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FLUID POWER ACTUATOR

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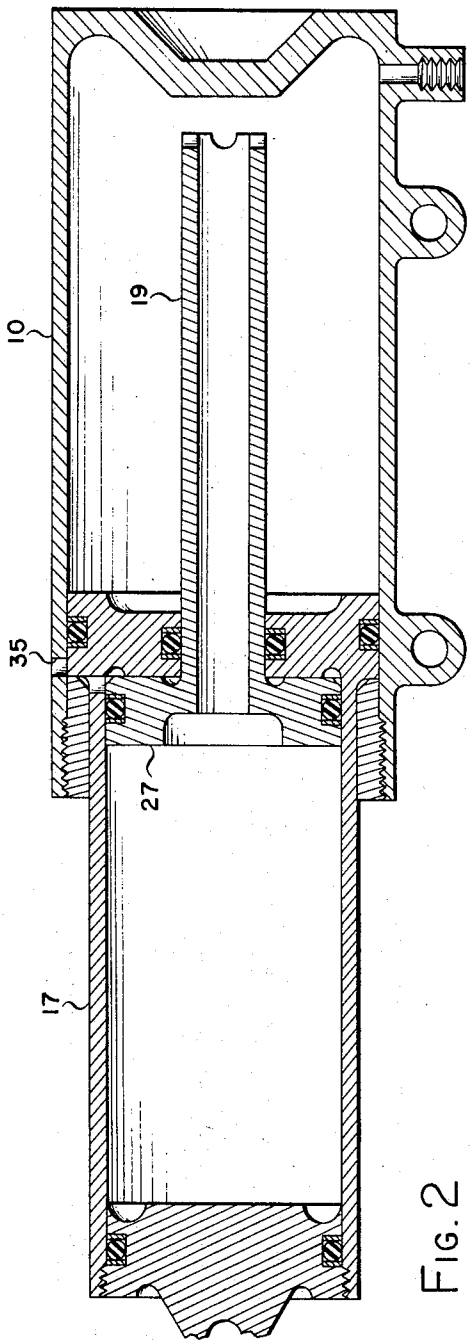


