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POWER-OPERATED HYDRAULIC ACTUATOR

Filed Dec. 22, 1945

2 SHEETS—SHEET 1

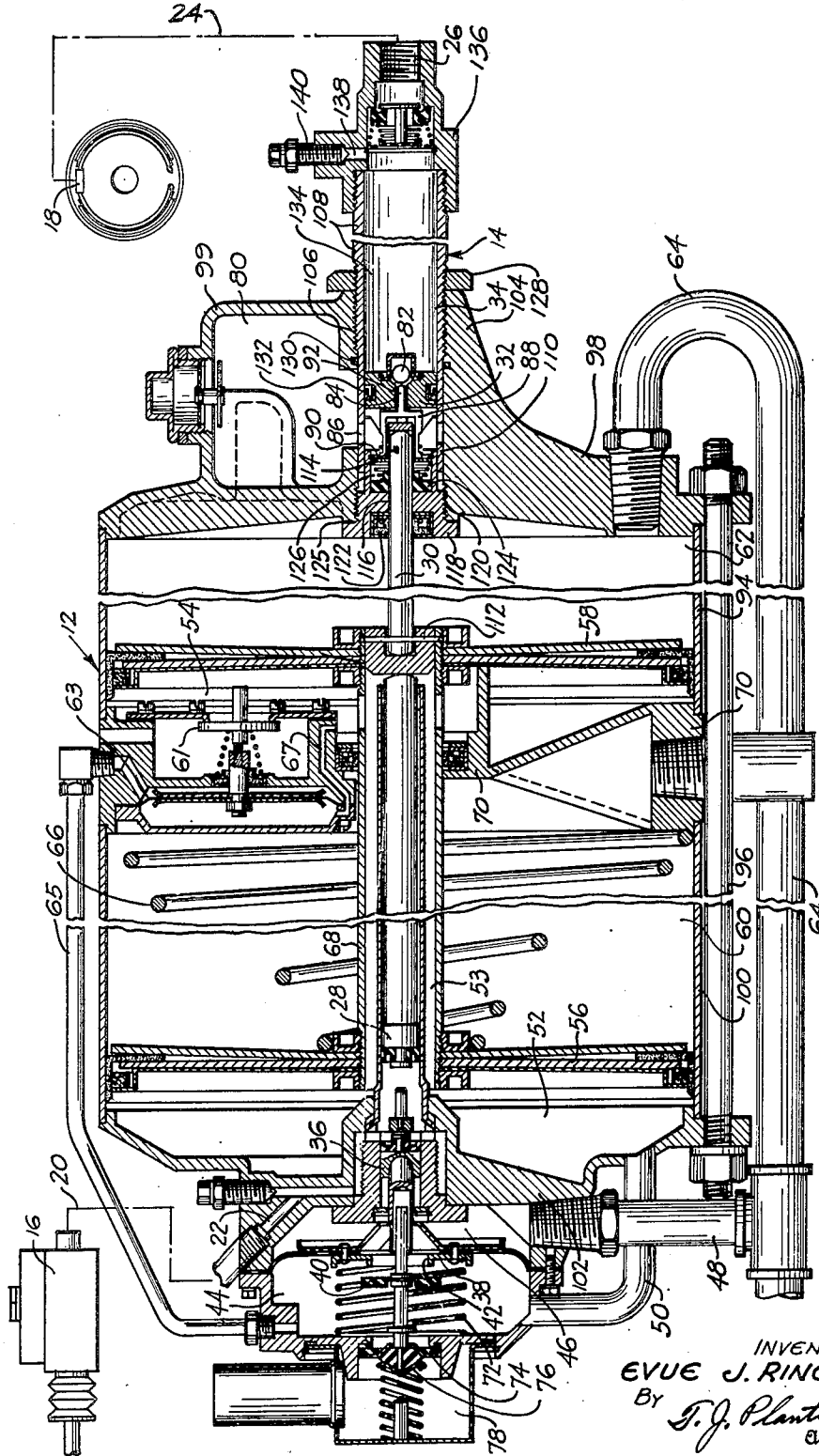


Fig. 1.

