This invention relates to a hydraulic motor installation in which the power agent is formed by a liquid under pressure contained in a main reservoir or vessel to which it is returned by the action of external means such as a solenoid traversed by an electric current and the magnetic core of which is connected to the piston of a pump.

Motors of this type have the advantage of being both simple and strong. In those which are known and which, in particular, have been employed for controlling the brakes of vehicles, the pump piston also constitutes the receiving or driven piston and acts, for example, upon the brake mechanism; but there must, of course, be as many solenoids as there are driven pistons required. The pump piston, therefore, is necessarily displaced in one direction by the liquid under pressure and in another by the solenoid which, by the same fact, returns the liquid to the main reservoir.

If the electric current fails momentarily, it is impossible to displace the piston in the direction corresponding to the action of the solenoid unless the liquid under pressure, which has just produced the displacement of the piston, is allowed to escape to the outside from the apparatus.

The present invention relates to an installation for a motor of the type indicated, constructed in such a way as to obviate the disadvantages mentioned.

The invention is characterized by the fact that the liquid under pressure is directed through an admission duct into a hydraulic motor which, during the course of its operation delivers liquid into an exhaust or discharge duct leading to a storage reservoir. The liquid can accumulate in this reservoir before being discharged therefrom and forced into the main reservoir by the movement of the pump piston, which latter will be moved away from its normal position by the discharged liquid itself and brought back to this position by the solenoid at the same time as it exerts its delivery action.

Other characteristic features of the invention will be explained hereinafter in the course of the following description; an embodiment of the invention being illustrated, simply by way of example, in the accompanying drawings, wherein:

Figure 1 is a diagrammatic view of the improved hydraulic motor installation complete.

Fig. 2 is a diagrammatic view of the hydraulic motor installation, limited to the case when the single motor is the cylinder shown in Fig. 1.

In Fig. 1, the liquid under pressure is contained in a main reservoir or power vessel 8 and can be delivered therefrom through suitable ducts to a hydraulic motor such as 25-26 which will be specifically described hereinafter. The liquid discharged from this motor is delivered to a storage vessel 3 from which it is withdrawn and pumped back to the main vessel 8. The vessels 8 and 3 are adapted to be put into communication, by means of valves 14 and 15, with a common duct 7 leading to the cylinder 4 of a pump 4-5 of the solenoid type, the core 5 of which forms the pump piston and is encircled by the coil or winding 6.

The motor 25-26 is enclosed in a rectangular casing R, represented in dotted lines; said casing also containing a distributor 27 into the opposite sides of which the upper ends of an admission duct 1 and a discharge duct 2 open. The cylinder part 26 of the motor, wherein the piston part 25 works, has its opposite ends connected with the distributor by ducts 28 and 29 that open into the distributor at points located, respectively, below and above the end of duct 2. The aforesaid end of duct 2 can be put in communication, alternatively, with ducts 28 and 29 by means of a slide valve 30 operated in any desired manner; and the passage of the liquid through said ducts 28 and 29 can be controlled by three-way valves 31 and 32, the handles of which are movable selectively into any one of four predetermined positions designated 0, I, II, III. A short connecting duct 34 joins the ducts 28 and 29, and the valves 31 and 32 are situated at the ends thereof, as shown.

In order to make the motor 25-26 op-
erate, it is sufficient, after having moved the handles of the three-way valves in position II, in which the passage of liquid through the cylinder ducts 28 and 29 and the said valves is permitted, to shift the slide valve 30 into one or the other of its two positions, thereby connecting the discharge duct 2 to receive a supply of liquid from the corresponding cylinder duct and deliver it to vessel 3. Thus, at each operation, the motor will deliver liquid to said vessel through duct 2 and automatic valve 23, and the liquid will accumulate therein and will act to compress or tension a compressible or yieldable body or element, air, for example.

