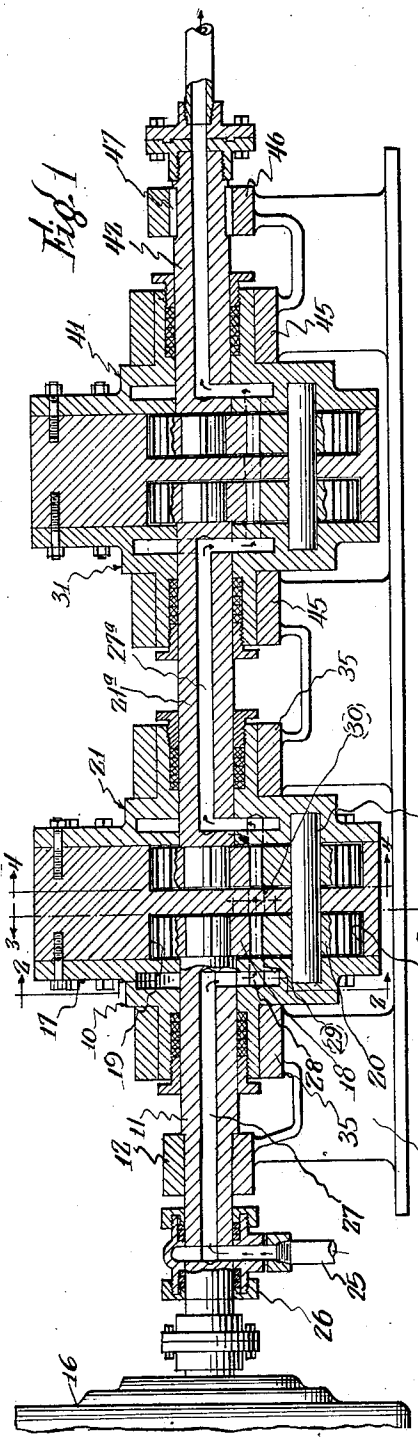
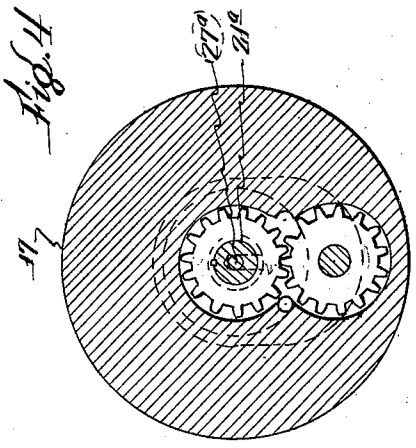
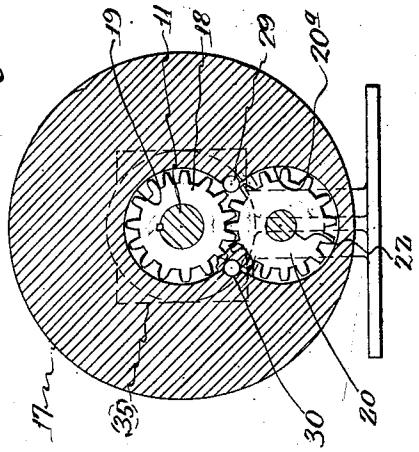
Feb. 2, 1932. W. W. SLOANE 1,843,246

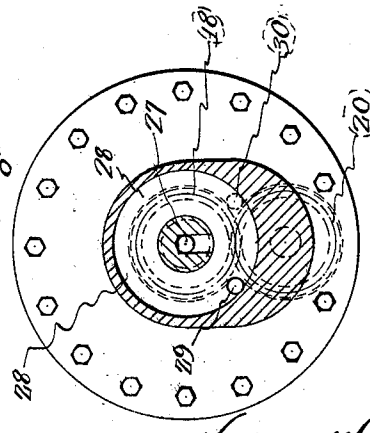
MULTIPLE STAGE HYDRAULIC PUMP

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UNITED STATES PATENT OFFICE

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MULTIPLE STAGE HYDRAULIC PUMP

Application filed November 5, 1927. Serial No. 231,214.

This invention relates to improvements in multiple stage hydraulic pumps and has for its principal object to provide an improved construction and arrangement of such pumps, whereby they may be driven at greater speeds and without the requirement of common gear reduction devices and produce their ultimate pressure in an efficient and dependable manner and practically without regard for differences in leakage in the several pump units constituting the different pressure-increasing stages.

As heretofore constructed, hydraulic rotary or gear pumps have usually been arranged in series with all of the pumps driven at a definite speed, but in such construction, it is usually desirable to rotate the driving member at a speed not exceeding the normal efficiency rate of one of the pump units. Accordingly, where relatively high speed prime movers are used, as for instance electric motors, it is usually necessary to interpose gear reduction devices between the motor and the common pump driving member which serves all of the pump units, or between a common driving member and the pump units.

