F. MARTIN.

CONTROLLING APPARATUS FOR PISTON PUMPS.

APPLICATION FILED OCT. 23, 1920.

1,418,953. Patented June 6, 1922.

2 SHEETS—SHEET 1.

Fig. 1.

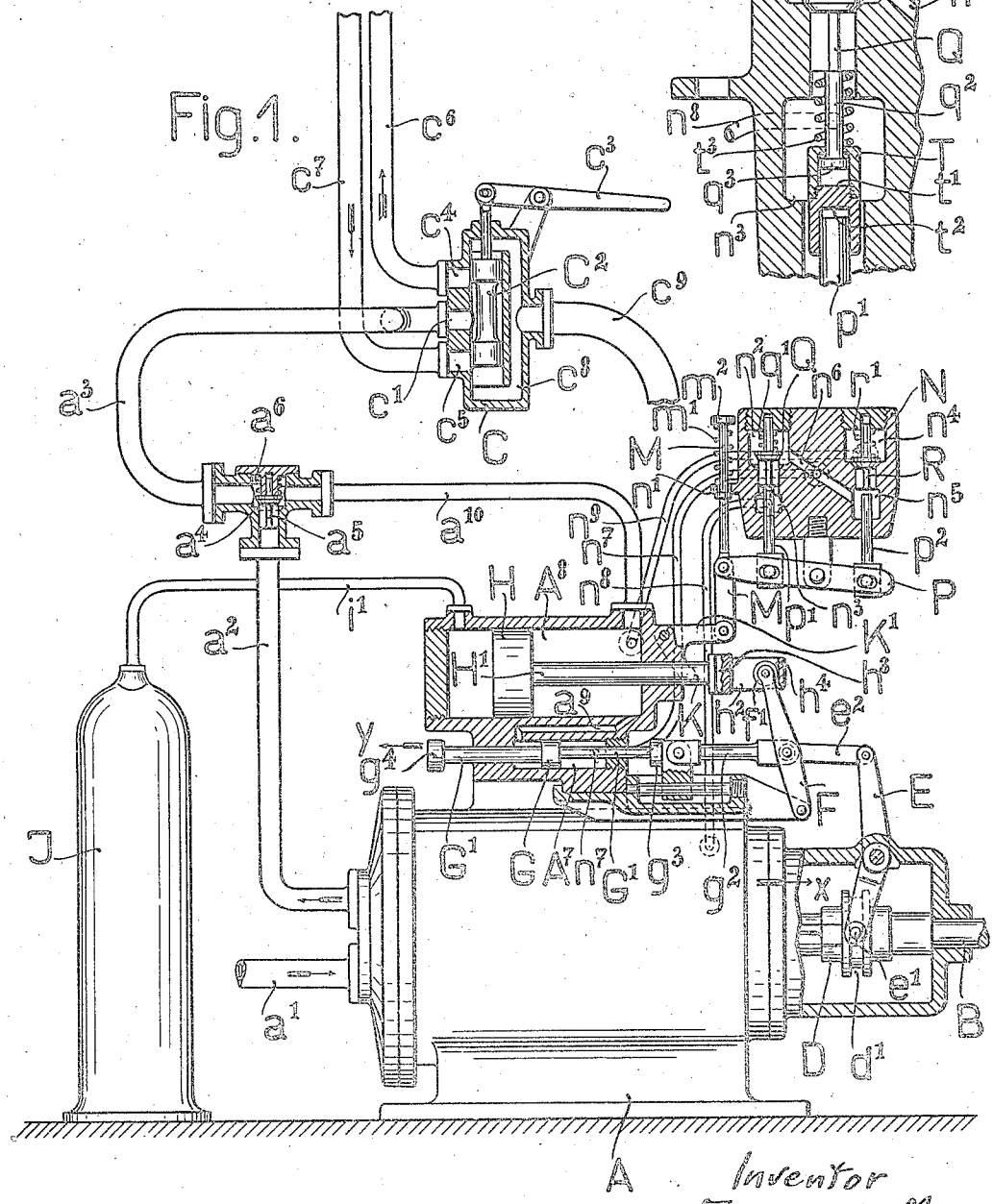


Fig. 2.

