July 13, 1943. J. MERCIER 2,323,927

EMERGENCY DEVICE FOR HYDRAULIC CONTROL SYSTEMS

Filed May 15, 1940

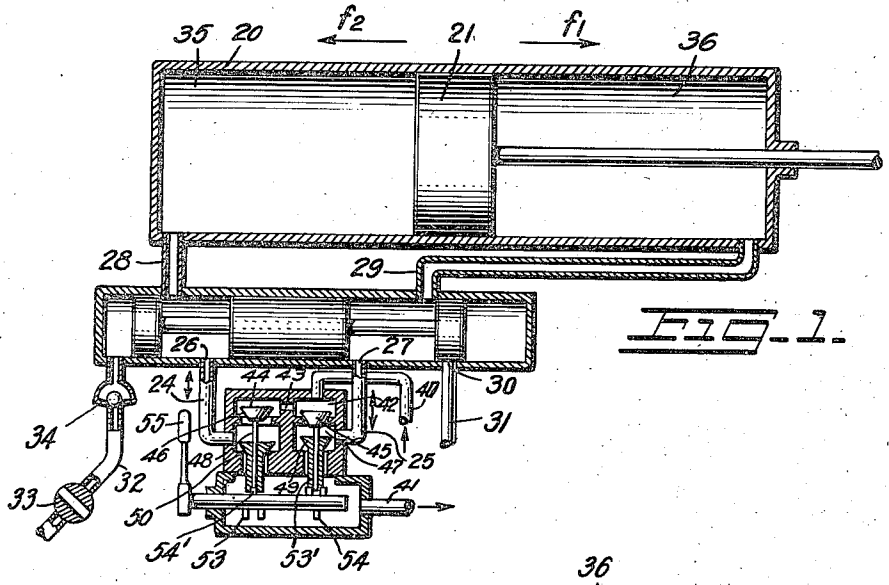

Fig. 1.

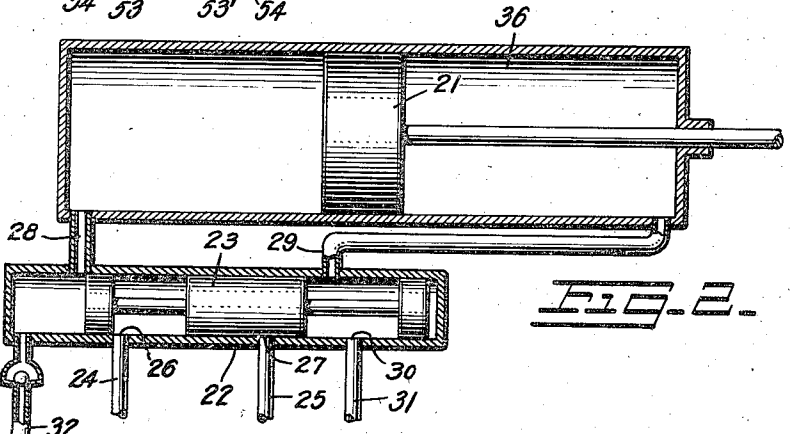

Fig. 2.