When the pressure in vessel 3 becomes high enough to open the automatic valve 15, the liquid will escape through duct 7 toward the pump cylinder 4 and will force piston 5 backward from its normal, dotted-line position. On reaching the end of its stroke, the rod of the piston will actuate a rocking switch 9 so as to close the circuit of a magnet 36 fed by a battery 12, and the armature of this magnet then closes the circuit of the solenoid 6 by means of a switch 37 connected with line L, the piston 5 being moved thereby through its discharge stroke.

During its latter stroke, the piston forces the liquid contained in cylinder 4 through the duct 7 and the upwardly-opening valve 14 into the main vessel 8; and when it reaches the end of its stroke, the switch 9 is again actuated, this time in a manner to open the magnet circuit. The switch 37 then opens automatically and cuts off the line current from the solenoid; and if, at this moment, the pressure in vessel 3 is still high enough to open valve 15, the piston will be forced back again into its full-line position and the operation of the pump will recommence. On the other hand, if the pressure is insufficient to open said valve, the operation of the pump will be suspended until the moment when the motor 25–26 will have supplied a fresh quantity of liquid to vessel 3.

Reverting to the motor 25–26, it will be seen that the cylinder 26 contains liquid on both sides of piston 25, so that a movement of the piston in either direction will effect a discharge of liquid through duct 29 or duct 22, as the case may be, assuming that valves 31 and 32 are in the open positions represented. The movement of the piston in either direction can be damped toward the end of its stroke by arranging a constriction 35 in the ends of the ducts 28 and 29 where they open into the cylinder; such constrictions providing openings or apertures of reduced section which are designed to be closed by the piston.

The piston 25 may be held in any one of its positions by moving the control levers or handles of valves 31 and 32 into the positions designated 0, in which ducts 28, 29 and 34 are closed. If desired, said piston may also be displaced freely under the action of an external force, for example a return spring 33, by turning valves 31 and 32 into position I, in which ducts 28 and 29 are placed in communication with each other through duct 34. An arrangement such as that just described may be employed for controlling the switch points on railway tracks, as well as for opening and closing the doors of vehicles, and for other uses; and in all such applications, the utilization of the damping means 35 is advisable.

Instead of having both faces in contact with liquid, the piston 25 may have only one face exposed to the action thereof, its other face being subjected to atmospheric action. This can be effected by moving either valve 31 or 32 into position III, whereupon the piston will be free to move in one direction; to the right, for example, if valve 32 occupies position III. Displacement in the opposite direction will be obtained by the expansion of spring 33, after the position of slide valve 30 has been shifted, so that the liquid in said cylinder at the left of the piston will be discharged through duct 28 into duct 2, and thence to the storage vessel 3.

In Figs. 1 and 2, the automatic valve 15 which controls communication between the storage vessel 3 and the duct 7 is under the control of a double solenoid comprising two separate windings 15” and 15” which act in opposition upon a common core, the stem of which is designed to force valve 15 downward into open position; the purpose being to enable the operation of the motor to continue if the line current fails momentarily. The upper winding 15’ is supplied with current from line L, while the lower winding 15’ is connected in series with a switch controlled by a lever 13 and is supplied from the previously mentioned battery 12. Lever 13 has two main positions, designated D and S, and in which the current supply from the battery 12 is closed and open, respectively; and there is also connected with switch 13 a solenoid that acts to close a valve 11 associated with the main vessel 8, said valve opening automatically when its controlling solenoid is de-energized by the movement of the switch lever to position S. In position D, the controlling solenoid and the winding 15’ are energized.

The pump 4–5 can also be arranged so as to act not only as a pump but also as a motor (see Figs. 1 and 3). This arrangement is applicable, for example, in the case where the mechanism 4–5 controls the brakes of vehicles. The rod of piston 5 is
here connected to actuate a brake lever 20 through the intermediary of a suitable lost-motion device such as a pin 19 fixed to the lever end and working in a slot 18 in the end of the rod, said lever normally tending to engage a stop 16 under the influence of a return spring 10. The stroke of the piston is divided into two parts: one serving for its operation in the capacity of a pump and the other for its operation in the capacity of a motor; this being permitted by the lost-motion connection 18-19, as will be understood.