In carrying out my invention I provide a series of separate pump units with both driving and driven members of the first pump rotatably mounted with respect to the fixed support and with the driven member connected independently to the driving member of the next succeeding pump, this arrangement being continued until the last pump in the series, in which the part corresponding to the driven member of the preceding pumps is fixed so as to form a reaction member for all of the preceding pump units.

The invention may be best understood by reference to the accompanying drawings, wherein:

Figure 1 is a longitudinal sectional view of a series of pump units constructed in accordance with my invention; and

Figures 2, 3 and 4 are sections taken on lines 2—2, 3—3 and 4—4 of Figure 1, respectively.

Referring now to the details shown in the drawings, I have utilized a series of four hydraulic geared pumps, indicated generally at 10, 21, 31 and 41 respectively, as a means of illustrating my invention, but it will be understood that any equivalent types of rotary pump may be utilized, if desired. In the form shown the first pump unit, 10, comprises a driving shaft 11 connected directly to the armature shaft of a motor 16, which forms the prime mover for the entire pump system. The drive shaft 11 of the first pump extends in an enlarged casing 17 and has a gear 18 fixed thereon and fitting closely within chamber 19 formed in the casing 17. The gear 18 is meshed with a companion gear 20 rotating about shaft 22 in chamber 20^a, the two gears 18 and 20 together forming the moving parts of a pressure pump of a type well known in the art. The inlet for the first pump herein consists of an inlet pipe 25 connected with gland 26 mounted on and communicating with a passage 27 extending through the center of shaft 11 into an enlarged chamber 28 formed in one end of the casing 17, thence through passage 29 at one side of the adjoining chambers 19 and 20^a within which the gears 18 and 20 rotate. The outlet for the first pump consists of a passage 30 disposed on the opposite side of connected chambers 19 and 20^a and communicating with the next pump unit indicated generally at 21 so as to form the inlet passage thereof.

The second pump unit shown herein is similar in construction to the first pump unit excepting that the parts are reversed so that casing 17 rotates on its axis due to the reaction of the fluid pressure between the gears 18 and 20 and the fact that it is free to rotate in bearings 35, 35, instead of being fixed as in usual pump constructions. The casing 17 therefore constitutes both the reaction member of pump 10, and the driving member of pump 21.

It should be noted that if the passage 30 were closed and the gear 18 were rotated, a fluid being allowed to enter the first pump 10 through the pipe 25, the fluid pressure would be so great as to prevent rotation of the gear 20 which would cause said gear to lock with the gear 18 and rotate the casing 17 at the speed of rotation of the drive shaft 11. The amount of opening of the passage-

way 30 controls the rate of speed of rotation of the casing 17, since the speed of rotation of said casing is dependent upon the speed of rotation of the gear 20.

The second pump unit 21 is similar in construction and operates in the same manner as the first pump unit, excepting that the fluid passes in a direction reverse to that in which it passes through the first unit 10. The second center shaft 21ª corresponds to the first driving shaft 11 and is connected with the alined gears in pumps 21 and 31 and thus forms the reaction member of the second pump 21, and the driving member of the third pump 31.

The third and fourth pumps 31 and 41, the latter forming the last pump in the series, are similar to pumps 10 and 21, so their detailed description need not be repeated. They rotate freely in bearings 45, 45, similar to bearings 35, 35, already described. However, the last pump 41 has its shaft 42, which constitutes the reaction member of the last pump, fixed in support 46 by suitable keys 47, or their equivalent, instead of being free to rotate. This shaft 42 therefore forms in effect a fixed reaction member for all of the pumps in the series.

It will now be clear from the foregoing description that when the first pump in the series is driven at a given rate of speed, the following pumps will each produce their proportion of increase in pressure with each of the units at substantially the same speed differential between its driving and driven members but at decreasing rates of revolutions. Since a given volume of fluid enters the pump unit 10 and this same volume of fluid is discharged through the pump unit 41 the pressure of this fluid is increased to four times its pressure before entering the pump unit 10 and since the speed of each pump unit decreases as the water pressure increases, this decrease in speed, assuming no leakage in the system, will be proportionate to the increase in pressure and the speed of the fourth unit will be one fourth the speed of the first unit. Thus, if four pump units of similar capacities are used and the first pump is driven at 1000 R. P. M. the first driving member or shaft 11 will rotate at 1000 R. P. M. while the driven member or casing 17 will have a theoretical differential of 250 R. P. M., or 750 R. P. M. speed. The casing 17 forms the driving member of the second pump 21 at 750 R. P. M., so that the shaft 21ª or reaction member of the second pump will have a theoretical speed of 500 R. P. M. Similarly, the theoretical reduction in speed through pumps 31 and 41 will be 250 R. P. M. each.

In the event that the leakages in the several units are equal, the relative speeds of rotation above mentioned will not be affected. However, with slight variations in leakages of the several pumps (as is often the case), there will be a slight relative increase in working speed of the more leaky pump, with a corresponding decrease in working speed of the more efficient pumps. This arrangement therefore provides an automatic compensation for leakages in the several pump units and assures an equal increase in pressure per stage.