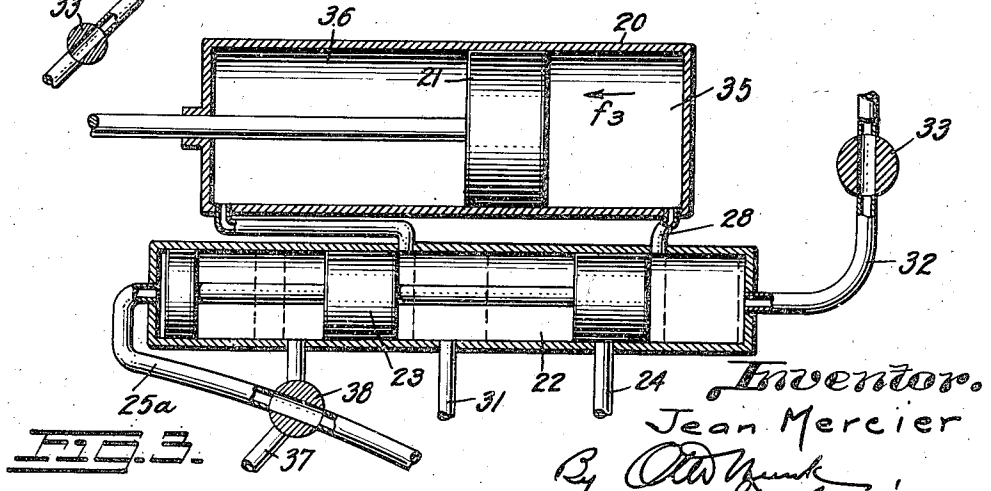

Fig. 3.

Inventor.
Jean Mercier
By [signature]
his Att'y.

Patented July 13, 1943 2,323,927

UNITED STATES PATENT OFFICE

2,323,927

EMERGENCY DEVICE FOR HYDRAULIC CONTROL SYSTEMS

Jean Mercier, Neuilly-sur-Seine, France; vested in the Alien Property Custodian

Application May 15, 1940, Serial No. 335,383
In France June 2, 1939

4 Claims. (Cl. 121—38)

The present invention relates to emergency devices for hydraulic control systems including an emergency conduit connected to a source of fluid under pressure, preferably independent of the source of fluid under pressure from which the normal conduit is fed.

These systems including an emergency conduit may be employed in particular in connection with aircrafts, for the control of retractable landing gears, flaps, and so on. They are applicable, as a rule, whenever it is desired to obtain a perfect safety of operation.

In systems of this kind, the emergency conduit feeds the fluid under pressure to the pressure fluid servo-motor which actuates the parts to be moved, from a separate source of pressure, when the normal source of pressure or the circuit connecting this source to the operating servo-motor fails to work. Preferably, in these systems, the normal conduit and the emergency conduit are connected to the same check valve or distributor located in the immediate vicinity of the servo-motor to be controlled. This distributor, this valve, this check valve, or the like, is, for this purpose, preferably subjected to the action of a constant elastic return force which tends to close the emergency conduit as long as the pressure supplied through the normal feed conduit remains above a predetermined value. On the contrary, this valve or distributor automatically opens the emergency conduit, while simultaneously closing the normal feed conduit whenever the pressure existing in the normal feed conduit drops to an insufficient value, that is to say below the above mentioned predetermined value.

Hydraulic control systems of this kind give, as a rule, perfectly satisfactory results in most cases. But it has been found that, sometimes, the servo-motor is not operated, despite the provision of the emergency conduit connected to a separate source of fluid under pressure. This may happen if, for instance, the outflow of the fluid from the servo-motor is impeded or stopped for some reason, for instance as a consequence of jamming or flattening of the exhaust conduit at any place whatever. In this case, a high counter-pressure is exerted on the valve, distributor, or the like, intended to act in an automatic manner. It may result therefrom that the opening of the emergency conduit does not correspond to the simultaneous full closing of the normal circuit which has failed to work. Consequently, the fluid fed by the emergency conduit, instead of operating the servo-motor in the desired direction, passes through the injured circuit and escapes at the place where it is broken or injured. It may also happen that this counterpressure produced by a jamming or breaking of the exhaust circuit is sufficiently high for preventing the operation of the servo-motor by the fluid fed through the emergency conduit, without preventing the normal working of the distributor or other valve which cuts off the normal circuit while opening the auxiliary circuit.

The object of the present invention is to provide a system of the type above described which is better adapted to meet the requirements of practice than those of the same kind used for the same purpose up to the present time, and in particular a system which obviates the drawbacks just above mentioned.

For this purpose, according to an essential feature of the present invention, I provide, on each servo-motor to which lead the normal and auxiliary feed conduits as above referred to, a distributing device of any type whatever, such as a slide valve device, a check valve device, etc., arranged in such manner that, in the case of the normal feed circuit failing to work, said distributing device not only cuts off this feed circuit and places the servo-motor in communication with the emergency circuit, but also, in the course of the same operation, simultaneously connects one side of the servo-motor with the atmosphere. This has for its effect to eliminate all the counter-pressures which might oppose the working of the servo-motor under the action of the fluid under pressure fed from the emergency circuit.