Due to the lost-motion connection 18-19, the piston can be moved to the right a distance to the equal to the length of slot 18 without affecting the position of the brake lever 20, but thereafter, on continued rightward movement of the piston, the latter and the brake lever move together as a unit. Conversely, the leftward or return movement of said lever is limited by stop 16, but the piston can move a slight distance further, and it is these two movements of the piston which constitute the two parts of its stroke mentioned above.

In this case, the operating stroke of the piston 5 corresponding to the pumping operation is comprised between the position represented in full lines and that represented in dotted lines, these positions corresponding, respectively, to the operation of the switch 9 in one or the other direction. The slot 18 is provided in the piston rod so as to render the operation as a pump completely independent of the operation as a motor.

The suction or receiving action of the aforesaid piston commences with the movement of the piston from its dotted-line position and extends toward the right of the figure.

The operation is as follows:

To effect braking, the lever 13 is first placed in position S, the valve 11 opens under the action of its magnet and the core of the double solenoid is held in raised position. At the same time, the circuit of solenoid 6 is broken by the release of the switch 37 and the liquid under pressure admitted through valve 11 forces piston 5 to the right to the end of its stroke.

Brake-releasing is effected by setting lever 13 in position D, in which position the windings 15" and 17" are excited, and piston 5 moves leftward under the action of solenoid 6 and forces back the liquid into power vessel 8. When the piston reaches the end of its stroke, shown in dotted lines, the solenoid is no longer excited; and if the pressure prevailing in the storage vessel 3 and derived from the operation of the motor 25-26 (Fig. 1) is at that moment higher than a predetermined value, the valve 15 opens and drives back piston 5 toward the right until it actuates the switch 9 which will restore the current in the solenoid.

The pumping operation will continue until the pressure in the storage vessel falls below a predetermined value. It is to be noted that if the valve 15 is open under the action of the pressure in said vessel during the delivery stroke of the piston, this valve will close in the following manner: in consequence of the movement of piston 5 toward the left, the pressure in the duct 7 rises rapidly, and at the moment where this pressure reaches a value corresponding to that prevailing at that moment in vessel 3, the valve 15 closes under the action of its spring. The liquid driven back by the piston 5 is discharged into the main or power vessel 8.

In the case where the piston 5 is at the end of its stroke toward the right, if the upper winding 15" of the double solenoid is de-energized, and if the lever 13 is placed in position D, it will be apparent that valve 15 will open under the action of the lower winding. In that case, the return spring 10 will pull piston 5 toward the left, thereby forcing the liquid into the storage vessel (Figs. 1 and 2).

When the current is restored in winding 15", the valve 15 closes and piston 5 moves to its dotted-line position under the action of solenoid 6, forcing the liquid ahead of it into the main or power vessel 8.

If at that moment the pressure prevailing in vessel 3 is greater than the value corresponding to the tension of the spring of valve 15, the mechanism 4-5 functions as a pump, as has previously been explained.

The winding 15" and the solenoid 6 being fed by the same line L, this arrangement enables the brakes to be released even if the current is broken in line L.

I claim as my invention:

1. A hydraulic motor installation, comprising a power vessel containing liquid and gas under pressure; a storage vessel; a cylinder, and a piston movable therein; a duct between said cylinder and the storage vessel; a valve opening toward the cylinder and located in said duct; a spring acting to close said valve; a duct between the cylinder and the power vessel; a valve opening toward the power vessel and located in the last-named duct; means for effecting the displacement of the piston in a given direction under the action of the liquid under pressure in the power vessel; external means of reduced power for effecting the displacement of the piston in the opposite direction during the first part of its stroke; means for keeping open the spring-closed valve during said displacement so as to force back into the storage vessel the liquid which has operated the piston; external means of greater power for effecting the movement of
the piston for the remaining length of its stroke; and means for enabling closure of the spring-closed valve during the last-named displacement.