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2 SHEETS—SHEET 2

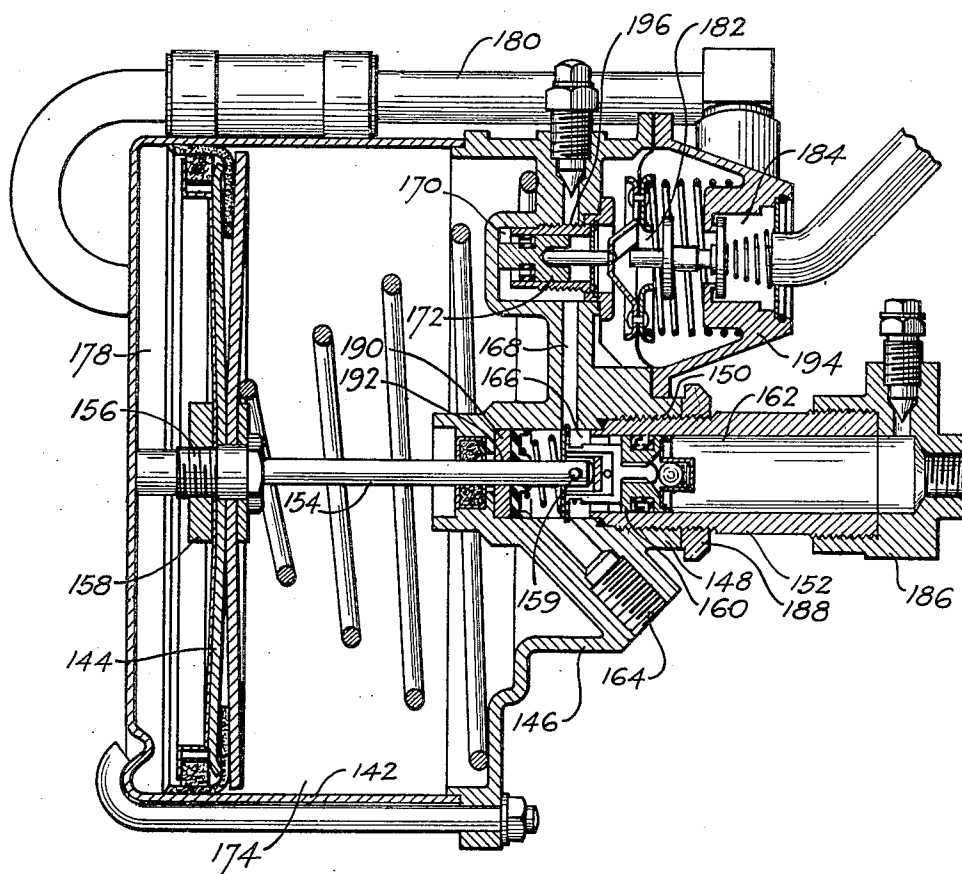


Fig. 2.

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POWER-OPERATED HYDRAULIC ACTUATOR

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9 Claims. (Cl. 60—54.6)

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This invention relates to power operated hydraulic actuators and particularly to the construction of a combined differential air pressure power unit and hydraulic cylinder operated thereby, such as disclosed in Price Patent No. 2,353,755, which issued July 18, 1944. Reference is also made to my co-pending divisional application Serial No. 293,795, filed June 16, 1952.

The primary object of the present invention is to improve and simplify the construction of such a combination power unit and hydraulic actuator, to the end of reducing the expense of building the same, particularly by making it easier to machine the bore of the hydraulic actuator, and by reducing the amount of waste or scrap material.

A further object of the present invention is to simplify the assembling of the combined power unit and hydraulic actuator.

Other objects and advantages will become apparent during the course of the following description, reference being had therein to the accompanying drawings, in which:

Figure 1 is a vertical section taken through a combined power unit and hydraulic actuator embodying my invention, the remaining elements of an illustrative pressure transmitting system being shown diagrammatically; and

Figure 2 is a vertical section taken through a second embodiment of my invention.