FIG. 2

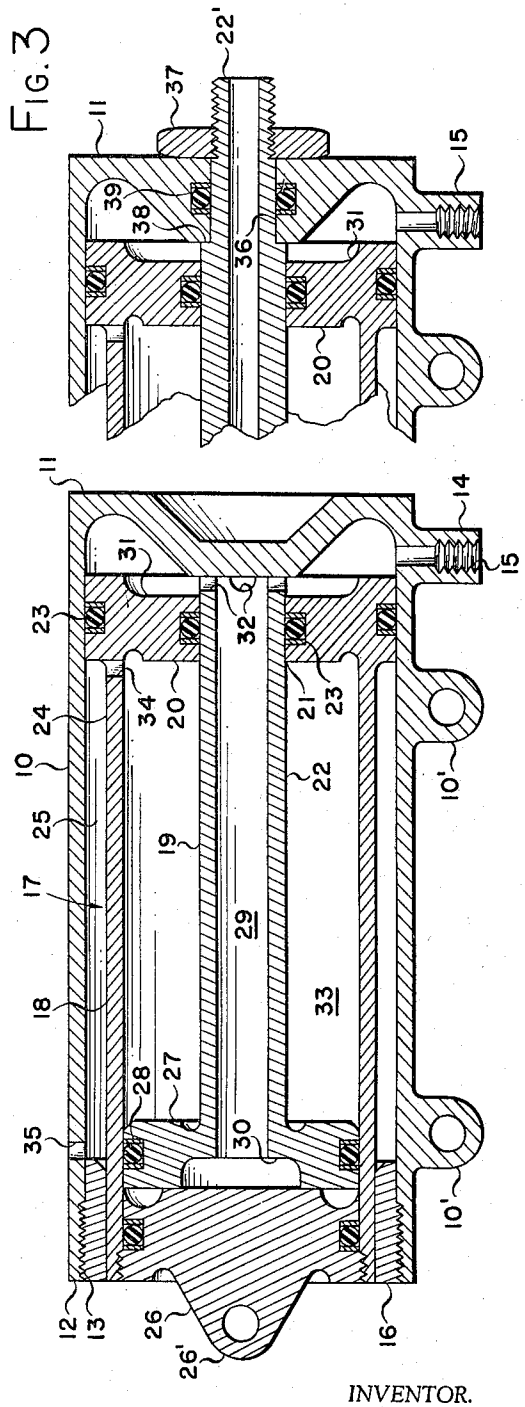


FIG. 3

FIG. 1

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FLUID POWER ACTUATOR

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ABSTRACT OF THE DISCLOSURE

A short, compact double cylinder is provided which consists of a piston within a piston and its cylinder. The inner piston is moved by the main piston at one end of its stroke to reduce the effective force of the main piston. This results in a stepped output force and by predesigning the relative lengths of the piston, the location of the step is established.

This invention relates to power actuators and more particularly to a fluid power actuator having multiple axially aligned surfaces against which the fluid pressure acts concurrently whereby to apply a greater effective force on the associated external load than conventional actuators of comparable dimensions.

The underlying purpose of the present invention is to produce an improved fluid power actuator with respect to size and weight both of the actuator per se and the associated apparatus necessary for its operation without any attendant loss in its performance, reliability and service. Thus, by constructing the actuator with multiple axially aligned surfaces that are interconnected one with another and arranged to receive fluid pressure in unison a compact, composite structure is obtained that is the full equivalent of substantially larger, heavier and more complex actuators constructed according to known prior art teachings. At the same time, the larger and/or multiple components of the system associated with and necessary for the proper operation of these prior actuators are avoided.

In many applications, fluid actuators are required to apply an appreciably greater force in one direction than in the other. In such applications external forces (which may be simply the pull of gravity with or without the help of a load or the dynamic forces of fluid pressure as in the case of the currents which act on the control surface of air and water craft) acting on the load impose a substantial resistance to the movement thereof against these forces while assisting in the reverse movement. While fluid actuators have been heretofore designed to take advantage of gravity, for example hydraulic jacks which apply a lifting force to the load and little or no downward force because of gravity assistance, these are often objectionable in that they are necessarily large and heavy, in order to provide a sufficiently large surface area against which fluid pressure may react to obtain the required force. In order to overcome this, resort has been had to dual actuators, i.e., actuators arranged in tandem or parallel. In those applications where length is a critical factor, parallel units have been employed; and where the transverse dimension is critical, tandem units have been used. In each case these parallel or tandem actuators

satisfy the space requirement but necessarily result in heavier and more complex mechanisms.

In addition, there are cases where an appreciably greater force is required for a portion of the total actuator stroke than for the balance thereof. Following the normal practice, the greater force is produced throughout the stroke so that to some extent the actuator is overpowered. This results in undue actuator structure, the addition of dampening means and oversized associated components such as fluid accumulators, pumps, etc.

It is, therefore, to the above applications where size and/or weight is an important or critical factor that this invention is primarily directed. To this end a short, compact fluid actuator of relatively small diameter having a comparatively powerful stroke is proposed. Generally stated, the actuator herein proposed is so formed as to produce an effective area to receive fluid pressure for its extension and/or contraction in a short, powerful stroke as compared with other actuators of the same size and dimensions.

This increase of power also allows for an actuator construction, i.e., arrangement and geometry, that may be tailored to applications requiring a stepped output force. Thus, by design the actuator automatically operates in separate and distinct stages whereby the force applied thereby is matched to the load requirements resulting in an optimum sized actuator and associated equipment necessary for its operation.

With the above and other objects in view as will be apparent, this invention consists in the construction, combination and arrangement of parts all as hereinafter more fully described, claimed and illustrated in the accompanying drawings wherein:

FIGURE 1 is a longitudinal section taken through a fluid actuator designed and constructed in accordance with the teachings hereof disposed in its fully contracted position;

FIGURE 2 is a similar view of the actuator disposed in the fully extended position; and

FIGURE 3 is a fragment of the stationary end of the actuator to show a modification thereof to accommodate dual fluid pressure sources.

