Jan. 15, 1952 H. M. STUELAND 2,582,512

MULTISPEED AND MULTISTROKE FLUID PRESSURE APPARATUS

Filed June 7, 1948

FIG. 1

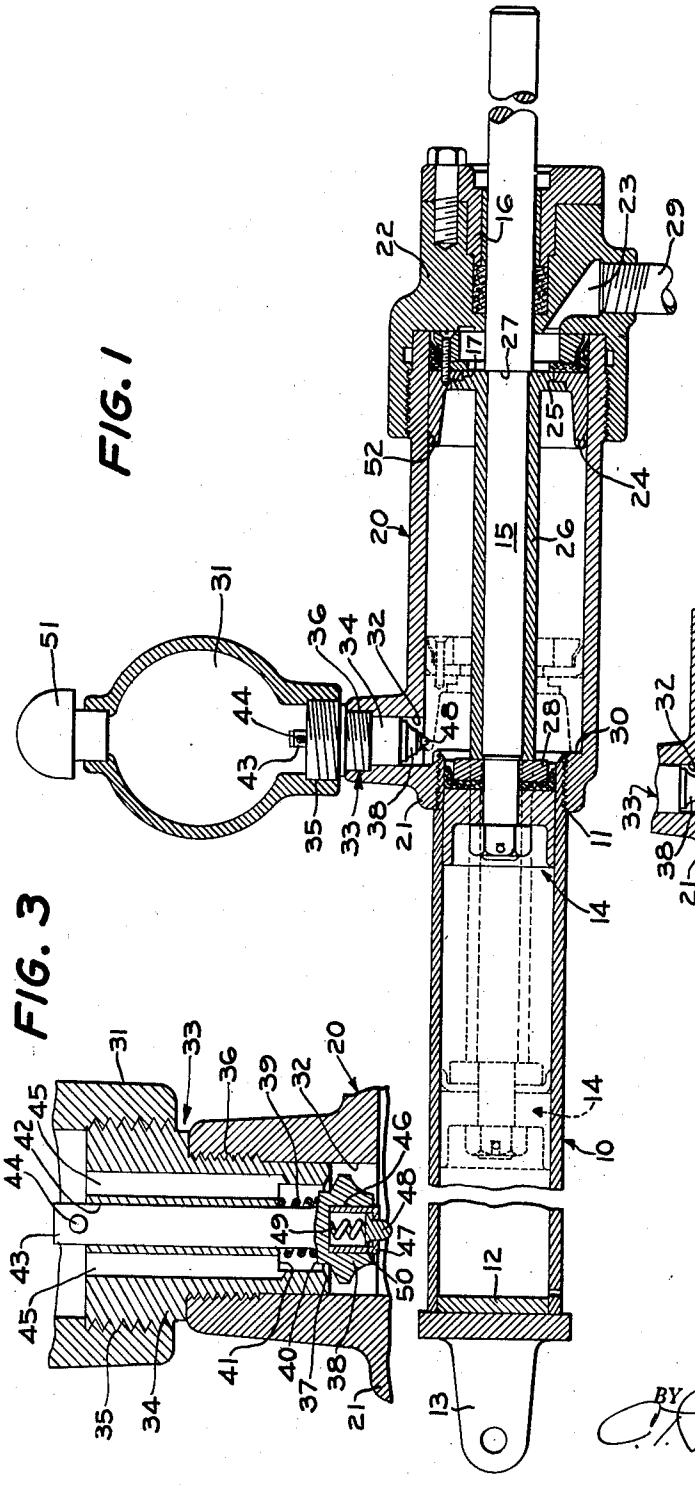


FIG. 2

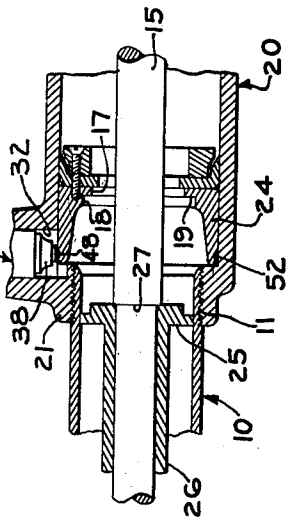


FIG. 3




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## MULTISPEED AND MULTISTROKE FLUID-PRESSURE APPARATUS

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6 Claims. (Cl. 60—97)

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This invention relates to a multi-speed and multi-stroke fluid-pressure apparatus. More particularly, the invention relates to such apparatus as adapted in form to a pair of fluid-pressure cylinders in which one has greater capacity but slower speed than the other.