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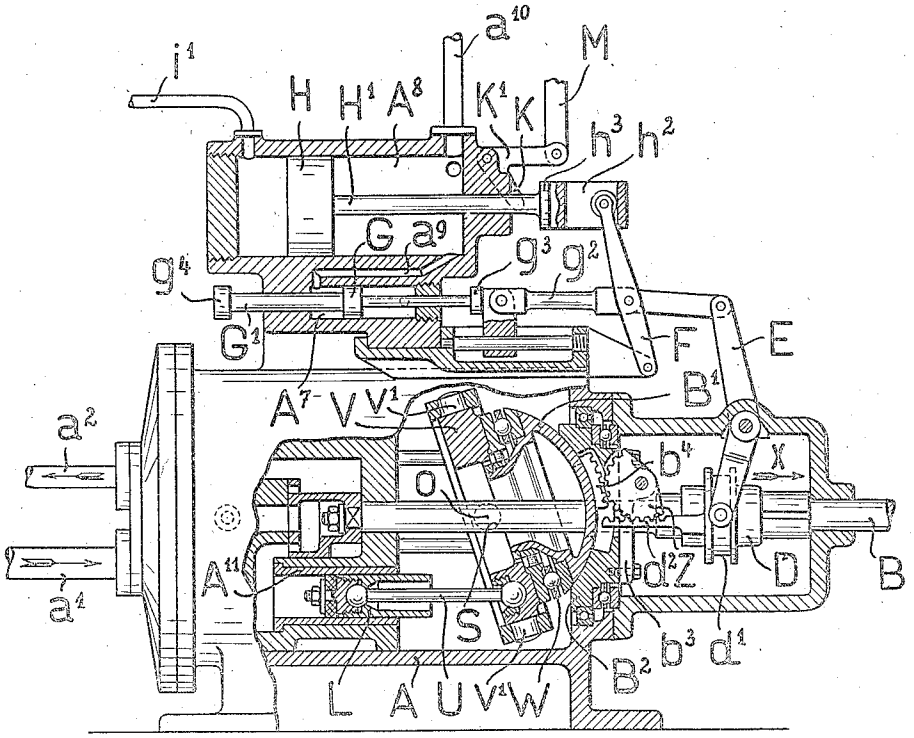
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2 SHEETS—SHEET 2.

Fig. 3.



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UNITED STATES PATENT OFFICE.

FRIEDRICH MARTIN, OF ESSEN GERMANY, ASSIGNOR TO FRIED. KRUPP AKTIEN-GESELLSCHAFT, OF ESSEN-ON-THE-RUHR, GERMANY.

CONTROLLING APPARATUS FOR PISTON PUMPS.

1,418,953. Specification of Letters Patent. Patented June 6, 1922.

Application filed October 23, 1920. Serial No. 419,043.

To all whom it may concern:

Be it known that I, FRIEDRICH MARTIN, residing at Essen, Germany, a citizen of the German Republic, have invented a certain new and useful Improvement in Controlling Apparatus for Piston Pumps, of which the following is a specification.

The present invention relates to controlling apparatus for piston pumps driven by a shaft and having variable stroke-length, in which a controlling piston, intended to alter the stroke-length of the working piston during the operation of the pump, is under the influence of the fluid pressure generated by the pump as well as of that of a power source acting in opposition to said pressure, so that the fluid pressure tends to displace the controlling piston in the direction of diminishing the stroke-length of the working piston. If with a pump of this kind the pressure conduit is shut off during operation, an increase of pressure will occur in the pump, which causes a shortening of the stroke-length of the piston. If the chamber containing the shut off pressure fluid were completely tight, then the stroke-length of the working piston would be diminished to the value of zero, and a condition of inertia would occur, in which the pump would have no pressure, even by continued rotation of the driving shaft. Really, such a condition can never be attained with the known pumps. On the contrary, as the stroke-length of the working piston, on account of the unavoidable leakage, can only be diminished onto an amount with which the pump delivers just so much fluid as corresponds to the losses by leakage, then a condition of inertia will occur with the said diminished stroke-length, wherein the pump continues to work under high pressure without producing useful work. In this resides a considerable disadvantage, as the pump is stressed and worn out unnecessarily.