Other features of the present invention will result from the following detailed description of some specific embodiments thereof.

Preferred embodiments of the present invention will be hereinafter described, with reference to the accompanying drawing, given merely by way of example, and in which:

Fig. 1 is a diagrammatic partial view showing in section a first embodiment of an emergency device according to the present invention, as applied to a double acting servo-motor.

Fig. 2 is a view, similar to Fig. 1, showing the position of the distributing device when the jack of Fig. 1 is fed with fluid under pressure from the emergency source;

Fig. 3 shows, in an analogous manner, still another embodiment of the invention, as applied to a single acting servo-motor.

In the embodiment of Fig. 1, a servo-motor 20 includes a cylinder in which is movably mounted a piston 21. In the immediate vicinity of this servo-motor, I provide a distributing device 22 which, in the example illustrated by the drawing, is of the slide-valve type. The movable element, which is frictionally engaged in 22, of this device is designated by reference character 23. Of course, I might also make use of a distributor of another suitable type, such as a check valve distributor or a rotary valve distributor, or the like.

Reference characters 24 and 25 designate two conduits of the normal feed circuit, which open, respectively, at 26 and 27 into body 22. This dis-

tributor body is connected, on the other hand, at 28 to one of the ends of the servo-motor and at 29 to the other end thereof. Body 22 is further provided with a conduit 31, opening at 30 into said body and opening directly into the exhaust or the atmosphere.

Reference character 32 designates an emergency conduit fed with fluid under pressure from a separate source which is not shown on the drawing. This conduit 32 is fitted with a cock 33. It is further provided, preferably, at 34, with a check valve which prevents the outflow of the fluid back from body 22 into conduit 32, while permitting the incoming fluid to enter said body 22. This conduit 32 acts as emergency conduit intended to act when the normal feed conduit fails to work.

The system above described will work in the following manner:

In the position of the parts illustrated by Fig. 1, slide valve 23 places conduit 24 in communication with the chamber 35 of servo-motor 20, and conduit 25 in communication with chamber 36 of the same servo-motor.

Thus, if conduit 24 is fed with the fluid under pressure from the normal source, and if conduit 25 is connected to the exhaust, piston 21 is moved in the direction of arrow f^1. If, on the contrary, it is conduit 25 which is fed with fluid under pressure from the source while conduit 24 is connected to the exhaust, piston 21 is displaced in the direction of arrow f^2.

The distributing device which controls these two conduits 24 and 25 is not shown and it may be made of any suitable structure, either conventional or not. I have found useful a distributing device as shown in Figure 1, including four poppet valves and means to control these valves from the outside. The operation of this device is as follows: Pipe 40 is connected to a source of fluid under pressure and pipe 41 to a return reservoir or to the atmosphere. The fluid arriving through pipe 40 enters chamber 42 which communicates through passage 43 with the corresponding chamber 44. Chambers 42 and 44 are separated by poppet valves 45 and 46 from chambers 47 and 48. Chamber 47 is connected by conduit 25 to port 27 in body 22. Chamber 48 is connected by conduit 24 to port 26 in the same body. Two further poppet valves, 49 and 50, separate chambers 47 and 48 from chamber 51 in the bottom part of the control device. Shaft 52 disposed in chamber 51 carried double cams 53 and 53' and single cams 54 and 54'. These cams are adapted to engage the spindles of the poppet valves. The spindles of upper poppet valves 45 and 46 pass through the center of the lower poppet valves 49 and 50. The single cams 54 and 54' are adapted to engage the spindles of the upper poppet valves and to lift them and the double cams 53 and 53' are adapted to act accordingly on the spindles of the lower poppet valves. Shaft 52 projects at one end to the outside and and its position can be controlled manually by lever 55 attached to the projecting end.