Referring more particularly to the drawings, **10** designates a cylindrical housing closed at one end **11** and open at the other end **12** which is internally threaded as at **13**. Appropriate attachment means, for example in the form of lugs **10'**, are provided on the housing **10** to facilitate anchoring it to suitable stationary structure with which it is to be associated. Adjacent its inner or closed end **11** the housing **10** is formed or otherwise provided with a radially projecting boss **14** pierced centrally by an internally threaded passage **15** constituting an inlet and return port for pressurized fluid from and to a suitable source within a system to be connected thereto in a conventional manner. Threadably secured to the threads **13** of the outer or open end **12** of the housing **10** is a bearing sleeve **16** which thereby establishes and defines the outer end opening thereof.

Mounted within the housing **10** is a piston assembly **17** comprising a first outer piston **18** and a second inner piston **19** freely reciprocable therein. The outer piston **18** is formed at its inner end (with respect to the housing **10**)

with a head 20 having an outside diameter substantially equal to the internal diameter of the housing 10 and adapted for sliding coaction therewith. The head 20 is pierced centrally with an opening 21 for the passage therethrough of a stem 22 substantially equal in overall diameter to the opening 21 and constituting an integral part of the piston 19. The peripheral surfaces of the head 20 adjacent the housing 10 and stem 22 are each grooved to accommodate a standard seal, for example an O-ring/backup washer combination 23.

Extending outwardly of the housing 10 from the head 20 is a cylindrical wall 24 having an outside diameter substantially equal to the inside diameter of the sleeve 16 adapted for sliding coaction therewith and to establish a space 25 between the wall 24 and housing 10. At its outer end the cylindrical wall 24 is closed by a transverse wall 26 which is designed to be disposed proximate the plane of the housing end 12 when the head 20 abuts the housing end 11. This wall 26 comprises a plug threadably secured in the outer end of the cylindrical wall 24 with a conventional seal similar to O-ring/backup washer 23 operatively installed in its peripheral surface. A clevis or eyebolt 26' is formed on or otherwise connected to the outer surface of the wall 26 to facilitate its mounting to the load.

The inner piston 19 is formed at its outer end (with respect to the housing 10) with a head 27 having an outside diameter substantially equal to the internal diameter of the wall 24 for sliding coaction therewith. The peripheral surface of the head 27 is grooved to accommodate a standard seal such as an O-ring/backup washer combination 28. Centrally the piston head 27 is integral with or otherwise secured to the outer end of the stem 22 and the head 27 and stem 22 are pierced by a bore 29. The outer face of the head 27 is additionally recessed centrally as at 30 to dispose the end of the bore 29 in spaced relation to the wall 26. The length of the stem 22 is such that when its inner end abuts the housing end 11 the outer face of the piston head 27 contacts the adjacent surface of the wall 26 when the piston 18 is fully disposed within the housing 10 with its head 20 abutting the housing wall 11. The inner face of the piston head 20 is recessed centrally to create a space 31 when thus disposed in the housing 10 and the end of the stem 22 located within this space 31 is provided with one or more radial ports 32 to establish communication between the passage 15 and the interior of the stem 22.

In view of the foregoing construction and arrangement it is apparent that the pistons 18 and 19 divide the housing 10 into four chambers, the first being the space 31, the second being the space 30, the third being the space 25, and a fourth, annular chamber 33 defined by the piston heads 20 and 27 and the wall 24 and stem 22. The spaces or chambers 30 and 31 are connected in constant fluid communication by the ports 32 and bore 29, and fluid under pressure from an associated system may be supplied to them through the passage 15 whereby such fluid pressure concurrently acts on the inner faces of piston head 20 and the wall 26 extending the outer piston 18 from the housing 10. One or more vent openings 34 are provided in the wall 24 of the piston 18 adjacent its head 20 to permit the escape of fluid during such operation from the chamber 33 to the space 25 where it is vented to atmosphere through an opening 35 in the wall of the housing 10 adjacent the sleeve 16.