The invention was developed primarily for use in power loaders, such as those conventionally mounted on agricultural tractors and used on farms for digging and loading manure and other materials. In such arrangement, it is known that the effort required to break loose and initially lift a quantity of material is substantially greater than the effort required to raise the quantity of material at a subsequent stage in the operation. In some instances, the problem has been eliminated by mechanical means providing linkage giving an increased mechanical advantage at the beginning of the digging and lifting operation. Inasmuch as it has become accepted practice to utilize fluid-pressure cylinders as the lifting means in such apparatus, it is desirable that the fluid cylinders be constructed so that they are capable of securing the same advantages as mechanical arrangements already known.

Accordingly, it is a primary object of the invention to provide a multi-speed and multi-stroke fluid-pressure apparatus for the purpose referred to. It is another object of the invention to adapt such apparatus to use in situations other than those involving the specific application referred to. It is a further important object of the invention to provide such apparatus in the form of a pair of cylinders arranged in coaxial end-to-end relationship to provide a compact extensible and retractable unit in which one cylinder has a larger bore and shorter stroke than the other. Still further, it is a feature of the invention to utilize fluid-pressure means for the purpose of supplying fluid pressure to the cylinder having the larger bore and subsequently applying fluid pressure to the cylinder having the smaller bore, whereby the operation is accomplished in the proper sequence; that is to say, using the more powerful cylinder first and the faster cylinder subsequently.

It is an object of the invention to provide a pair of cylinders rigidly connected in coaxial end-to-end relationship with the piston in the cylinder having the larger bore provided with a port normally closed by a portion of the piston in the cylinder having the smaller bore, and to provide means for supplying fluid under pressure to the larger piston whereby both pistons move simultaneously in the same direction until the larger piston is stopped, after which the application of fluid pressure will be directed to the smaller piston to continue the stroke of the smaller piston in the same direction. In this form of the invention, it is a feature to provide an expansion chamber communicating with the cylinder having the larger bore, which chamber serves to absorb fluid that would otherwise be likely to become trapped in the system.

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The foregoing and other desirable objects and important features inherent in and encompassed by the invention will become apparent to those skilled in the art as the disclosure of a preferred embodiment of the invention is made in the following detailed description and accompanying sheet of drawing, in which

Figure 1 is a longitudinal sectional view of the cylinder and piston assembly embodying the invention;

Figure 2 is a fragmentary sectional view of a portion of the structure shown in Figure 1, the pistons being relatively disposed in different positions; and

Figure 3 is an enlarged fragmentary sectional view of the valve means that controls communication between one cylinder and the expansion chamber.

The dual-cylinder apparatus comprises a first cylinder 10 and a second cylinder 20. The cylinders are arranged in coaxial end-to-end relationship, one end of the cylinder 10 being externally threaded at 11 for screw-threaded engagement with an internally threaded portion 21 of the cylinder 20, this means serving to rigidly interconnect the cylinders. The opposite end of the cylinder 10 is closed at 12 and may be provided with a connecting element 13 by means of which the assembly may be connected to either the moving or stationary part of a load-moving structure of the type referred to above, for example. The opposite end of the cylinder 20 includes a closure housing 22 provided with a passage or port 23 by means of which fluid pressure may be admitted to or exhausted from the interior of the cylinder assembly.

The cylinder 10 carries for reciprocation therein a piston member 14, and the cylinder 20 carries for reciprocation therein a piston member 24. The piston 14 is provided with a piston rod 15 which extends axially through the cylinder 20, through the piston 24, and through an appropriately packed bearing 16 in the closure housing 22. The remote or outer end of the piston rod may be suitably connected to either a stationary or a moving part of the load-moving apparatus

in opposition to the connection of the connecting element 13 at the opposite end of the assembly.

The piston 24 is preferably in the form of a flanged cup having its radial wall provided with an aperture or port 17 which is rabbeted at 18 to provide an annular shoulder or seat 19 (Figure 2).

The pistons are normally positioned as shown in Figure 1 and are moved to the left, first in unison, and then the piston 24 is stopped and the piston 14 continues. The means for accomplishing this result includes the port 17 and a closure portion 25 which is here shown as being formed integrally with a longitudinal sleeve 26 fixed to the piston rod 15 between a shoulder 27 on the rod and a collar 28 which abuts the rear face of the piston 14. In the normal position of the parts the portion 25, being circular and conforming to the seat 19 of the port 17, closes the port 17 and is exposed to fluid pressure entering the interior of the cylinder 20 through the passage 23 previously referred to, it being understood that the passage 23 may be connected by any suitable means, such as a conduit 29, to a suitable source of fluid pressure (not shown). Therefore, fluid pressure entering through the passage 23 is applied against the fluid-receivable portions of both pistons 14 and 24, acting through the port 17 against the portion 25 to move both pistons simultaneously in the same direction.