The present invention has for its object to overcome this disadvantage.

The invention is illustrated on the accompanying drawing as applied to a multiple-cylinder piston pump of a hydraulic power plant, the axes of the pump cylinders being arranged on a cylindrical surface around a driving shaft common for all the pump cylinders.

Fig. 1 shows a side elevation, partly in section, of one embodiment of the invention, together with the adjacent parts of the pumping plant,

Fig. 2 a section, in larger scale, of a modified detail of the subject matter of the invention, and Fig. 3 is a view on a larger scale showing the means for varying the stroke-length of the pump.

A is the housing of the pump, to which are connected the suction pipe a' and a pipe a^2 of the pressure system. The pump comprises, as usual, a plurality of stationary cylinders A'', arranged parallel to their driving shaft B, Fig. 3. In each cylinder is a piston L, connected by a rod U with a cam disc V, which is in turn connected with the housing A by a joint comprising two pairs of pins v' and S, at right angles to each other. The axes of said pins intersect in a point o, forming the center of said joint and lying in the axis of the shaft B. The cam disc V is mounted, through a ball bearing W, on a support B', which is adjustably mounted on a disc B^2, rigidly connected with the shaft B, so that it can turn, relatively to the latter, about an axis which lies at right angles to the axis of shaft B at the point o. To adjust the support B', a sleeve D is provided, which can slide but not turn upon shaft B, which is driven at a constant speed, as by an electric motor. Sleeve D is provided, on each side of shaft B, with a rack d^2, meshing with a gear sector Z. Each of these sectors is rotatably mounted on a bridge b^3, rigid with the disc B^2, and meshes with a gear segment b^4, on the support B', so that the latter can be turned about its axis, passing through center o, by a displacement of sleeve D, which, accordingly varies the stroke of the piston L, it being shortened when said sleeve is moved in the direction of arrow x. Into the pressure conduit there is inserted between the pipe a^2 and a pipe a^3 connected thereto, return valve a^4, the valve body a^5 of which, acted upon by a spring a^6, tends to shut off the pipe a^3 from the pipe a^2, which leads directly to the pump housing A. The pipe a^3 opens into a central port c^1 of a slide valve box C, within which a slide valve C^2 may be displaced by a hand lever c^3 mounted on the valve-box C. Two ports c^4 and c^5 are provided in the valve box C, one on each side of the central port c^1 and adapted to be closed simultaneously by the slide valve C^2. From the port c^4 a pressure

pipe c^6 leads to a working machine connected with the hydraulic power plant, while a drain pipe c^7 is connected with the port c^5 for carrying away the waste water from the working machine. Lastly, another drain pipe c^9 is connected with the inner chamber c^8 of the valve box C.

A stud e^1 on one of the two arms of a bell crank lever E, rotatably mounted on the pump housing A, engages in a groove d^1 of the muff D. The other arm of the bell crank lever E has hinged connection, through a link e^2, with a single-arm lever F, also rotatably mounted on the pump housing A. By means of a rod g^2 the lever F is also in hinged connection with the rod G^1 of a small piston G displaceable within a cylinder A^7, said piston rod G^1 having stop collars g^3 and g^4.