2. A hydraulic motor installation, comprising a power vessel containing liquid and gas under pressure; a storage vessel; a cylinder, and a piston movable therein; a duct between said cylinder and the storage vessel; a valve opening toward the cylinder and located in said duct; a spring acting to close said valve; a duct between the cylinder and the power vessel; a valve opening toward the power vessel and located in the last-named duct; means for effecting the displacement of the piston in a given direction under the action of the liquid under pressure in the power vessel; external means of reduced power for effecting the displacement of the piston in the opposite direction during the first part of its stroke; means for keeping open the spring-closed valve during said displacement so as to force back into the storage vessel the liquid which has operated the piston; external means of greater power for effecting the movement of the piston for the remaining length of its stroke; means for enabling closure of the spring-closed valve during the last-named displacement; and automatic means controlled by the position of the piston for imparting to the piston a series of oscillations along the said remaining length of its stroke under the action of the external means of greater power so as to drive back into the power vessel the liquid contained in the storage vessel so long as the pressure in the said storage vessel exceeds the tension of the spring of the aforesaid valve.

3. A hydraulic motor installation, comprising a power vessel containing liquid and gas under pressure; a storage vessel; a cylinder connected to both vessels; a piston working in said cylinder; external means for effecting the operation of said piston as a pump for a part of its stroke when the pressure in the storage vessel exceeds a given value; means for effecting the displacement of the piston as a motor during the other part of its stroke under the action of the pressure prevailing in the power vessel; means for enabling said piston to deliver to the storage vessel the liquid which has caused the movement of the piston for the other part of its stroke; a driven member moved by the piston during its operation; and a lost-motion connection between the said driven member and the piston for rendering the operation of the piston as a pump independent of its operation as a motor.

4. A hydraulic motor installation, comprising a power vessel containing liquid and gas under pressure; a storage vessel; a cylinder, and a piston movable therein; a duct between said cylinder and the storage vessel; a valve opening toward the cylinder and located in said duct; closing means for said valve; a duct between the cylinder and the power vessel; a second valve opening toward the power vessel and located in the last-named duct; means for effecting the displacement of the piston in a given direction under the action of the liquid under pressure in the power vessel; external means of reduced power for effecting the displacement of the piston in the opposite direction during the first part of its stroke; means for keeping open the first valve during said displacement so as to force back into the storage vessel the liquid which has operated the piston; external means of greater power for effecting the movement of the piston for the remaining length of its stroke; and means for enabling closure of the first valve during the last-named displacement.

5. A hydraulic motor installation, comprising a power vessel containing liquid and gas under pressure; a storage vessel; a cylinder, and a piston movable therein; a duct between said cylinder and the storage vessel; an automatic valve opening toward the cylinder and located in said duct; a duct between the cylinder and the power vessel; a valve opening toward the power vessel and located in the last-named duct; means for effecting the displacement of the piston in a given direction under the action of the liquid under pressure in the power vessel; external means of reduced power for effecting the displacement of the piston in the opposite direction during the first part of its stroke; means for keeping open the automatic valve during said displacement so as to force back into the storage vessel the liquid which has operated the piston; external means of greater power for effecting the movement of the piston for the remaining length of its stroke; means for enabling closure of the automatic valve during the last-named displacement; and automatic means controlled by the position of the piston for imparting to the piston a series of oscillations along the said remaining length of its stroke under the action of the external means of greater power so as to drive back into the power vessel the liquid contained in the storage vessel so long as the pressure in the said storage vessel is able to open the said automatic valve.

6. A hydraulic motor installation, comprising a power vessel containing liquid and gas under pressure; a storage vessel; hydraulic motors, one of which comprises a piston working in a cylinder; means for operating said motors by the action of the liquid under pressure of the power vessel; means enabling said motors to deliver in the storage vessel the liquid which has previously operated the motors; external means for effecting the operation of the said pis-
ton as a pump for a part of its stroke when the pressure in the storage vessel exceeds a given value, the other part of said stroke being utilized for the displacement as a motor of the said piston; a driven member moved by the piston during its operation; and a lost-motion connection between the said driven member and the piston for rendering the operation of the piston as a pump independent of its operation as a motor.

In testimony whereof I affix my signature.

HENRI PIEPER.