

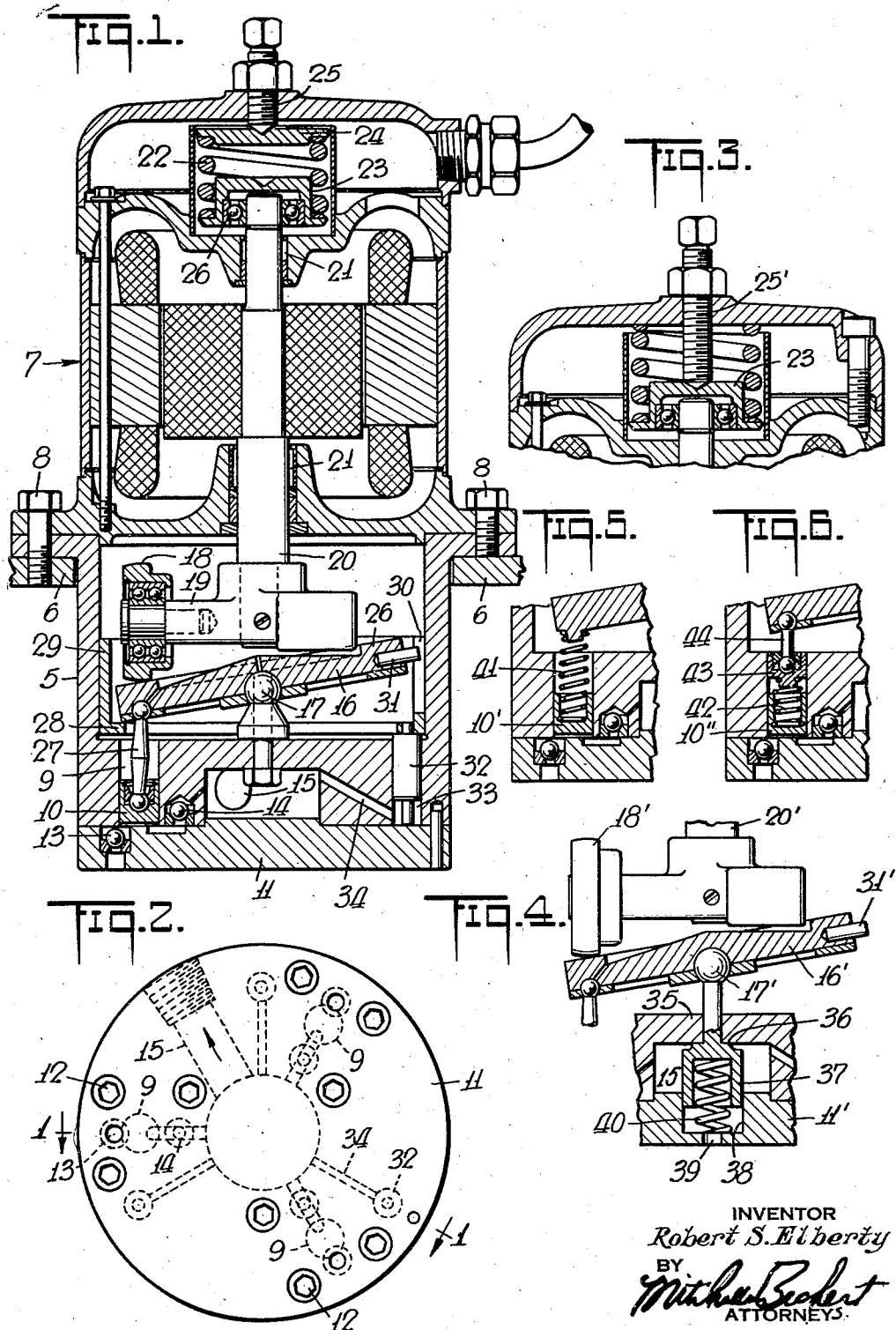
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PUMP

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My invention relates to a variable delivery pump of the swash-plate type.

It is an object to provide a pump of the character indicated, which will produce a volume of flow in generally inverse proportion to the head.

It is another object to provide a pump of the character indicated in which the flow is automatically regulated in accordance with the discharge head of the pump.

Another object is to provide a pump in which the volume is automatically regulated in generally inverse proportion to the head until a definite head is attained after which the volume remains constant.

Another object is to provide a simplified form of swash-plate pump which may be regulated and adjusted in accordance with the desired volume and head and, in general, the object is to provide an improved form of pump of the character indicated.