As it will be seen from the above given description the piston rod G^1 is in constant positive connection with the muff D, in such a manner that a displacement of this piston rod in the direction of the arrow y causes a displacement of the muff D in the direction of the arrow x, and, as a consequence, a shortening of the stroke-length of the working piston. The collar g^3 is now so arranged that it limits the displacement of the piston rod in the direction of the arrow y when the muff D has arrived in the position that corresponds to the zero length of the stroke of the working piston. On the other hand, the collar g^4 limits the displacement of the piston rod G^1 in the direction opposite to the arrow y when the muff D has reached the position corresponding to the maximum stroke-length of the working piston. The piston rod G^1 has different diameters on both sides of the piston G, so that the piston G acts as a differential piston, its annular area to the right on the drawing being the greater. The free end of the lever F carries a roller f^1 and projects into a slot h^2 running in axial direction, of a piston rod H^1 provided with a stop collar h^3 and carrying a piston H operating in a cylinder A^8. At its end remote from the piston H, the slot h^2 terminates with an abutment h^4 co-operating with the free end of the lever F which carries the roller f^1. The right-hand end of the cylinder A^8 is, by means of a passage a^9, permanently connected with the left-hand end of the cylinder A^7. The right-hand end of the cylinder A^8 is, moreover, connected with the pipe a^3 through a pipe a^{10}. The left-hand end of the cylinder A^8 is connected, by means of a pipe i^1, with a bottle J, which contains compressed air, the pressure of which is approximately equal to the mean operating pressure of the pump. The right-hand end of the cylinder A^8, and, as a consequence, also the left-hand end of the cylinder A^7, are therefore constantly under pressure.

In bearings on the cylinder A^8 is carried a bell crank lever K K^1, the one arm, K, of which extends into the path of the collar h^3 of the piston rod H^1. The other arm, K^1, of the bell crank lever is connected by means of a link M, with a double-armed lever P mounted on the valve casing N. The link M extends beyond the lever P and passes through an eyelet n^1 on the valve casing N, with sufficient play, so that the bell crank lever K K^1 and the lever P may rock unrestricted within certain limits.

A rod p^1, slidable in the valve casing N, engages one of the arms of the lever P, and another rod p^2, also slidable in the valve casing N, engages the other arm of this lever. In the valve casing N are provided two double chambers, which each consist of two communicating chambers n^2, n^3 and n^4, n^5. The chamber n^2 may be shut off from the chamber n^3, into which the rod p^1 extends, by means of a valve Q, actuated by a spring q^1, while the chamber n^4 may be shut off from the chamber n^5, into which the rod p^2 extends, by means of a valve R, actuated by a spring r^1. The described parts are so arranged that the two rods p^1 and p^2, intended for opening these valves, simultaneously abut against the valves Q and R, when the two latter are in their closing position. As long as the arm K of the bell crank lever K K^1 is out of touch with the collar h^3 of the piston rod H^1, the lever P, through the intermediary of a spring m^1 acting against a collar m^2 forming the end of the rod M, is held in a position wherein the rod p^1 keeps the valve Q in the open position against the action of the spring q^1, as shown in the drawing. The rod p^2 then is at a certain distance from the valve R, which is kept in its closing position by the spring r^1. The chambers n^2 and n^5 communicate with each other through a passage n^6, which, in its turn, is connected with the right-hand end of the cylinder A^7 through a pipe n^7. The chamber n^3 is connected with the suction chamber of the pump through a pipe n^8, and the chamber n^4 with the right-hand end of the cylinder A^8 through a pipe n^9. As long as the collar h^3 is out of touch with the arm K of the bell crank lever K K^1, and the valve Q, as a consequence, is kept in its opening position by the spring m^1, as shown in the drawing, the right-hand room of the cylinder A^7 will consequently communicate with the suction chamber of the pump through the path n^7 n^6 n^2 n^3 n^8. There is consequently no pressure in this room of the cylinder A^7. As the left-hand room of the cylinder A^7, as stated hereabove, is constantly under pressure, the piston rod G^1 tends, therefore, to move in the opposite direction to the arrow y, and keeps, consequently, the roller f^1 of the lever F in contact with the abutment surface h^4 of the slot h^2 of the piston rod

H^1, both when it is at rest and during a displacement in any direction. As long as the collar h^3 does not touch the arm K of the bell crank lever K K^1, the piston H is consequently in constant force closing positive connection with the muff D, on which position the stroke-length of the piston of the pump is depending. The position of the collar h^3 is now selected in suchwise, that when the piston H moves in the direction of the arrow y, the collar comes in contact with the arm K of the bell crank lever K K^1 only when the piston H has attained a position to which corresponds a comparatively short stroke-length of the working piston.