Referring to Figure 1 the structure with which I am primarily concerned is the combination of the differential air pressure power cylinder indicated generally at 12 and the hydraulic actuator indicated generally at 14, said hydraulic actuator being operable by the power unit 12. The complete system, which may be used to control the application of brakes or the like, includes a conventional master cylinder 16, a plurality of conventional wheel cylinders 18, a conduit 20 connecting master cylinder 16 to a port 22 provided in the combination power and hydraulic unit, and conduits 24 connecting the wheel cylinders to a port 26 also provided in the combination power and hydraulic unit.

Pressure developed in the manually operated master cylinder 16 acts on piston 28 to develop a force acting through rod 30 on piston 32, which is reciprocable in the bore 34 of hydraulic actuator 14. The pressure developed in the master cylinder 16 also acts against a valve-operating-piston 36 which is connected to a valve-seat-providing-member 38. A valve member 40 is adapted to cooperate with valve seat 38 to control the opening 42 provided in the center of said valve seat. In the released position of the

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system, valve member 40 is spaced from its seat and aperture 42 therefor permits communication between chamber 44 and chamber 46. Because chamber 46 is connected by means of conduit 48 with a suitable source of vacuum, such as the usual intake manifold, while chamber 44 is connected by means of conduit 50 with chamber 52 of the power cylinder, which in turn is connected by passage 53 with chamber 54 of the power cylinder, the rear surfaces of tandem pistons (or pressure responsive movable members) 56 and 58 are normally subjected to vacuum. Chambers 60 and 62, which are in front of the respective pistons 56 and 58, are connected by means of conduit 64 to the vacuum source. Therefore, when the valve members 38 and 40 are in the relative positions shown, vacuum is present on both sides of both power pistons and spring 66 holds the tandem piston combination in the leftward position, as shown, the power pistons being interconnected by means of the tube 68. A sealed partition 70 prevents communication between chambers 54 and 60 of the power cylinder.

When the pressure acting against piston 36, tending to move the same toward the left, is sufficient to compress spring 72, valve seat 38 contacts valve element 40, thereby cutting off communication between the vacuum source, on the one hand, and chambers 52 and 54 of the power cylinder, on the other hand. Further movement of piston 36 towards the left lifts valve members 74 and 76 from their respective seats, thereby permitting air to flow from chamber 78 into chamber 44 and thence to chambers 52 and 54 of the power cylinder, developing a differential over the power cylinder pistons to move the same toward the right. The force exerted by the power cylinder pistons through rod 30 urges piston 32 in hydraulic actuator 14 on its pressure stroke, the total output of the hydraulic actuator being developed by the combined effort of the power cylinder pistons and of the manually created pressure acting against piston 28.

A fast application valve corresponding to that disclosed in T. H. Thomas application Serial No. 623,832, filed October 22, 1945, now abandoned, may be used to speed the change of pressure in power cylinder chamber 54. This valve includes poppet 61 and diaphragm 63 connected thereto. The chamber at the right of the diaphragm is connected by means of conduit 65 with chamber 44 of the control valve, and the chamber at the left of the diaphragm is connected by means of passage 67 with chamber 54 of the power cylinder. Operation of the fast application valve is

fully explained in the Thomas application above referred to.

In the released position of piston 32, communication is permitted between the bore 34 of actuator 14 and the hydraulic reservoir 80, fluid being allowed to flow past ball check valve 82, and through passage 84 to the rear of piston 32, whence it communicates through opening 86 with the reservoir. During the pressure stroke of the power pistons 56 and 58, the ball valve 82 cuts off the passage 84 because of the removal of pressure exerted on forked member 88 by washer 90, which in released position causes the forward extension 92 of said forked member to hold the ball valve away from its seat.

The present invention is primarily concerned with the construction of the front or right end of power cylinder 12 and the hydraulic actuator 14 which is supported thereon. In general, power cylinder 12 comprises a cylindrical shell 94, to which is secured by suitable means, such as a plurality of bolts 96, an end plate 98. In the illustrated power cylinder, because it is designed to use a tandem piston construction, a second shell 100 is provided, separated from the shell 94 by the aforementioned partition 70. At the rear of shell 100 a suitable end plate 102 is provided, which supports the structure of the control valve.