The forced extension of the piston 18 constitutes the initial stage of the total operation of the actuator whereby the entire fluid pressure is applied to the piston 18. When the head 20 of the piston 18 contacts the head 27 of piston 19, the piston 19 is forced outward constituting a second stage of the actuator operation. During this stage of the operation the stem 22 is no longer in abutment against the housing wall 11 so that the reaction force to the movement of the piston 18 is no longer resisted thereby and the effective force of the fluid pressure on the piston 18 is reduced accordingly. Thus, by predetermined design the length of the stem 22 relative to the length of the housing 10 may be established to give the desired stepped output force of the actuator.

Conversely, retraction of the outer piston 18 into the housing 10 may be accomplished by an external force such as gravity and/or external load assistance applied to the outer end or wall 26 thereof in which case fluid within the chamber 30 is vented through bore 29, ports 32, chamber 31 and passage 15. Where power retraction is desired, i.e., a double stroke actuator, the vent opening 32 is adapted to receive an appropriate fitting whereby it is connected to a source of fluid of a conventional system whereby fluid pressure is delivered through the space 25, each vent 34 and into the chamber 33 to act against the outer face of the piston head 20 in opposition to the piston head 27 whereby the outer piston 18 is contracted into the housing 10. In this case fluid within the chamber 30 is vented through bore 29, ports 32, chamber 31 and passage 15 as previously stated.

FIGURE 3 shows a slightly modified form of the invention whereby the actuator herein proposed is adapted to receive fluid pressure from two sources. This has the added advantage of power cylinder reliability with tandem cylinders' transverse dimension without tandem cylinders' objectionable length. In short, this modified form of the invention permits dual pistons in a short cylinder where each system shares the load and a failure of one system reduces the load capability but does not eliminate the actuator as an operating unit.

In this form of the invention no radial ports 32 are provided in the stem 22 of the inner piston 19 which is extended to pass through an opening 36 provided therefor in the housing wall 11 to which it is immovably secured by a nut 37 operative on the external end 22' thereof in opposition to a shoulder 38 formed on the stem 22. The circumferential face of the wall 11 defining the opening 36 therein is grooved to accommodate a seal such as, for example, an O-ring/backup washer combination 39 to prevent fluid leakage therethrough. The external end 22' of the stem 22 is adapted to receive a standard fitting for the connection of an appropriate pressurized fluid system thereto. Thus, fluid pressure is available through the external end 22' to act on the wall 26 concurrently with fluid pressure through the passage 15 for action against the inner face of piston head 20. The several seals as shown or their equivalent as well as additional seals following conventional practice are employed to ensure isolation of the individual fluid systems as applied to the actuator in the manner hereinabove described.

While particular embodiments of the invention are herein illustrated and described, various changes and modifications thereto will appear to those skilled in the art. The appended claims, therefore, are intended to cover all such modifications and equivalents that fall within the true spirit and scope of the invention.

What is claimed is:

1. A fluid power actuator comprising:

a cylindrical housing open at one end;

a piston assembly reciprocably mounted within said housing for extension and retraction through said open end,

said piston assembly including a pair of pistons each movable relative to said housing and to each other and one of said pistons having multiple axially aligned surfaces exposed to pressurized fluid entering the other end of said housing; said one piston includes a head defining a surface, a cylindrical wall extending from one side of said head through said open end, and an end wall defining another surface closing the outer end of said cylindrical wall; said other piston includes a head slidable on and within said cylindrical wall, a seal between said other piston head and said cylindrical wall, and a

stem extending from said other piston head for abutment with said other end of the housing; said other piston further includes a fluid passage for exposing said other surface to the same fluid pressure as said first surface;

fluid inlet means in said housing in communication with said surfaces; and

a port in said housing in opposition to and isolated from said surfaces.

2. The actuator of claim **1** including an opening piercing said one piston head, and a hollow stem projecting from one side of said other piston head and passing through said opening for abutment against the end wall of said housing.

3. The actuator of claim **2** wherein said stem has a predetermined length shorter than that of said one piston whereby said stem is located in spaced relation with said housing end wall when the piston assembly is fully extended as aforesaid.

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