This stroke-length of the working piston must, however, be sufficiently greater than the stroke-length by aid of which the pump would deliver only a quantity of fluid which corresponds to the losses by leakage which latter may be ascertained by experience. On the further displacement of the piston H in the direction of the arrow y, a force-closing positive connection will therefore exist between the piston H and the valve Q (by intermediary of the collar h^3, the bell crank lever K K^1, the rod M, the lever P, and the rod p^3), which connection results in that the valve Q approaches to its seat. The positive connection, which existed before the collar h^3 comes to make contact with the lever arm K, between the piston H and the muff D, will then remain unchanged, so that no further shortening of the stroke-length of the working piston will occur. The conditions are now so chosen that the length of the piston stroke present at the moment when the valve Q reaches its seat, is still greater, for a small convenient amount, than that stroke-length with which the pump would deliver so much fluid only as is lost by leakage.

For the normal operation of the pump, the parts of the described apparatus are in the position represented in the drawing. The piston valve C^2 is then adjusted in such a manner that the pressure pipe c^6 leading to the working machine is in connection with the pipes a^2 and a^3 leading from the pump, and the pipe c^7 serving to lead off the waste water from the working machine, is connected with the drain pipe c^9. Further, the collar h^3 of the piston rod H^1 is out of contact with the arm K of the bell crank lever K K^1 so that the valve Q is held in its open position by the spring m^1, and consequently the controlling piston H is in force-closing positive connection with the muff D, on the position of which latter the stroke-length of the working piston depends.

The pump then operates just as pumps of known art referred to in the preamble, as the controlling piston H, on whose position the stroke-length of the working piston depends, is subjected to the fluid pressure, in such a manner that the fluid pressure tends to displace the controlling piston in the direction of shortening the stroke-length of the working piston, that is, in the direction of the arrow y. If, now, the consumption of pressure fluid is slight, then the piston H adjusts the pump automatically to a correspondingly short stroke-length of the working piston; and inversely, for a greater consumption of pressure fluid, to a correspondingly greater stroke-length.

The individual advantage of the subject matter of the present invention will fully appear if the delivering action of the pump is broken off, by adjusting, the piston valve C^2 so that the ports c^4 and c^5 are closed. An increase of pressure will then occur in the pipes a^2, a^3 and a^{10}, as well as at the right-hand side of the piston H, which latter then moves to the left, whereby the stroke-length of the working piston is diminished. In this displacement of the piston H, the collar h^3 lastly touches the arm K of the bell crank lever K K^1. On the further displacement of the piston H in the same direction, the stroke-length of the pump is further diminished and the rod p^1 will be lowered and the rod p^2 raised through the intermediary of the bell crank lever K K^1, the rod M and the double-armed lever P.

As a consequence, the valve Q, under the action of the spring q^1, comes to shut off finally the chamber n^2 and the port n^6 from the chamber n^3, and, therefore, also from the suction chamber of the pump. The piston H assumes now a position which corresponds to a stroke-length of the pump by which the quantity delivered by the pump is only slightly greater than the fluid quantity which is lost by leakage.

On the further displacement of the piston H, immediately after the valve Q has come to take its seat, the valve R is lifted by the rod p^2 against the action of the spring r^1, so that pressure fluid on the right-hand side of the piston G enters into the cylinder A^7 from the cylinder A^8 through the pipe n^9, the chambers n^4 and n^5, passage n^6 and pipe n^7. Now the piston G comes to act as an independent auxiliary motor. The pressure fluid namely acts now on both sides of the piston G after the valve R has been lifted. As, however, the right-hand annular area of the piston G is the greater one, the latter will be displaced in the direction of the arrow y, the roller f^1 of the lever F disengaging the abutment surface h^4 of the slot h^2. On this displacement of the piston G, the muff D is still further displaced in the direction of the arrow x, and the stroke-length of the working piston consequently diminished until it finally becomes zero, when the collar g^2 has come to strike against the front face of the cylinder A^7.

As no more fluid circulation can take

place, in the pressure pipe a^2 when the stroke-length is zero, the valve a^5 of the return valve a^4 will, actuated by the spring a^6, shut off the pipes a^9 and a^{10} from the pipe a^2, so that the pump will be without pressure, even if the driving shaft B continues to run.