A further advantage of the construction and arrangement above described is the provision of a multiple speed reduction within the pump system itself which eliminates the necessity of separate gear reductions where a relatively high speed prime mover, such as an electric motor, is utilized.

Although I have shown and described one embodiment of my invention, it will be understood that the construction and arrangement of the various parts may be altered or changed without departing from the spirit or scope thereof. Furthermore, I do not wish to be construed as limiting myself to the specific form illustrated, excepting as it may be limited in the appended claims.

I claim as my invention:

1. In a multiple-stage pump system, a plurality of rotary pump units operatively connected together in series, each rotary pump unit including a driving member and a reaction member, a fluid inlet in each driving member and a fluid discharge in each reaction member, a prime mover connected to the driving member of the first unit, the reaction members of each of the units except the last forming the driving members of the next succeeding unit, and the reaction member of the last unit forming the final reaction member for all the preceding units.

2. In a multiple-stage pump system, a plurality of rotary pump units operatively connected together in series, each rotary pump unit including a driving member and a reaction member, a fluid inlet in each driving member and a fluid discharge in each reaction member, a prime mover driving the first unit, and the driving and reaction members of each of said units being freely rotatable at differential rates relative to each other, with the exception of the reaction member of the last unit, which is fixed to form a final reaction member for the preceding units.

3. In a multiple stage pump system, a prime mover, a plurality of rotary pump units each connected together in series, a drive shaft connected from said prime mover to said first rotary pump unit, a fluid inlet in said shaft, a casing concentric with said shaft and rotatable thereabout, a driven shaft connected with a second rotary pump unit, said casing serving as a reaction member for said first rotary pump unit and a driving member for said second rotary pump unit, a fluid outlet in said last mentioned shaft, said last mentioned driven shaft

constituting a reaction member for said second rotary pump unit and a driving member for a rotary pump unit succeeding said second rotary pump unit, and a stationary reaction member for the last rotary pump unit having a fluid discharge outlet therein.

4. In a multiple stage pump system, a prime mover, a plurality of rotary pump units each connected together in series, a drive shaft connected from said prime mover to said first rotary pump unit, a fluid inlet in said drive shaft, a casing concentric with said shaft and rotatable thereabout, a driven shaft connected with a second rotary pump unit, said casing serving as a reaction member for said first rotary pump unit and a driving member for said second rotary pump unit, and said last mentioned driven shaft having a fluid discharge outlet therein and constituting a reaction member for said second rotary pump unit and a driving member for a rotary pump unit succeeding said second rotary pump unit, the reaction member of the last unit having a fluid discharge outlet therein and being held in a fixed position to form the final reaction member for all the preceding units.

5. In a multiple stage pump system, a prime mover, a plurality of rotary geared pump units each connected together in series, a drive shaft connected from said prime mover to a gear in said first rotary pump unit and forming a driving member for said unit, a fluid inlet in said drive shaft, a casing concentric with said shaft and rotatable thereabout, a gear within said casing having a shaft driven thereby, a fluid discharge outlet in said last mentioned shaft, said casing constituting a reaction member for said first rotary pump unit and a driving member for said second rotary pump unit, said last mentioned driven shaft constituting a reaction member for said second rotary pump unit and a driving member for a rotary pump unit succeeding said second rotary pump unit, and a stationary reaction member for the last rotary pump unit having a fluid discharge outlet therein.

6. In a multiple stage pump system, a prime mover, a plurality of rotary geared pump units each connected together in series, a drive shaft connected from said prime mover to a gear in said first rotary pump unit and forming a driving member for said unit, a fluid inlet in said drive shaft, a casing concentric with said shaft and rotatable thereabout, a gear within said casing having a shaft driven thereby, said casing constituting a reaction member for said first rotary pump unit and a driving member for said second rotary pump unit, and said last mentioned driven shaft having a fluid discharge outlet therein and constituting a reaction member for said second rotary pump unit and a driving member for a rotary pump unit succeeding said second rotary pump unit, and means for holding the reaction member of the last unit in a fixed position to form the final reaction member for all the preceding units, said final reaction member being provided with a fluid discharge opening therein.

7. In a multiple-stage pump system, a plurality of rotary pump units operatively connected together in series, each rotary pump unit including a driving member and a reaction member, the first rotary pump unit including a shaft having a fluid inlet therein, a prime mover connected to said shaft for driving the first rotary pump unit, the reaction members of each of the units except the last forming the driving members of the next succeeding unit, and the reaction member of the last unit comprising a shaft held in a fixed position having a fluid discharge outlet therein and forming the final reaction member for all the preceding units.

Signed at Chicago, in the county of Cook and State of Illinois, this 1st day of November, A. D. 1927.

WILLIAM W. SLOANE.