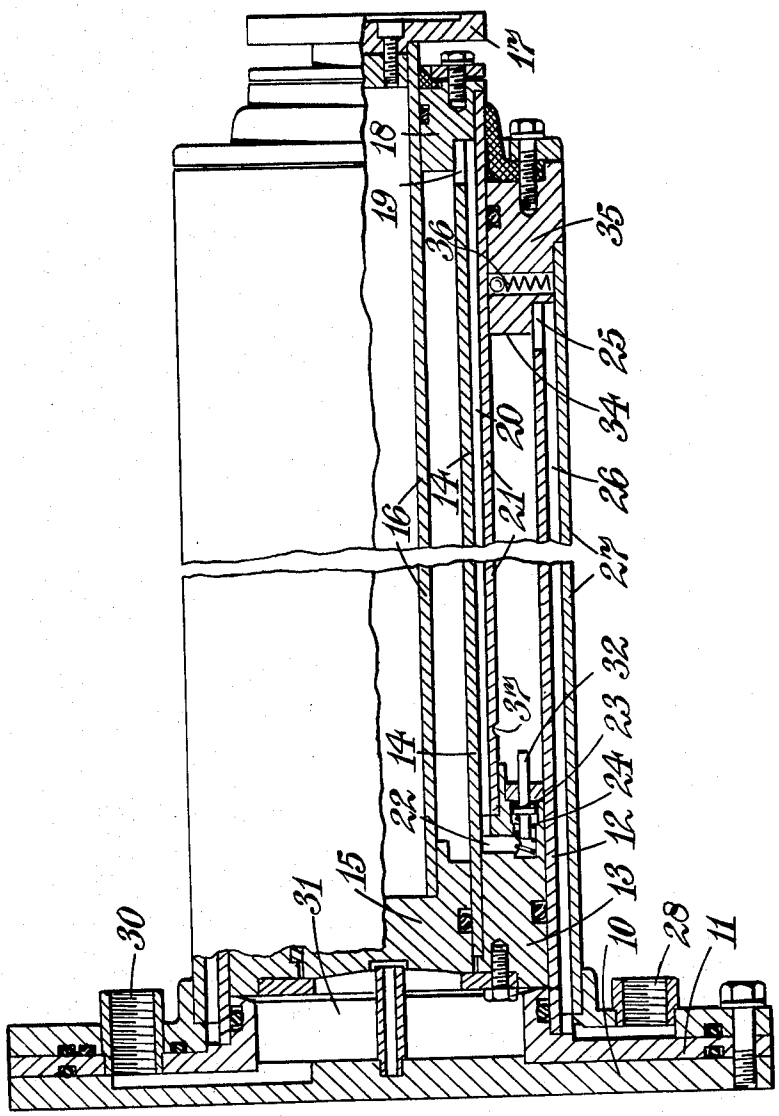
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TWO/STAGE FLUID PRESSURE OPERATED PISTON AND CYLINDER ASSEMBLIES

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TWO-STAGE FLUID PRESSURE OPERATED PISTON AND CYLINDER ASSEMBLIES

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This invention relates to two-stage fluid pressure operated piston and cylinder assemblies, for example hydraulic jacks and rams.

According to this invention, a two-stage double-acting piston and cylinder assembly comprises an inner piston and cylinder with the inner cylinder movable and preferably integral with an outer piston within an outer cylinder, means for applying fluid pressure at one end of the assembly to one face of both pistons in the direction to force the pistons outwardly from said one end, an outlet path for fluid from the other face of the inner piston at the other end of the inner cylinder remote from the said one end through the outer piston into the outer cylinder, and valve means in said outer piston normally closing said outlet path to the passage of fluid but arranged so as to be opened when the outer piston is at the outward limit of its travel and openable also under fluid pressure when pressure is applied to the outer cylinder to return the pistons towards said one end.

With this construction, the valve in the aforesaid outlet path is normally closed so trapping the fluid in the cylinder of the inner piston. The inner piston therefore cannot move in its cylinder and the applied pressure causes the outer piston which carries the inner cylinder to move outwardly, the two pistons moving together. When the outer piston has reached the outward limit of its travel, the valve is opened so permitting the fluid to escape from the inner cylinder and hence allowing the inner piston to move outwardly. The outer piston is thus extended to its full extent first and the inner piston is then extended to its full extent. The movement of the inner piston (which constitutes the operating member to be moved, for example the operating member of a ram or jack) is thus precisely controlled by the amount of fluid forced into the assembly irrespective of any loading or absence of loading on the pistons. If no valve were provided in the manner described above, both the inner and outer pistons would be free to move independently and a condition could arise, for example, where the inner piston could move backwards due to an applied load and in doing so cause the outer piston to move forwards by perhaps a smaller amount without any change in the supply of fluid to the assembly from any external source.