As soon as the length of the piston stroke has been adjusted to zero, any further movement of the piston H in the direction of the arrow y is impossible. The piston, on the contrary, now moves gradually towards the right under the action of the air pressure existing on its left-hand side and in consequence of the leakage existing in the cylinder A^8, the pipes a^{10} and a^9, and at the piston valve C^2. On this movement towards the right the piston H does not act upon the lever F, as the slot h^2 is long enough to prevent such action. The piston G remains consequently in its extreme position, which corresponds to the zero length of the piston stroke. The arm K of the bell crank lever K K^1, which abuts against the collar h^3 of the piston rod H^1, follows the movement of the piston H so that the valve R is gradually lowered and the rod p^1 again approaches the valve Q. At that moment, when the valve R has reached its closing position, the rod p^1 comes in contact with the valve Q. On the further travel of the piston H, the valve Q will be raised, so that the right-hand side of the cylinder A^7 comes again in communication with the suction chamber of the pump through the path n^7 n^6 n^2 n^3 n^8. As a consequence, the fluid pressure on the left-hand side of the cylinder A^7 preponderates and the piston G then travels to the right until the roller f^1 of the lever F again comes in contact with the abutment surface h^4 of the piston rod H^1. As the pump is now again adjusted to a stroke-length which delivers a fluid quantity that is considerably greater than the losses from leakage, then the piston H again travels to the left and the above-described cycle of actions is repeated. The piston G namely returns to its extreme position corresponding to the zero length of the piston stroke and remains again for a longer time in this position whereupon it again temporarily moves to the right and immediately thereupon returns to its extreme position. Therefore the pump with exception of short interruptions, remains without pressure. With the present invention the disadvantages present in pumps of known art as above described, are therefore avoided, which consist in that the pump, even when it does not produce any useful work, continues to operate with only a certain dead stroke-length corresponding to the losses by leakage, under higher stress and corresponding wear.

If the working machine is to be restarted, the ports c^4 and c^5 have to be opened through the displacement of the piston valve C^2. As a consequence, the pressure diminishes in the pipes a^9 and a^{10}, as well as on the right-hand side of the piston H, which latter, actuated by the air pressure on its left-hand side, now travels quickly to the right. This movement of the piston H causes the piston G to travel to the right, and the roller f^1 of the lever F again comes into contact with the abutment surface h^4 of the piston rod H^1. There now again exists a positive force-closing connection between the controlling piston H and the muff D, upon the position of which latter the stroke-length of the pump depends. As soon as the piston H has traveled so far that the resulting stroke-length corresponds to the fluid consumption of the working machine, the condition of inertia again sets in from which the description of the operation started.

If the piston valve C^2 remains a longer time in the closing position, the piston G, as related above, can travel temporarily so far to the right that the roller f^1 of the lever F again comes into contact with the abutment surface h^4 of the piston rod H^1. During this movement of the piston G there will occur an intermediary position to which corresponds a stroke-length with which the pump just would cover the losses by leakage. If now the displacement of the piston G should take place very slowly, it would occur that the pistons G and H, after several movements back and forth, would at last adjust themselves, so, that the piston G, on the one hand, will assume the intermediary position above mentioned, and the pump, therefore, only delivers so much fluid as the losses by leakage amounts to; and that, on the other hand, the valves Q and R, whose position is controlled by the piston H, simultaneously assume their closing position. The pump would then continuously work with the stroke-length corresponding to the position of the piston G under high stress and corresponding great wear. In order to avoid this disadvantage, which has to be prevented just by this invention, care must be taken that the piston G is quickly moved so far out of this extreme position, which corresponds to the zero stroke-length, that the roller f^1 comes into contact with the abutment surface h^4 of the piston rod H^1. For this purpose, with the embodiment represented in Fig. 1, the outer diameter of the valve Q must be large enough so that the passage area permits a quick flow of the fluid present on the right-hand side of the piston G in the cylinder A^7, even with very small stroke-length of the valve Q. In Fig. 2 is shown an embodiment which insures an absolute safe manner of operation, even with comparatively small diameter of the valve Q.

