each pump barrel having an internal helical groove and each rotor having a helical configuration, return conduits connecting certain of the recesses of the outlet manifold respectively with non-aligned recesses of the inlet manifold, each of said sleeves having in the plane of its associated manifold a lateral port communicating with the axial opening of the sleeve, each of the sleeves in recesses interconnected by said return conduits being rotatable to permit its lateral port to register alternatively with the associated return conduit or with the associated manifold, whereby said sleeves can be adjusted to interconnect pump-barrels alternatively in series or in parallel, the sleeves in the recesses of one manifold having openings at their ends opposite the respectively aligned pump barrels, pump-driving means including shafts extending through said last mentioned openings and operatively connected to the rotors, the sleeves in the recesses of the other manifold being closed at their ends opposite the respectively aligned pump barrels, the several pump barrels being releasably secured in the closed-end sleeves and having sliding fits in the other sleeves, each of said sleeves being axially movable to permit its withdrawal from the associated recess, and releasable means for retaining each sleeve in its recess.

5. A pumping apparatus as set forth in claim 4 with the addition of a gear housing mounted on said base, an annular series of pinions mounted in said gear housing and operatively connected respectively to said shafts, and a common drive gear mounted within the gear housing and meshing with said pinions.

6. A pumping apparatus as set forth in claim 5 with the addition that said pinions are of different sizes and are so connected to said shafts that the rotor of the first of any two pumps connectible in series will be driven at a higher speed than the rotor of the second of such two series-connectible pumps.

7. A pumping apparatus, comprising first and second pumps each having a barrel provided internally with a helical groove and a helical rotor within the barrel, an inlet manifold, an outlet manifold, said pump barrels extending in parallel spaced relation between said manifolds, said outlet manifold having a cylindrical recess coaxial with said first pump, said inlet manifold having a cylindrical recess coaxial with said second pump, a return conduit connecting said recesses, a valve sleeve in each of said recesses, each of said valve sleeves having an axial opening communicating with the coaxial pump and also having a lateral port, each valve sleeve being rotatable to connect said port alternatively to the return conduit or to the associated manifold whereby the pumps may be alternatively connected between said manifolds in series or in parallel, driving means for rotating the pump rotors, each of said valve sleeves being open at both ends and slidably and rotatably receiving at one end the barrel of the associated pump, said driving means including a shaft connected to the rotor of such pump and projecting through the other end of the valve sleeve, the manifold at the opposite end of such pump having an opening through which the barrel of such pump can be axially withdrawn, and a removable closure for such opening.

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