The assembly is double-acting since, by applying fluid pressure to the outer cylinder, the pistons can be caused to retract. Since this fluid pressure opens the valve, the fluid pressure is always applied to both pistons simultaneously.

The above described construction of piston and cylinder assembly finds particular application where it is required to have accurate position control during extension in accordance with the supply of the pressurised fluid. Since the arrangement is double-acting, the pistons can be moved retracted as well as extended by fluid pressure without any external loading.

Most conveniently the valve is mounted on the outer piston at the said one end thereof and has a striker pin which is arranged to strike an abutment at the said other end of the outer cylinder when the outer piston has moved outwardly to its fullest extent, the valve then being forced

open against spring pressure normally holding the valve closed. In this construction the outlet passage from the inner cylinder may be through an outlet port at the said other end of the inner cylinder to an annular region around the inner cylinder within the outer piston, which annular region leads to the valve so that, when the valve is open, the fluid can pass into the outer cylinder. It is most convenient to have the outlet from the outer cylinder at the said one end of the assembly and the outer cylinder may be provided with an outlet port leading to an annular passage around the outer cylinder extending to the said one end of the outer cylinder.

The following is a description of one embodiment of the invention reference being made to the accompanying drawing.

This drawing is a side elevation, partly in section, of a two-stage double-acting hydraulically-operated piston and cylinder assembly.

The base of the assembly shown in the drawing comprises a circular plate **10** to which is sealed an annular member **11** carrying an outer cylinder **12**. Within the outer cylinder **12** is a larger diameter piston **13** carrying an inner cylinder **14** within which is movable an inner piston **15**. The inner piston **15** includes a cylindrical member **16** extending through the length of the assembly and carrying the operating member **17** which is to be moved by this assembly. The tube **16** is slidable within an end plate **18** forming the closure for the inner cylinder, sealing being effected by means of O-ring seals. The inner cylinder is constituted by an annular region between the tube **16** and the cylinder wall **14** and this annular space has an opening **19** forming a port leading into an annular region **20** within the outer piston. This annular region **20** lies between the wall **14** of the inner cylinder, which wall is carried on the outer piston, and a second tubular wall **21** also secured on the aforementioned end plate **18** so that the two members **14** and **21** will move together. At the base end of the tubular member **21**, in the piston **13**, the annular region **20** between the members **14** and **21** leads via a port **22** to a spring-loaded valve **23** which is normally kept closed by means of a helical coil spring **24**. This valve, when open, provides communication between the aforementioned annular region **20** between the members **14** and **21** and the interior of the outer cylinder **12**. The outer cylinder has an outlet port **25** at its outer end which communicates with an annular passage **26** between the cylinder wall **12** and an outer cylindrical wall **27**, which annular passage **26** leads to the base of the assembly and thence to an exhaust port **28**.

To move the pistons outwardly, hydraulic fluid is applied through an inlet port **30** in the base of the assembly, this port **30** leading to a chamber **31** open to the base ends of both pistons. Hence the pressure is applied to one face of both the pistons. Since the valve **23** is normally closed however, no fluid can escape from the inner cylinder and hence the inner piston will remain fixed within the inner cylinder. The application of hydraulic fluid to the inlet port **30** therefore moves the outer piston which carries with it the inner cylinder and inner piston. The outer piston will move to the full extent of its travel whereupon a plunger **32** on the valve **23** strikes against an abutment **34** of the outer end ring **35** of the outer cylinder causing the valve to open against the spring pressure provided by the aforementioned spring **24**. This permits fluid to escape from the inner cylinder so that the inner piston **15** can now move outwardly within the inner cylinder **14**. The fluid escapes from the inner cylinder through the annular region **20** between the members **14** and **21** and through the valve **23** into the outer cylinder and thence through the annular region **26** to the outlet port **28**. The pistons may be retracted by apply-

ing fluid pressure to the port 28. This fluid pressure will pass through the annular region 26 into the outer cylinder and hence will be applied to the valve 23 and will cause it to open against the spring pressure. The pressurized fluid therefore also passes through the valve 23 and the annular region 20 between the members 14 and 21 into the inner cylinder. Pressure is thus applied to both pistons simultaneously causing them to retract together forcing the fluid from the base end of the pistons out through the port 30.

It will be noted that the fluid inlets and outlets for both directions of operation are situated at the base end of the assembly. The assembly forms a double-acting double extension assembly in which the pistons can be pumped down as well as pumped up, no return load being necessary in order to effect return of pistons. By the provision of the valve 23, it is ensured that the outer piston extends first and subsequently the inner piston moves outwardly, the inner piston only starting to move when the outer piston has reached the end of its travel. The outward movement of the member 17 is thus positively controlled in accordance with the amount of fluid entering through the port 30 and is independent of any loading on the assembly.

