J. MERCIER

FLUID-OPERATED JACK

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Inventor

Jean Mercier

By Flinger, atty.
The present invention concerns fluid operated jacks, and more especially double acting jacks.

The object of the present invention is to provide a jack of this kind which is better adapted to meet the requirements of practice and which is particularly advantageous for use with retractable landing gears for airplanes.

According to an essential feature of the present invention, the apparatus includes a double acting jack, operated by means of a fluid, preferably a non-elastic fluid, acting under the control of a suitable distribution system on the faces of one or several pistons, in combination with a safety device for returning the parts into one of the two extreme positions thereof, in the case of the control through the distribution system above referred to failing to work, said device being housed inside the jack.

The safety return device may for instance consist of a coil spring in compression located inside the jack system, or a rubber cable in tension, also disposed inside the system, or again, preferably, compressed air stored up in advance in one of the chambers if the return stresses to be exerted are somewhat important.

Another feature of the present invention consists in the provision of an automatic device for locking the parts in the extreme position corresponding to that produced by the automatic return device, in such manner, for instance, as to keep the landing gear of an airplane locked in the unfolded, or operative, position.

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 drawings, given merely by way of example, and in which:

Fig. 1 is an axial sectional view of a jack according to the present invention;

Figs. 2 and 3 are views, similar to Fig. 1, of two other embodiments of the invention;

Fig. 4 is a side elevational view of a system including a jack controlling a jointed arm.

In the embodiment of Fig. 1, the jack includes a cylinder and a piston sleeve. Cylinder 3 has a solid end 50 and another end 3' provided with a hole, and a sleeve 4 is movable inside cylinder, being in sealing engagement with the edge of the hole provided in end 3'.

Pixed to the end 50 of cylinder 3, there is a hollow rod 45 carrying a piston 44 which is arranged in sealing engagement with the inner wall of sleeve 4. On the inner end, sleeve 4 carries a piston element 4" provided with an axial hole in which rod 45 is slidable with a sealing engagement. These parts therefore form two chambers of variable volume, f and 2a, the first chamber being limited by cylinder 3 and sleeve 4 movable therein, whereas the other chamber consists of the space between piston elements 44 and 4". As in the preceding embodiment, an increase in the pressure in chamber 1 produces an expansion of the jack, whereas an increase in the
pressure in chamber 2a produces a retraction of the jack. Variations of these pressures are obtained by means of at least one source of pressure connected with conduits 6 and 7a. Conduit 6 opens directly into chamber 1, while conduit 7a opens into a passage 46 provided axially in rod 45 and opening itself into chamber 2a. In this embodiment of the invention, the automatic return of the parts to their predetermined position is obtained through the action of a mass of compressed gas enclosed in chamber 13, limited, inside sleeve 4, by piston 44. This mass of compressed gas is introduced into sleeve 4 through valve 14. It will be readily understood that, in case of failure of the positive control action exerted through conduits 6 and 7a, this mass of compressed gas will tend to expand and will bring the jack into the expanded position.

The jack diagrammatically shown by Fig. 3 includes parts forming five different chambers. The main cylinder is 19. The jack piston is 20. Inside this jack piston, and in sealing engagement with the inner wall thereof, there is an auxiliary piston 21, freely movable therein. Between the outer surfaces of the jack piston 20 and the inner surface of the main cylinder 19, there is an annular piston 22, in sealing engagement with both of these surfaces and free to move.

Another annular element 23, movable along piston 20 as it will be hereinafter explained, forms sealing means around piston 20. The five chambers above referred to are the following: Chamber 15 constituted by the left hand part of cylinder 19, and limited by ring 23. Chamber 16, constituted by the left hand side of piston 20, and limited by auxiliary piston 21; chamber 17, formed by the annular space between cylindrical elements 19 and 20 and limited at the ends by annular elements 22 and 23; chamber 18 formed by the right hand side of hollow piston 20 and limited by auxiliary piston 21; and finally chamber 19 formed by the annular space between cylinder 19 and piston 20 and limited by annular piston 22. The cylindrical wall of hollow piston 20 is provided with conduits 27 through which chambers 16 and 17 communicate together. These two last mentioned chambers are filled with a fluid. The hydraulic control of the jack is ensured by means of a liquid under pressure which can be fed into chambers 15 and 18 through conduits 24 and 25.

A mass of compressed gas is imprisoned in chamber 17, into which it is introduced through a valve 26.

The elastic return of the parts into a predetermined position (retracted position) is obtained by means of a plunger axially introduced into chamber 17, said plunger being at a pressure sufficient for reducing the length of the jack by pushing auxiliary piston 21 toward the left, which piston 21 in turn acts on the fluid present in chamber 16. The fluid in chamber 16 is thus driven out, through orifices 27, into chamber 17 where it causes piston 20 to move toward the left.