There is provided at the juncture of the cylinders 10 and 20, a shoulder 30 which provides a stop against which the leading edge of the piston 24 abuts, this means thus limiting the stroke or travel of the piston 24. After the piston 24 is thus stopped, the continued application of fluid pressure effects continued movement of the piston 14 in the cylinder 10, the closure portion 25 separating from the seat 19 of the port 17 so that the port 17 provides, in effect, a fluid-pressure passage through which fluid pressure may act on the piston assembly 14. The cylinders 10 and 20 are themselves in fluid-interchange relationship.

The assembly also includes means for the escape or expansion of any fluid or vapor that may accumulate in the cylinder 20 between the pistons 24 and 14. This means takes the form of an expansion chamber 31 connected in communication with the interior of the cylinder 20 by means of a port 32. Opening and closing of the port 32 is controlled by a valve, indicated in its entirety by the numeral 33.

The detailed structure of the valve appears best in Figure 3, wherein it is shown that the valve includes a main body 34 threaded at 35 into the chamber 31 and threaded at 36 into a portion of the cylinder 20 that includes the port 32. The lower portion of the valve body 32 includes a valve seat 37, the communication of which with the chamber port 32 is controlled by a poppet type valve 38 normally held in open position by a coil spring 39. The spring operates between a shoulder 40 on the valve 38 and a shoulder 41 formed as the result of a counterbore in association with a bore 42 axially through the valve body 34 for the purpose of carrying a valve stem 43 formed on and extending upwardly from the head of the valve 38. A stop pin 44 at the upper end of the valve stem 43 engages an upper portion of the valve body 34 to prevent complete escape of the valve 38 downwardly into the cylinder 20. The valve body is provided with a plurality of vertical bores or passages 45 communicating the interior of the chamber 31 with the valve seat 37 and consequently communicating the valve chamber with the chamber port 32 and interior of the cylinder 20.

The lower end of the head of the valve 38 is recessed or drilled at 46 and receives an inverted cup-shaped member 47. The member 47 is preferably connected to the valve 38 by means of a press fit in the recess 46. The bottom or circular flange of the member 47 is apertured to provide for the extension therethrough of a detent member 48 which is spring-loaded by a compression spring 49. The detent member 48 is flanged at 50 to prevent escape thereof from the member 47. The chamber 31 may be vented at the top thereof, as at 51, in any suitable fashion.

The operation of the assembly is as follows: With the parts in the full-line position shown in Figure 1, fluid pressure is introduced through the passage 23 against the fluid-receivable portions of the pistons 14 and 24, the fluid-receivable portion of the piston 14 comprising the circular closure portion 25. Consequently, both pistons 14 and 24 move simultaneously to the left until the piston 24 is stopped by the shoulder 30. Simultaneously with the attainment by the piston 24 of its final position, as shown in dotted lines in Figure 1, and in full lines in Figure 2, the valve means 33 operates to disconnect communication between the chamber 31 and cylinder 30. This result is accomplished by means of engagement between the detent 48 and the piston 24, the latter having an annular groove 52 therein in which the detent member 48 seats. The detent means thus provides releasable means for releasably locking the piston 24 against retrograde movement. In addition, the engagement between the piston 24 and detent 48 moves the valve 38 tightly against the seat 37, the comparative loading on the springs 39 and 49 providing for this result.

With the piston 24 stopped and locked as aforesaid, the continued application of fluid pressure against the portion 25 unseats the portion from the seat 19 on the port 17 and the piston 14 continues to the left. In the use of the assembly with a load-moving apparatus of the character referred to above, it will be seen that increased power and slow speed is obtained during that initial portion of the stroke in which the pistons 14 and 24 move in unison; and that increased speed, but less power, is obtained when the piston 14 moves by itself after the piston 24 has stopped. In the particular arrangement shown, the assembly is of the one-way type; that is to say, fluid under pressure is supplied through the passage 23 to move the pistons forcibly as aforesaid, thus contracting the distance between the connecting element 13 and the part to which the free or remote end of the piston rod 15 may be connected. Restoration of the parts to their normal position is accomplished by exhausting fluid through the passage 23, the pistons returning to their original position as by means of the weight of the load imposed on the assembly. In the case of a power loader, forcible contraction of the assembly will be utilized to raise the shovel to dumping position, after which fluid will be exhausted through the passage 23, and the weight of the shovel in returning to its normal position will effect movement of the pistons 14 and 24 to their original positions.