Briefly stated, in a preferred form of the invention I employ a swash-plate for actuating one or more pump pistons having suction and discharge valves associated therewith in the usual manner. Means, which I will term broadly a crank, is employed to rock the swash-plate about its pivot so as to reciprocate the pistons. The pump parts are so constructed and arranged that upon the attainment of a high head the pump strokes are automatically decreased so as to reduce the flow. The pump may also be arranged to reduce the flow as the head increases and after a definite head is attained to maintain a definite flow at the attained or a higher head. Such a pump has many uses, among others, in the machine tool industry.

In the drawing which shows, for illustrative purposes only, preferred forms of the invention—

Fig. 1 is a vertical section through one form of my improved pump, the section being taken substantially in the plane of the broken line 1—1 of Fig. 2;

Fig. 2 is a bottom plan view of the lower or pump piston section of the pump shown in Fig. 1;

Fig. 3 is a fragmentary, sectional view illustrating a slightly modified form of adjustment means;

Fig. 4 is a fragmentary view of a pump like that shown in Fig. 1 but illustrating a modification;

Figs. 5 and 6 are fragmentary sectional views illustrating still further modifications.

As illustrated, the body 5 of the pump is suitably supported as indicated at 6 and dips into an oil sump. The driving means for the pump in the form illustrated is an electric motor 7 and

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when such a motive means is employed the motor frame may be directly secured to the pump body 5 as by means of bolts, screws or the like 8.

The pump body 5 in the form shown includes a bottom or cylinder block section having a plurality (in this case three) of cylinders 9. Each cylinder has a piston 10. The bottom 11 of the pump body is secured as by means of screws 12 to the cylindrical body 5 and the bottom plate is provided with inlet valves 13, one for each cylinder, as will be understood. The cylinder block or bottom of the pump body is provided with discharge valves 14, one for each cylinder, and the combined pump outlet 15 leads from the discharge chamber into which all of the discharge valves empty.

The pistons 10 are operated by means of a swash-plate 16, which may be pivoted at its center upon a ball pivot 17 for universal rocking motion as is common for a swash-plate. The swash-plate is actuated by means which I will term broadly a crank and, as illustrated, there is an anti-friction roller 18 mounted on a crank arm 19, which is in turn fixedly carried by a rotatable shaft 20, which in this case is the rotor shaft of the motor. In the form shown in Figs. 1 and 2, the shaft 20 is mounted for vertical movement preferably in needle bearings 21—21. The shaft 20 is urged in operative direction, that is, toward the swash-plate or downwardly, as viewed in Fig. 1, as by means of a coil spring 22 seating on a flange on a bearing cap 23 and at the upper end against an abutment plate 24, the position of which, and consequently the stress of the spring, may be adjusted as by means of an adjustment screw 25. Between the bearing cap 23 and the upper end of the shaft 20 I prefer to provide an anti-friction bearing of the so-called radial thrust type 26, all as will be understood.

The operation of the pump as thus far described is as follows:

The motor shaft 20 is rotated and carries with it the crank arm and roller 18. The roller rides on the roller track surface 26 at the top of the swash-plate and in so doing the swash-plate is rocked and the pistons are reciprocated through the medium of the connecting rods 27 having ball or universal joint connections with the pistons and the swash-plate. Fluid such as oil enters each cylinder through the inlet valve 13 as the piston rises, and as the piston descends the oil escapes past the discharge valve 14 into the discharge chamber and discharge pipe 15.

Now, as the discharge pressure rises, the pistons meet increasing resistance, which tends to put

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increasing upward pressure on the shaft 20 and tends to compress the spring 22 so as to shorten the piston strokes. In order to more accurately regulate this upward movement of the shaft 20 and shortening of the piston strokes, I prefer to employ a stroke regulator which may consist of an annular plate 28 having a long bearing sleeve 29 slidable within the cylindrical pump body 5. This sleeve 29 preferably has a vertical slot 30 therein for the reception of a pin 31 so that the wobble plate does not rotate during its rocking motion. The stroke regulating plate 28 is urged upwardly by a plurality (in this case three) of pistons 32 sliding in cylinders 33 in the cylinder block. The space beneath the pistons 32 is connected to the discharge chamber by means of passages 34. Thus, as the discharge head of the pump rises, the pressure transmitted to the bottom ends of the pistons 32 will raise the stroke regulator plate 28. This plate 28 is arranged to be contacted by one of the driving members, either the crank, roller 18, or the swash-plate itself, and in the form shown this plate is in position to be contacted by the swash-plate. Thus, when the plate 28 is raised, the swash-plate is slightly rocked about its central pivot 17 so as to shorten the stroke of each piston and the greater the discharge pressure of the pump the higher will the stroke regulator plate 28 be raised and the more will the strokes be shortened. Thus, at low head, when the plate 28 is in its lowestmost position, the pump will pump maximum volume, but at low head. As the head increases, the strokes will be progressively shortened and, if desired, the parts may be so proportioned that at any predetermined head the swash-plate will be so flattened in its position that there will be no further pumping action.