In the position shown in the drawing, fluid under pressure will be admitted through pipe 40 into chamber 42 and through passage 43 into chamber 44. Poppet valve 46 being lifted by the action of single cam 54' on its spindle, fluid will flow from chamber 44 through chamber 48 and conduit 24 to port 26 and from there through the body and conduit 28 to one end of jack 20. This will move the piston in the direction of arrow f_1. The fluid discharged from chamber 36 is exhausted through conduit 28 and port 27. From there it will flow through conduit 25 into chamber 47 and through poppet valve 49 which is lifted due to the action of double cam 53' on its spindle, into chamber 51 and thence to the return reservoir.

If the position of lever 55 is reversed, cam 54' will cease to act on poppet valve 46, which will accordingly be closed. On the other hand, double cam 53 will then be engaging the spindle of poppet valve 50, which will accordingly be opened. The action on poppet valves 45 and 49 will be the reverse, so that 45 will be open and 49 shut. In this position, fluid under pressure will be admitted through chamber 42, conduit 25, port 27 and conduit 29, and the discharge will take place through conduit 28, port 26, conduit 24, chamber 48, poppet valve 50 and chamber 51.

When some breakdown occurs in the feed circuit, the pilot opens cock 33, which has for its effect to admit into the distributor the pressure existing in the auxiliary, or emergency, circuit. It will be seen, from the drawing, that this pressure acts on the left hand side of slide valve 23, in such manner as to put this slide valve toward the right while releasing, or opening the orifice of conduit 31, and closing the openings 26 and 27 of conduits 24 and 25 (see Fig. 2). It is clear that, in this position, the whole distributing device, and consequently the servo-motor, is separated from the normal circuit. The pressure supplied by the emergency circuit acts, through distributor body 22, on piston 21, so as to move the latter in the direction of arrow f^1. This action cannot be disturbed by a counter-pressure existing in chamber 36, since this chamber is directly connected to the atmosphere through conduit 31. The displacement of piston 21 in the direction of arrow f^1, as produced by the pressure supplied in the emergency circuit by the auxiliary source, corresponds to the operations the correct working of which is absolutely necessary, such for instance as the expansion of the retractable landing gear in order to permit landing.

Distributing device 22 is shown in the drawing without means to restore the movable element 23 to the position in which it is shown if the said element should be displaced into another position. This structure is frequently used on aircraft to insure complete revision of the hydraulic system whenever a failure in the regular feed and discharge line has forced the pilot to operate the emergency means. In the source of this revision, the distributing device must be dismounted and afterwards reassembled, and this operation is the only opportunity to restore movable element 23 to its normal position. This complication is in many cases intentionally introduced.

In cases where the perfect order of the hydraulic system is not so important, and if it is desired to use the distributing device again without dismounting it, spring means may be provided, for instance in the right hand side of valve body 22, acting on the movable element to restore it to its regular position. Instead of the spring means, the movable element 23 could be provided with an end projecting to the outside which would afford control of the element's position. In both cases, check valve 34 will be omitted so that the parts of the distributing device which are in communication with conduit 32 can be vented through this conduit by disconnecting it from the separate source of fluid under pressure and opening valve 33.

The embodiment illustrated by Fig. 3 of the drawing corresponds to the same principle applied to the case of a single acting servo-motor. In this embodiment, I have chosen, for the corresponding parts, the same reference characters as in Figs. 1 and 2. The pressure of the normal circuit is fed, through conduit 24, to distributing device 22, and it acts, through the connecting pipe 28 of the distributing device, in the chamber 35 of servo-motor 20, so as to push the piston 21 thereof toward the left (arrow f^3). The outflow from the servo-motor then takes place through conduit 29, and conduit 25, which communicates with conduit 29 through body 22. The fluid passes to a conduit 37, in which is fitted a three way cock 38. This cock is adapted to place conduit 25 in communication with a conduit 39 adapted to be fed with fluid under pressure, for instance from a pump.