As previously stated, leakage of fluid past the piston 24 may account for the accumulation of fluid or fluid vapors in the cylinder 20. However, inasmuch as the valve seat 37 is normally uncovered by the valve 38 during movement of the

piston 24 to the left, such fluid or fluid vapors may escape into the expansion chamber 21. Since the piston 24 locks the valve 38 in closed position, continued application of fluid pressure through the passage 23 and port 17 cannot be by-passed into the chamber 31. Similarly, when the piston 14 is returning to the right from its farthermost position to the left, during which phase of operation it will be exhausting fluid pressure through the passage 23, fluid will not enter the chamber 31 but will pass through the port 17 and out through the passage 23. Of course, movement of the piston 14 to the point at which the portion 25 seats again on the seat 19 of the port 17 will not in itself completely exhaust all the fluid in the cylinders; however, when the portion 25 engages the piston 24, the two pistons move as one, and the piston 24 is simultaneously returned to its position at the right hand end of the cylinder 20, exhausting fluid through the passage 23. Any fluid that may remain in the cylinder 20 is between the pistons 14 and 24 and is of a relatively small quantity such that it may be readily transferred to the expansion chamber 31 upon subsequent movement of the piston 24 to the left.

*Summary*

The principal characteristic of the invention is a compact assembly including means for providing a short power stroke and a subsequent speed stroke. It should be understood of course that the proportions of the various parts may be altered to suit patricular situations in which it is desired to use either assembly. The disclosed form of the invention is obviously susceptible to further modifications and alterations, all of which may be made without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. A dual-cylinder fluid motor comprising a pair of coaxial, end-to-end cylinders having their proximate ends open and in fluid-interchange relationship, one of the cylinders having a larger bore than the other, and joint means securing the cylinders together at their open ends, the difference in bores providing at the junction of said open ends an interior annular shoulder; a first piston in the smaller cylinder normally positioned at said shoulder and movable toward and back from the other end of said smaller cylinder; a second piston in the larger cylinder normally positioned in axially spaced relation to said shoulder and movable toward and back from said shoulder; means in the larger cylinder providing a fluid inlet at the side of the second piston remote from said shoulder; means in the second piston providing a fluid port therethrough communicating opposite sides of said second piston; means fixed to the first piston and extending into the larger cylinder and cooperative with the second piston to close said port when both pistons are in said normal positions, said port-closing means presenting a fluid-receivable area to the fluid inlet means to combine with the fluid-receivable area of the second piston, said port-closing means having such external dimensions as to be receivable by the smaller cylinder, whereby fluid admitted to the larger cylinder through said inlet means and against the aforesaid combined areas moves both pistons simultaneously until the second piston is stopped at the annular shoulder, after which admission of fluid through said inlet means effects continued movement of the first piston and port-closing means; and a piston rod connected to the first piston and extending axially outwardly through one end of the motor.



2. The invention defined in claim 1, further chracterized in that: releasable means is provided adjacent the annular shoulder for retaining the second piston in shoulder-proximate position and against retrograde movement until engaged by the port-closing means upon return movement of the first piston and said port-closing means.

3. The invention defined in claim 1, further characterized in that: the port in the second cylinder is circular and concentric on the cylinder axis, and the port-closing means is circular and complementary to said port and has an outside diameter such that said port-closing means slidably fits the smaller cylinder.

4. The invention defined in claim 1, further characterized in that: the piston rod extends from the larger-cylinder side of the first piston; the port in the second piston is centrally located; the piston rod extends freely therethrough and through the end of the larger cylinder remote from said annular shoulder; and the port-closing means is fixed to the piston rod.

5. The invention defined in claim 1, further characterized in that: fluid-expansion means is provided adjacent said annular shoulder, including a passage communicating with the larger cylinder; a normally open valve is provided in said passage so that fluid between the pistons may enter said passage as the second piston approaches said shoulder; and means is provided for cooperation between said valve and the second piston for effecting closing of said valve when the second piston reaches the shoulder.

6. The invention defined in claim 5, further characterized in that: said cooperative means between the valve and second piston includes releasable means for retaining the second piston against retrograde movement until engaged by the port-closing means upon return movement of the first piston and said port-closing means.

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## REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

| Number | Name | Date |
|---|---|---|
| 747,772 | Rickman | Dec. 22, 1903 |
| 834,825 | Logan | Oct. 30, 1906 |
| 851,277 | Clark | Apr. 23, 1907 |
| 2,451,089 | Hunter | Oct. 12, 1948 |
| 2,464,962 | Bent | Mar. 22, 1949 |
| 2,465,714 | Elliott | Mar. 29, 1949 |
| 2,470,074 | Manning | May 10, 1949 |

FOREIGN PATENTS

| Number | Country | Date |
|---|---|---|
| 479,434 | France | Jan. 4, 1916 |
| 530,834 | France | Oct. 11, 1921 |