In the drawing the inner piston assembly comprises the inner piston 15 the cylindrical member 16 and the operating member 17. The inner cylinder and outer piston assembly comprises the cylinder 14, the piston 13, the end plate 18 the wall 21 and the valve 23. The outer cylinder assembly comprises the cylinder 12 the wall 27, the base 11 and the ring 35. These or some of the components of individual assemblies may be formed in one piece for convenience of manufacture.

When the retraction of the member 17 is also required to be positively controlled a catch device may be provided to hold the outer piston 13 in its extended position in the outer cylinder 12 until the inner piston 15 is fully retracted in the inner cylinder 14. The catch device comprises a set of three spring loaded catches 36 (which may be balls, rollers or pins) located symmetrically around the inside face of the ring 35 and bearing on the wall 21. An annular groove 37 is formed on the exterior of the wall 21 adjacent the valve 23 the spring loaded catches 36 engaging the groove 37 when the outer piston 13 is fully extended in its cylinder 12.

When the assembly is fully extended and fluid is introduced into port 28 to retract the pistons 13, 15, the fluid will exert pressure on the ring 13 and the piston 15, and the inner and outer pistons will move as a single unit, being latched by the engagement of the catch 36 with the groove 37. When the piston 15 is fully retracted the pressure of the fluid on the piston 13 overcomes the engagement of the catch and the outer piston 13 retracts within the outer cylinder 12. Provided that the loading on the assembly is insufficient to break the engagement of the catch, the pistons retract in turn, independently of the loading on the assembly and dependent only on the fluid entering through the port 28.

We claim:

1. A two-stage double acting piston and cylinder assembly comprising an inner piston and cylinder, an outer piston and cylinder, the inner cylinder being movable with the outer piston within the outer cylinder, means for applying fluid pressure at one end of the assembly to one face of both pistons in the direction to force the pistons outwardly from said one end, an outlet path for the fluid from the other face of the inner piston at the other end of the inner cylinder remote from said one end through the outer piston into the outer cylinder, and valve means in said outer piston normally closing said outlet path to the passage of fluid, said valve means having valve opening means arranged to be actuated by the outer piston when the outer piston is at the outward limit of its travel; said valve means being openable also under fluid pressure when pressure is applied to the outer cylinder to return the pistons towards said one end.

2. An assembly as claimed in claim 1 wherein the inner cylinder is formed in one piece with the outer piston.

3. An assembly as claimed in claim 1 wherein the said other end of the outer cylinder is provided with an abutment and wherein the valve means is mounted on the outer piston at the said one end thereof and the valve means has spring means normally holding it closed and a striker pin which is arranged to strike the abutment when the outer piston has moved outwardly to its fullest extent, the valve means then being forced open against the pressure of the spring means.

4. An assembly as claimed in claim 3 wherein the outlet path comprises an outlet port at the said other end of the inner cylinder in communication with an annular region around the inner cylinder within the outer piston, which annular region leads to the valve means so that, when the valve means is open, the fluid can pass into the outer cylinder.

5. An assembly as claimed in claim 1 comprising an outlet from the outer cylinder at the said one end of the assembly, and an annular passage around the outer cylinder connecting an outlet port into the outer cylinder at the said other end of the outer cylinder to the said outlet.

6. An assembly as claimed in claim 1 wherein the means for applying fluid pressure to one face of both pistons to force the pistons outwardly from said end comprises an inlet at the said one end of the assembly.

7. A two-stage double acting piston and cylinder assembly comprising an inner piston and cylinder, an outer piston and cylinder, the inner cylinder being movable with the outer piston within the outer cylinder, means for applying fluid pressure at one end of the assembly to one face of both pistons in the direction to force the pistons outwardly from said one end, an outlet path for the fluid from the other face of the inner piston at the other end of the inner cylinder remote from said one end through the outer piston into the outer cylinder, and valve means in said outer piston normally closing said outlet path to the passage of fluid, said valve means having valve opening means arranged to be actuated by said outer piston when the outer piston is at the outward limit of its travel; said valve means being openable also under fluid pressure when pressure is applied to the outer cylinder to return the pistons towards said one end, further comprising a catch device for retaining the outer piston in its extended position in the outer cylinder and disengageable by a force between the outer piston and outer cylinder above a predetermined value.

8. An assembly as claimed in claim 7 wherein the catch device comprises a spring loaded member and socket, one mounted on the outer piston and the other on the outer cylinder for engagement when the outer piston is fully extended in the outer cylinder.

References Cited by the Examiner

UNITED STATES PATENTS

2,079,684	5/1937	Church	92—30 X
2,487,920	11/1949	Celenza	91—169
3,188,917	6/1965	Quayle	91—168

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