In this second embodiment, a two-part muff T is inserted between the rod p^1 and the valve Q, which muff is slidable upon

the rod p^1 and bolt q^2 having a head q^3 and secured to the valve Q. The muff T has, on the one hand, an abutment surface t^1, with which it is able to make contact with the head q^3 of the bolt q^2 when it approaches the valve Q, and on the other hand, an abutment surface t^2 for the rod p^1. These parts are so arranged that, on the one hand, the rod p^1 is in contact with the abutment surface t^2, and, on the other hand, the abutment surface t^1 is in contact with the head q^3 of the bolt q^2, when the valve Q assumes its closing position and when the lever P is in that angular position in which in the embodiment of Fig. 1 the rod p^1 comes to touch the valve Q. Between the muff T and the valve Q there is inserted a spring t^3, the strength of which is such that when simultaneously the abutment surface t^1 is in contact with the head q^3 of the bolt q^2 and the rod p^1 with the abutment surface t^2 this spring exerts a force against the valve Q that is nearly the same as the resistance with which the valve Q acts against displacement from its closing to its opening position under the action of the fluid pressure acting upon it and of the pressure of the spring q^1.

If now, with the last described apparatus, a slow displacement of the piston H to the right takes place after the zero stroke-length has been adjusted, then the spring t^3 will first be compressed by the rod p^1 after it has come to touch the abutment surface t^2 of the muff T, the valve Q, which is under the influence of the spring q^1 and the fluid pressure, remaining in its closing position. As soon as, however, on the further movement of the rod p^1, wherein the muff T now partakes, the abutment surface t^1 has come into contact with the head q^3 of the bolt q^2, then the valve Q is lifted on the further displacement of the piston H, so that pressure fluid passes over from the chamber n^2 into the chamber n^3 and the suction chamber which is in constant communication with the latter through the pipe n^8. As a consequence, a reduction of the pressure will occur in the chamber n^2. A very slight reduction of pressure suffices to obtain a preponderance of pressure from the spring t^3 over the pressure from the spring q^1 and the pressure fluid. The valve Q then immediately moves so far in the opening direction, independent of the rod p^1, that even with a comparatively small diameter of the valve Q, a passage of sufficient area is produced. The pressure fluid can now flow out quickly from the cylinder A^7, and the piston G, as soon as it has started, travels therefore immediately and without fail so far to the right, that the roller f^1 of the lever F comes in contact with the abutment surface h^4 of the piston rod H^1.

As the pump from now on is adjusted to a stroke-length by which the delivered fluid quantity is considerably greater than the losses by leakage, the controlling piston H again travels to the left, so that the rod p^2 approaches the valve R and lifts it. At the same time, the rod p^1 moves down, and the valve Q is again pressed down to its seat. The fluid pressure is therefore now transferred over the path n^9, n^4 n^5 n^6 n^7 onto the larger area of the differential piston G, so that this latter travels to the left and adjusts the pump again to the zero stroke-length.

A similar device as is provided to obtain a quick opening movement for the valve Q, as illustrated in Fig. 2, may naturally also be applied to obtain a quick opening movement for the valve R.

I claim:

1. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length of the pump, a controlling piston, means connecting said controlling piston to said adjusting member, means enabling said controlling piston to be actuated by the fluid pressure generated by the pump in the sense of shortening the stroke-length of the pump, a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, means for adjusting the pump so that it will be without pressure, an auxiliary motor for actuating said adjusting means, and means operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length for causing said auxiliary motor to function.

2. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length, a controlling piston and an auxiliary motor, means connecting said controlling piston and auxiliary motor to said adjusting member, means enabling said controlling piston to be actuated by the fluid pressure generated by the pump in the sense of shortening the stroke-length of the pump, a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, and means operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length for causing said auxiliary motor to function whereby the stroke-length of the pump may be diminished to the value of zero.

3. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length, a controlling piston and an auxiliary motor, means connecting said controlling piston and auxiliary motor to said adjusting member and allowing the adjusting member to be displaced by said auxiliary motor independently of

said controlling piston in the sense of shortening the stroke-length of the pump, means enabling said controlling piston to be actuated by the fluid pressure generated by the pump in the sense of shortening the stroke length of the pump, a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, and means operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length for causing said auxiliary motor to function whereby the stroke-length of the pump may be diminished to the value of zero.

4. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length of the pump, a controlling piston, means connecting said controlling piston to said adjusting member, means enabling said controlling piston to be actuated by the fluid pressure generated by the pump in the sense of shortening the stroke-length of the pump, a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, means for adjusting the pump so that it will be without pressure, an auxiliary motor for actuating said adjusting means, said auxiliary motor having a cylinder, a piston working therein under the action of the fluid pressure generated by the pump and a starting gear operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length for causing said auxiliary motor to function.

5. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length of the pump, an auxiliary motor having a cylinder permanently communicating on its one side with the pressure chamber of the pump, a differential piston working in said cylinder and having its smaller area on said side of the cylinder, means establishing communication between the other side of the cylinder and the pressure chamber of the pump, a discharge conduit also communicating with said other side of the cylinder, and a starting gear for controlling said other side of the cylinder to communicate either with the pressure chamber of the pump, or with said discharge conduit, a controlling piston, means connecting said controlling piston and said differential piston to said adjusting member and allowing the adjusting member to be displaced by said differential piston when driven by the fluid pressure acting on its larger area independently of said controlling piston in the sense of shortening the stroke length of the pump, means enabling said controlling piston to be displaced by the fluid pressure of the pump also in the sense of shortening the stroke-length of the pump, and a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, said starting gear of the auxiliary motor being operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length for causing said auxiliary motor to function in the sense of shortening the stroke-length of the pump whereby the stroke-length of the pump may be diminished to the value of zero.

6. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length of the pump, a controlling piston, means connecting said controlling piston to said adjusting member, means enabling said controlling piston to be actuated by the fluid pressure generated by the pump in the sense of shortening the stroke-length of the pump, a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, means for adjusting the pump so that it will be without pressure, an auxiliary motor for actuating said adjusting means, said auxiliary motor comprising a cylinder, a piston working therein, means connecting said cylinder on the working side of said piston to the pressure chamber of the pump, a discharge conduit communicating with said cylinder on the working side of the piston also, a starting valve for controlling the communication between said cylinder and the pressure chamber of the pump, a push rod for opening said starting valve operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length, an outlet valve for controlling the communication between said cylinder and the discharge conduit, a second push rod positively connected to said first-named one for opening said outlet valve when said starting valve is closed, an abutment piece interposed between said second push rod and said outlet valve, and a spring interposed between said outlet valve and said abutment piece whereby during the opening of said valve said spring will first be compressed.

7. A controlling apparatus for piston pumps with shaft drive and a variable stroke-length comprising an adjusting member for varying the stroke-length of the pump, a controlling piston, means connecting said controlling piston to said adjusting member, means enabling said controlling piston to be actuated by the fluid pressure generated by the pump in the sense of shortening the stroke-length of the pump, a source of power acting on the controlling piston in opposition to the fluid pressure of the pump, means for adjusting the pump so that it will be without pressure, an aux-

iliary motor for actuating said adjusting means, said auxiliary motor comprising a cylinder, a piston working therein, means connecting said cylinder on the working side of said piston to the pressure chamber of the pump, a discharge conduit communicating with said cylinder on the working side of the piston also, a starting valve for controlling the communication between said cylinder and the pressure chamber of the pump, a push rod for opening said starting valve operable by the controlling piston when having reached a position corresponding to a comparatively small stroke-length, an outlet valve for controlling the communication between said cylinder and the discharge conduit, a second push rod positively connected to said first-named one for opening said outlet valve when said starting valve is closed, an abutment piece interposed between said second push rod and said outlet valve and having sliding movement relatively to said push rod, and a spring interposed between said outlet valve and said abutment piece whereby during the opening of said valve said spring will first be compressed.

The foregoing specification signed at Essen, Germany, this 17th day of June, 1920.

FRIEDRICH MARTIN.

In presence of—
HANS GOTTSMANN,
JOHANN DECKERS.