However, the pressure in chamber 17 must be sufficiently low not to oppose the hydraulic controlling action exerted through pipes 24 and 25.

Auxiliary piston 22, which is in sealing engagement with the outer wall of 20 and the inner wall of 19 prevents leakage of the fluid present in chambers 16, 17 and which is under pressure of the gas stored up in chamber 17. Fluid tight piston 21 ensures the preservation of the compressed gas of chamber 17. If this piston 21 did not exist, the gas present in chamber 17 and the fluid present in chambers 16 and 16' would be mixed into a single fluid.

It will be readily understood that, with such an arrangement, in case of the hand control exerted through pipes 24 and 25 failing to work, the gas pressure in chamber 17 tends to push piston 21 toward the left, which discharges fluid from chamber 16 into chamber 17 through apertures 27. Therefore, if the jack is in an expanded or intermediate position, the pressure thus developed in chamber 16 causes piston 20 to move toward the left and brings back the jack into the retracted position.

An automatic locking of the parts in the retracted position is obtained by means of balls 28, or the like, movably carried by the flanged portion 20b of piston 20, which balls drop into recesses provided in the inner wall of cylinder 19, at at the depth of said recesses 29 being less than half the length of the balls 28. Each ball is pushed into the corresponding recess 29 and kept therein by locking ring 23, when the thrust exerted on the face 30 of said ring 23 both by the pressure in chamber 16' and by a spring 31 interposed between ring 23 and a collar 28b of cylinder 20 is higher than that exerted by the pressure in chamber 15. Unlocking can take place only when a sufficient increase of pressure is produced in chamber 15. A shoulder 32 limits the movement of annular piston 22.

Fig. 4 shows the application of the jack of Fig. 2 to the operation of a jointed arm the elements 33 and 34 of which are pivoted about hinge 35. Automatic locking takes place when the piston 36 of the jack, pushed inside of cylinder 37 brings arm 33 and 34 into line with each other, and engages the finger 38 of its spindle 39 into a housing 40 of arm 33, said housing 40 being brought into register with finger 38 only when elements 33 and 34 are in line with each other.

In a general way, 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 therein or 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 accompanying claims.

What I claim is:

1. In combination, a double action jack including two parts movable axially one inside the other, so as to form at least two chambers of variable volume, means for conveying fluid under pressure to these chambers, respectively, means, provided inside said jack, for continuously urging said parts in the direction of both the left and the right, said motion being brought about by means of fluid pressure in chambers 16 and 16' and the difference of pressure on the opposite faces thereof, for keeping said locking means in operative position.

2. A double action jack which comprises, in combination, two parts slidable in each other with a fluidtight fit, forming at least two chambers of inversely variable respective volumes, control means for feeding fluid under pressure to either of these two chambers at will, cooperating means carried by said respective parts for forming an internal chamber of a volume variable...
in accordance with the relative position of these parts, and a cushion of compressed gas in this last mentioned chamber adapted elastically to urge said parts toward one of their extreme positions with respect to each other, whereby said parts are automatically brought into said extreme position in case of failure of said control means to work.

3. A double action jack which comprises, in combination, two parts slidably in each other with a fluidtight fit forming at least two chambers of inversely variable volumes, control means for feeding fluid under pressure to either of these chambers at will, cooperating means carried by said respective parts for forming an internal chamber of a variable volume in accordance with the relative position of said parts, a cushion of compressed gas in this last mentioned chamber adapted elastically to urge said parts toward one of their extreme positions with respect to each other and means, adapted to be brought out of action by the feed of said fluid to one of said chambers, for locking said parts in the last mentioned extreme position, whereby, in case of failure of said control means to work, said parts are automatically brought into and maintained in, said extreme position.

4. A double action jack which comprises, in combination, two parts, slidable in each other with a fluidtight fit, forming at least two chambers of inversely variable respective volumes, control means for forcing fluid into either of said chambers at will, and yielding elastic means, interposed between said parts and located inside at least one of them, for urging them toward a predetermined relative position, whereby said parts are automatically brought into said relative position in case of failure of said control means to work.

5. A double action jack which comprises, in combination, two parts, slidable in each other with a fluidtight fit, forming at least two chambers of inversely variable respective volumes, control means for forcing fluid into either of said chambers at will, yielding elastic means, interposed between said parts and located inside at least one of them, for urging them toward a predetermined relative position, whereby said parts are automatically brought into said relative position in case of failure of said control means to work.

6. A double action jack which comprises, in combination, two parts, slidable in each other with a fluidtight fit, forming at least two chambers of inversely variable respective volumes, control means for forcing fluid into either of said chambers at will, and yielding pneumatic means, interposed between said parts inside at least one of them, for urging them toward a predetermined relative position, whereby said parts are automatically brought into said relative position in case of failure of said control means to work.