The shells 94 and 100 may be conveniently formed by a deep drawing process wherein the wall portion is gradually forced outwardly until the cylindrical shape is assumed. End plate 102, partition 70, and end plate 98 are all formed by casting, because of the relatively intricate shape of these parts.

The casting 98 which provides the front end plate of the power cylinder has formed integral therewith the reservoir casing 99. Also integral with the end plate 98 is an outwardly extending sleeve or hollow boss 104 which is internally threaded as shown at 106. Screwed into sleeve 104 is a tubular member 108 which may be simply a piece of conventional tubing provided with suitable externally threaded portions, and internally machined to obtain the proper wall finish for the hydraulic bore 34.

The inner end 110 of tube 108 is suitably guided in casting 98, and the opening 86 is formed in the wall of the tube.

The power piston 58 is connected by means of the cross-pin 112 to the rod 30, the front end of said rod being connected by means of a cross-pin 114 with the piston 32. The rod 30 extends through an opening 116 provided in a closure member or plug 118 which is inserted in an opening 120 provided through the center of casting 98. Suitable seals 122 and 124 and a gasket 125 are provided to prevent communication between chamber 62 of the power cylinder and chamber 126 at the rear of the hydraulic actuator.

The tube 108, after it has been screwed into the threaded opening provided in sleeve 104, is secured in position by means of a lock nut 128. A suitable seal 130 is required to prevent escape of liquid from the reservoir 80 along the outer surface of the tube 108, and the usual seal 132 is provided to prevent communication between chamber 134 of the hydraulic actuator and chamber 126 thereof, except through passage 84 in piston 32.

Secured to the forward end of tube 108, as by the illustrated threaded connection, is a fitting 136, which contains the port 26, into which the end of conduit 24 may be inserted, the fitting

136 also containing a bleed opening 138 normally closed by plug 140.

The combination of a power cylinder end plate having an integral sleeve with a tubular member secured in said sleeve and machined to form a cylinder bore has certain important advantages over power operated hydraulic actuators heretofore used: (1) the walls of tube 108 are less likely to have objectionable porosity than the walls of a cast cylinder; (2) the tubular member 108 is easier to handle during machining of the hydraulic bore than a casting would be; and (3) if, for any reason, the bore of the hydraulic actuator proves to be unfit, only the tube need be scrapped and the rest of the parts are not affected. The significance of the listed advantages is due to the fact that the critical part of a combination unit of this type is the bore in which the hydraulic piston operates. The requirements as to the other parts of the structure are not so critical and do not require such careful handling and inspection.

An additional advantage of the present invention lies in the ease with which the structure may be assembled. Heretofore it would have been extremely difficult to assemble a hydraulic piston having a direct mechanical connection with the operating rod, such as that provided by pin 114. Such a direct mechanical connection between the power piston and the hydraulic piston is advantageous because the power cylinder return spring retracts the hydraulic piston, and there is no need for an additional return spring in the hydraulic actuator. With the present construction, after the power cylinder has been assembled, and the end plate 98 secured thereto, the power piston assembly may be drawn toward the right by applying suitable pressure thereto, thus causing the end of rod 30 to protrude beyond the casting 98. It is relatively simple to connect piston 32 to the protruding end of rod 30 by means of pin 114, and then slide tube 108 over piston 32 and screw the tube into position in member 98.

Figure 2 illustrates the application of the principles of my invention to a smaller unit having a single-piston power cylinder. In this construction, the power cylinder may consist primarily of a cup-shaped stamped shell 142 which contains a power piston (or pressure responsive movable wall) 144, and to the front end of which is secured a casting 146. The casting 146 is provided with a forwardly extending sleeve or hollow boss 148 which is internally threaded as shown at 150 to receive the externally threaded tubular member 152. Rod 154 is provided with a threaded portion 156 and may thus be clamped by means of nut 158 to power piston 144. At its forward end rod 154 is secured by means of pin 159 to piston 160, which is reciprocable in the bore 162 provided in tubular member 152.