This device will operate in the following manner:

In the case of a breakdown occurring in the normal fluid circuit 24—25, the pilot opens the cock 33 of the emergency conduit 32 which is connected to a source of auxiliary pressure. The fluid under pressure thus fed from said source pushes slide valve 23 toward the left, so as to cut off both of the normal conduits 24 and 25 of the servo-motor. Simultaneously, conduit 28 is connected to conduit 32, and conduit 29 is placed in communication with conduit 31. Thus, the piston 21 of the servo-motor is operated, in the direction of arrow f^3, the outflow of the fluid from chamber 36 taking place through conduit 29, the body 22 of the distributing device and conduit 31, which opens directly into the atmosphere. In order to be able to bring back slide valve 23 into the normal working position thereof (which is the position illustrated in dotted lines in Fig. 3) I place, through cock 38, or any other equivalent part, conduit 25a in communication with conduit 39 which, as above explained, is fed with a fluid under pressure by a pump or the like. This fluid pushes back slide valve 23 toward the right.

In a general manner, while I have, in the above description, disclosed what I deem to be practical and efficient embodiments of the present invention, it should be well understood that I do not wish to be limited thereto as there might be changes made in the arrangement, disposition and form of the parts without departing from the principle of the present invention as comprehended within the scope of the appended claims.

What I claim is:

1. A system of the type described, which comprises a hydraulic servomotor, said servomotor being connected by two pipes to valve means controlling the supply and discharge of fluid, said valve means comprising a valve body having two distributing ports connected to said pipes, two inlet and outlet ports, at least one of said ports being adapted to communicate with a source of fluid under pressure, a separate inlet port adjacent one end of said valve body, a conduit connecting said separate inlet port to another source of fluid under pressure, and a separate outlet port, a movable valve element inside said valve body, including pressure responsive means, said element being adapted to afford, in one position, communication between said inlet and outlet ports and said distributing ports, while obstructing said separate outlet port, and to afford, in its second position, communication between said separate inlet port and one of said distributing ports and between said separate outlet port and the other distributing port while obstructing the communication between said distributing ports and said first mentioned inlet and outlet ports, and further valve means to admit fluid under pressure from said conduit to said pressure responsive means to shift said movable valve element from the first to the second position.

2. A system of the type described, which comprises a hydraulic servomotor, said servomotor being connected by two pipes to valve means controlling the supply and discharge of fluid, said valve means comprising a valve body having two distributing ports connected to said pipes, an inlet port adapted to communicate with a source of fluid under pressure, an outlet port, a separate inlet port adjacent one end of said valve body, a conduit connecting said separate inlet port to another source of fluid under pressure, and a separate outlet port, a movable valve element in said valve body, including pressure responsive means, said element being adapted to afford, in one position, communication between said inlet and outlet ports and said distributing ports, while obstructing said separate outlet port, and to afford, in its second position, communication between said separate inlet port and one of said distributing ports and between said separate outlet port and the other distributing port while obstructing the communication between said distributing ports and said first mentioned inlet and outlet ports, and further valve means to admit fluid under pressure from said conduit to said pressure responsive means to shift said movable valve element from the first to the second position.

3. A system of the type described, which comprises a hydraulic servomotor, said servomotor being connected by two pipes to valve means controlling the supply and discharge of fluid, said valve means comprising a valve body having two distributing ports connected to said pipes, two inlet and outlet ports adapted to communicate alternatively with a source of fluid under pressure, a separate inlet port adjacent one end of said valve body, a conduit connecting said separate inlet port to another source of fluid under pressure, and a separate outlet port, a movable valve element in said valve body, including pressure responsive means, said element being adapted to afford, in one position communication between said inlet and outlet ports and said distributing ports, while obstructing said separate outlet port, and to afford, in its second position, communication between said separate inlet port and one of said distributing ports and between said separate outlet port and the other distributing port while obstructing the communication between said distributing ports and said first mentioned inlet and outlet ports and further valve means to admit fluid under pressure from said conduit to said pressure responsive means to shift said movable valve element from the first to the second position.

4. A system according to claim 1 in which said valve body has a cylindrical bore, said movable valve element having three piston-like portions slidably engaging the wall of said cylindrical bore, anad two recessed portions to form two annular chambers inside said valve body.

JEAN MERCIER.