In the slight modification illustrated in Fig. 3, I employ an adjustable stop screw 25' which may be positioned to contact the bearing cap 23 in any desired position of elevation. Thus, when the bearing cap 23 is in contact with the adjustable stop screw 25' there can be no further upward movement of the shaft 20 and consequently the pump will deliver a constant volume at the head attained at the time of contact between the cap 23 and the stop screw 25', or at a higher head.

In the modification shown in Fig. 4, the pump parts may be substantially as heretofore described and the operation of pumping will be substantially the same. However, in the modification shown in Fig. 4, the shaft 20' is preferably held against endwise movement and consequently there will be no raising or lowering of the roller 18' as in the previous example. In the form of Fig. 4 the swash-plate 16' is mounted on a ball pivot 17' carried on a stem extending through the upper wall 35 of the cylinder block and into the pump discharge chamber. Within the chamber the stem has an enlarged piston surface 36 and cylindrical skirt 37, which fits in a bore 38 in the bottom block 11'. The space beneath the sleeve 37 is open to the sump through an opening 39. A spring 40 is interposed between the bottom of the cylinder 38 and the piston member 36 and constantly urges the piston member and consequently the ball pivot 17' upwardly. With the ball pivot 17' in its uppermost position as shown, the swash-plate will be rocked to its maximum extent and the pump strokes will be at their maximum. However, as the head increases the increased pressure acting on the piston 36 in the discharge chamber will force the pivot point 17' downwardly against the action of the spring 40.

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As the ball pivot 17' is lowered, the swash-plate is flattened out and the stroke of each piston is of course reduced. There is thus no need of a stroke regulator such as the plate 28 of Fig. 1, but I prefer to employ means such as the pin 31' which may ride in a slot in the pump housing to prevent rotation of the swash-plate.

In the modification shown in Fig. 5, the swash-plate is connected to each piston 10' by means of a spring 41. This spring is securely connected to the swash-plate and to the piston by any suitable means such as by grooving the piston and a lug on the swash-plate and snapping the spring into the grooves. Thus, upon the attainment of a high head in a pump as shown in the Fig. 5 modification, the spring 41 will be compressed and the pump stroke thus shortened so as to produce the results heretofore described in connection with the previous forms of the invention.

In the modification shown in Fig. 6 instead of connecting the spring 42 directly with the swash-plate I connect the spring to the piston 10'' and to a lug on a slide guide 43. The slide guide and swash-plate are connected by a short link 44 having proper ball or other connections with those members. The actions of the forms shown in Figs. 5 and 6 are substantially the same. However, with the slide guide 43 present there is no tendency for the spring to cant nor to in anywise tend to bind the piston 10''.

Spring mounted pistons of the types shown in Figs. 5 and 6 are adaptable to pumps in general and may be actuated by means other than a swash-plate.

In all forms of the invention, therefore, I have provided means for automatically shortening the stroke and consequently reducing the volume at increased heads. As stated, the pump may be designed so as to cause the flow to cease entirely upon the attainment of a predetermined or higher head.

While the invention has been described in considerable detail and preferred forms illustrated, it is to be understood that various changes and modifications may be made within the scope of the invention as defined in the appended claims.

I claim:

1. A variable delivery pump of the character indicated, a plurality of cylinders, pistons operable therein, a swash-plate member operatively connected to said pistons for operating the latter, a crank member for operating the swash-plate member, spring means for normally urging one of the two last mentioned members in a direction to produce maximum piston stroke, said spring means being yieldable to shorten the piston stroke when operating against a high head, means for adjusting the stress of said resilient means, and means independent of said pistons and actuated by the delivery pressure of said pump for shortening the piston strokes.

2. In a variable delivery pump of the character indicated, a frame, a plurality of cylinders, pistons therein, a swash-plate for operating said pistons, means for operatively connecting said swash-plate and pistons, crank means for operating said swash-plate, spring means in fixed location on said frame for urging the pivot of said swash-plate and the crank relatively to each other in a direction to produce the maximum piston stroke, and means independent of said pistons and actuable by the delivery pressure of the pump for acting on said spring means to move said pivot and crank relatively to each other for shortening the piston stroke.