Because port 164 is connected directly to the operator operated master cylinder, there is no need for a reservoir in this construction. Port 164 is connected through chamber 166 and passage 168 with the chamber 170, in which is located valve operating piston 172. Chamber 174 of the power cylinder is in constant communication with the vacuum source through a suitable port (not shown), and, in released position of the unit, chamber 178 of the power cylinder is also connected to the vacuum source through conduit 180 and port 182 of the valve. Movement of piston 172 under the influence of pressure developed in the operator operated master cylinder first cuts off chamber 178 from the vacuum

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source and subsequently brings it into communication with the air which enters through chamber 134, thereby causing the power piston to travel toward the right and move piston 160 on the pressure stroke. The manually developed pressure present in chamber 165 acts against the rear of piston 160 to assist the power piston in developing brake applying effort.

As in the embodiment shown in Figure 1, a suitable fitting 186 is secured to tube 152 at the outer end thereof, a lock nut 188 is used to secure tube 152 in position, and a suitable plug or closure member 190 is used to close the centrally located opening in end plate 146, except for the hole 192 through which the rod 154 extends.

It will be apparent that the casting 146 not only provides an end plate for the power cylinder and a sleeve to receive the tubular member 152, but also furnishes part of the casing of the control valve, the casting 194 being secured thereto to complete the valve housing. In order to provide a bore for valve operating piston 172, a sleeve 196 may be secured in place in casting 146, as shown.

Although particular embodiments of my invention have been described, it will be understood by those skilled in the art that the object of the invention may be attained by the use of constructions different in certain respects from those disclosed without departing from the underlying principles of the invention. I therefore desire by the following claims to include within the scope of my invention all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cup-shaped shell for said power unit, a power piston reciprocable in said shell, an end plate secured to one end of said shell having an opening through the center thereof and having an integral hollow internally threaded boss concentric with said opening and extending outwardly from the end plate, an externally threaded tube secured in said boss and providing a hydraulic master cylinder bore, a housing member secured to said end plate eccentrically located with respect to the end plate center and forming together with the end plate the casing of a control valve, a piston reciprocable in the hydraulic master cylinder bore, a rod secured to the power piston, a cross-pin connecting said rod to the hydraulic piston, a closure member closing the centrally located opening through the end plate except for a hole which accommodates the aforementioned rod, a lock-nut screwed onto said threaded tube and resting against the outer end of the hollow boss to retain the threaded tube in position, and a fitting secured to the outer end of the tubular member and adapted to receive the end of a liquid-carrying conduit.

2. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cylindrical shell for said power unit, a pressure responsive movable wall reciprocable in said shell, an end plate secured to one end of said shell having an integral internally threaded sleeve extending outwardly therefrom, a control valve casing on said end plate and offset to one side of said sleeve, an externally threaded tube secured in said sleeve and providing a hydraulic master cylinder bore, a piston slidably received in said bore, means connecting said piston to the aforementioned pressure responsive movable wall,

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a lock-nut screwed onto said tubular member and resting against the hollow end of the sleeve to retain the tubular member in position, and a bleed port provided in said tube and fixed in a predetermined position by means of the cooperative relationship between the lock-nut and the connection between the tube and the end plate.

3. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cylindrical shell for said power unit, a pressure responsive movable wall reciprocable in said shell, an end plate secured to one end of said shell having an integral internally threaded sleeve extending outwardly therefrom, a control valve casing on said end plate and offset to one side from said sleeve, an externally threaded tube secured in said sleeve and providing a hydraulic master cylinder bore, a piston slidably received in said bore, and means connecting said piston to the aforementioned pressure responsive movable wall.

4. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cylindrical shell for said power unit, a pressure responsive movable wall reciprocable in said shell, an end plate mounted on one end of said shell having an integral internally threaded sleeve extending outwardly therefrom, a control valve casing integral with said end plate and offset to one side of said sleeve, a plurality of bolts extending longitudinally from the end plate to the rear of the power unit to retain said end plate in tight engagement with the front of the shell, an externally threaded tubular member secured in the end plate sleeve and providing a hydraulic master cylinder bore, a piston slidably received in said bore, means connecting said piston to the aforementioned pressure responsive movable wall, and a lock nut screwed onto said tubular member and engaging the outer end of the end plate sleeve to retain the tubular member in position.

5. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cylindrical shell for said power unit, a pressure responsive movable wall reciprocable in said shell, an end plate mounted on one end of said shell having an integral internally threaded sleeve extending outwardly therefrom, a control valve housing on said end plate at a location offset to one side of said sleeve, a first bleed outlet in said housing, a plurality of bolts extending longitudinally from the end plate to the rear of the power unit to retain said end plate in tight engagement with the front of the shell and to locate said bleed port in a predetermined position, an externally threaded tubular member secured in the end plate sleeve and providing a hydraulic master cylinder bore, a piston slidably received in said bore, means connecting said piston to the aforementioned pressure responsive movable wall, a lock nut screwed onto said tubular member and engaging the outer end of the end plate sleeve to retain the tubular member in position, a second bleed outlet for said bore and securely located on the same side of said bore as said first bleed outlet by means of said lock-nut and the connection between said sleeve and said externally threaded tubular member, and a fitting secured to the outer end of the tubular member and adapted to receive the end of the liquid-carrying conduit.

6. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cup-shaped shell for said power

unit, a power piston reciprocable in said shell, an end plate secured to one end of said shell having an opening therethrough and having an integral hollow internally threaded boss concentric with said opening and extending outwardly from the end plate, an externally threaded tube secured in said boss and providing a hydraulic master cylinder bore, a housing member secured to said end plate eccentrically located with respect to the end plate center and forming together with the end plate the casing of a control valve, a piston reciprocable in the hydraulic master cylinder bore, a rod secured to the power piston, a cross-pin connecting said rod to the hydraulic piston, a closure member closing the opening through the end plate except for a hole which accommodates the aforementioned rod, a lock-nut screwed onto said threaded tube and resting against the outer end of the hollow boss to retain the threaded tube in position, and a fitting secured to the outer end of the tubular member and adapted to receive the end of a liquid-carrying conduit.

7. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cup-shaped shell for said power unit, a power piston reciprocable in said shell, an end plate secured to one end of said shell having an opening therethrough and having an integral hollow internally threaded boss concentric with said opening and extending outwardly from the end plate, an externally threaded tube secured in said boss and providing a hydraulic master cylinder bore, a housing member secured to said end plate eccentrically located with respect to the end plate center and forming together with the end plate the casing of a control valve, a piston reciprocable in the hydraulic master cylinder bore, a rod secured to the power piston, a closure member closing the opening through the end plate except for a hole which accommodates the aforementioned rod, a lock-nut screwed onto said threaded tube and resting against the outer end of the hollow boss to retain the threaded tube in position, and a fitting secured to the outer end of the tubular member and adapted to receive the end of a liquid-carrying conduit.

8. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cup-shaped shell for said power unit, a power piston reciprocable in said shell, an end plate secured to one end of said shell having an opening therethrough and having an integral hol-

low internally threaded boss concentric with said opening and extending outwardly from the end plate, an externally threaded tube secured in said boss and providing a hydraulic master cylinder bore, a housing member secured to said end plate eccentrically located with respect to the end plate center and forming together with the end plate the casing of a control valve, a piston reciprocable in the hydraulic master cylinder bore, a rod secured to the power piston, a closure member closing the opening through the end plate except for a hole which accommodates the aforementioned rod, and a lock-nut screwed onto said threaded tube and resting against the outer end of the hollow boss to retain the threaded tube in position.

9. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a cup-shaped shell for said power unit, a power piston reciprocable in said shell, an end plate secured to one end of said shell having an opening therethrough and having an integral hollow internally threaded section concentric with said opening, an externally threaded tube secured in said section and providing a hydraulic master cylinder bore, a housing member on said end plate eccentrically located with respect to said bore and forming together with the end plate the casing of a control valve, a piston reciprocable in the hydraulic master cylinder bore, a rod secured to the power piston, a closure member closing the opening through the end plate except for a hole which accommodates the aforementioned rod, and a lock-nut screwed onto said threaded tube and resting against the outer end of the hollow boss to retain the threaded tube in position.

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