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3. In a variable delivery pump of the character indicated, a plurality of cylinders, pistons therein, a swash-plate operatively connected to said pistons for actuating said pistons by said swash-plate, a rotatable shaft having a crank thereon for operating said swash-plate, said shaft being resiliently urged in a direction toward said swash-plate, and means independent of said pistons and actuated by the delivery pressure from the pump for causing said crank and shaft to be moved in a direction away from said swash-plate for shortening the pump stroke.

4. In a variable delivery pump of the character indicated, including a swash-plate and a crank for actuating the same, a plurality of cylinders, pistons in said cylinders and operatively connected to said swash-plate, and means independent of said pistons and actuated by the delivery pressure of the pump for moving the pivot of the swash-plate and said crank away from each other, for the purpose described.

5. In a variable delivery pump of the character indicated, including a shaft having a crank thereon, a plurality of cylinders, a swash-plate pivotally mounted at its center and positioned to be operated by said crank, pistons in said cylinders and operatively connected to said swash-plate, spring means for normally urging the pivot point of said swash-plate and said shaft relatively in a direction to produce maximum rocking motion of said swash-plate, and means independent of said pistons and actuated by the delivery pressure of the pump and acting against said resilient means to move the pivot point of said swash-plate and said shaft relatively in a direction to lessen the amplitude of rocking action of said swash-plate.

6. In a variable delivery pump of the character indicated, a plurality of cylinders, pistons therein, a swash-plate operatively connected to said pistons for actuating said pistons by said swash-plate, a shaft having a crank for operating said swash-plate, resilient means for urging said crank and shaft in a direction to produce maximum rocking of said swash-plate, and means independent of said pistons and movable by the delivery pressure of said pump for causing said shaft and crank to be moved relatively to the pivot point of said swash-plate for reducing the amplitude of rocking motion of said swash-plate.

7. In a variable delivery pump of the character indicated, a plurality of cylinders, a swash-plate, a plurality of pistons in said cylinders and actuated by said swash-plate, a pivot member for said swash-plate, a crank for actuating said swash-plate to rock the same about its pivot, resilient means for urging the pivot of the swash-plate in a direction to obtain maximum rocking motion of the swash-plate by said crank, and piston means operable by the delivery pressure of said pump and acting against said resilient means for moving the pivot point of said swash-plate in a direction to cause a reduction of the rocking motion of said swash-plate by said crank.

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8. In a variable delivery pump of the character indicated, a plurality of cylinders, a plurality of pistons in said cylinders, a swash-plate for actuating the same, a crank for actuating the swash-plate, said crank being mounted on a longitudinally movable shaft, spring means for urging said shaft in a direction to cause said crank to produce maximum rocking motion of said swash-plate, regulating means including a member movable by the delivery pressure of the pump for limiting motion of said shaft for lessening the rocking movement of said swash-plate by said crank.

9. In a variable delivery pump of the character indicated, a swash-plate member, a crank member, a stroke regulator cooperable with one of said members, pistons, cylinders for said pistons, said swash-plate being operatively connected to said pistons for operating the latter by said swash-plate, said stroke regulator including means independent of said pistons and actuable by the delivery pressure of the pump for limiting the rocking movement of said swash-plate by the crank.

10. In a variable delivery pump of the character indicated, a plurality of cylinders, a plurality of pistons in said cylinders, a swash-plate operatively connected to said pistons for actuating the latter, means including a longitudinally movable shaft for actuating said swash-plate, spring means for urging said shaft in a direction to cause said swash-plate to impart maximum strokes to said pistons, and means for adjusting the stress on said spring means.

11. In a variable delivery pump of the character indicated, a plurality of cylinders, a plurality of pistons in said cylinders, a swash-plate operatively connected to said pistons for actuating the latter, means including a longitudinally movable shaft for actuating said swash-plate, spring means for urging said shaft in a direction to cause said swash-plate to impart maximum strokes to said pistons, control means independent of said pistons and actuated by the delivery pressure of the pump and acting against said spring means to cause said swash-plate to impart shorter strokes to said pistons, and means for limiting the action of said control means to limit the stroke shortening function thereof.

12. In a variable delivery pump of the character indicated, a plurality of cylinders, a plurality of pistons in said cylinders, a swash-plate operatively connected to said pistons for actuating the latter, resilient means for causing said swash-plate to impart maximum strokes to said pistons, control means actuated by the delivery pressure of said pump and acting against said resilient means to cause said swash-plate to impart shorter strokes to said pistons, and stop means to limit the action of said control means.

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