Oct. 6, 1931. C. S. BRAGG ET AL 1,826,416

POWER ACTUATOR

Original Filed Jan. 5, 1925

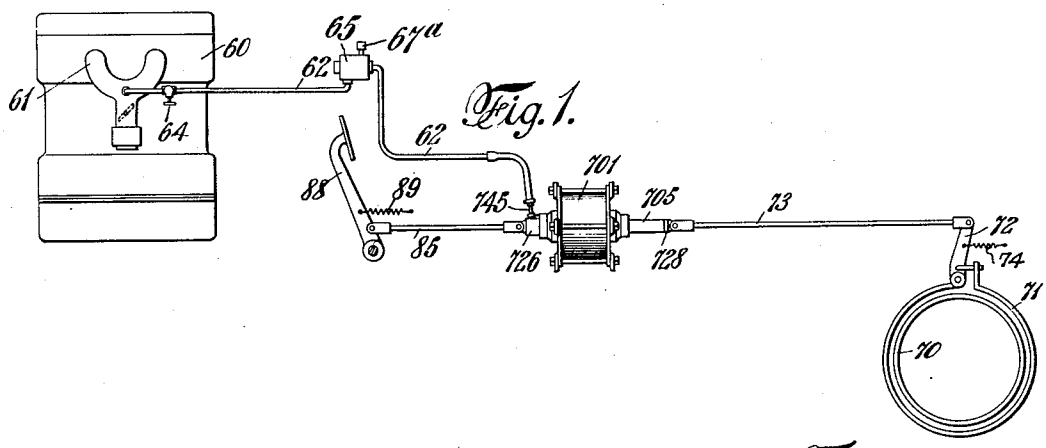

Fig. 1.

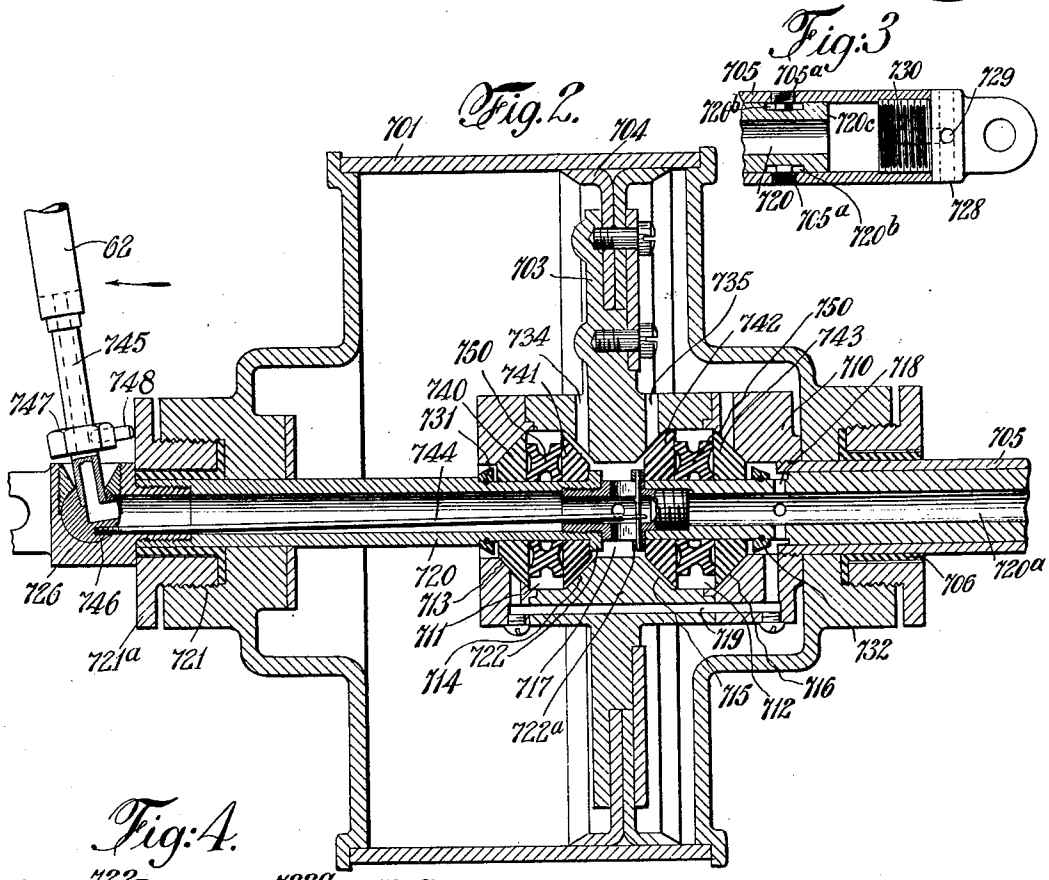

Fig. 2.

Fig. 3

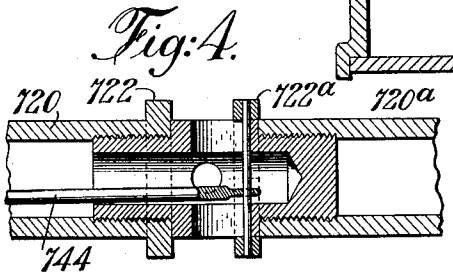

Fig. 4.

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UNITED STATES PATENT OFFICE

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POWER ACTUATOR

Original application filed January 5, 1925, Serial No. 506. Divided and this application filed August 30, 1926. Serial No. 132,367. Renewed December 10, 1930.

Our invention consists in the novel features hereinafter described, reference being had to the accompanying drawings, which illustrate one embodiment of the same, selected by us for purposes of illustration, and the said invention is fully disclosed in the following description and claims.

This application is a division of our former application filed January 5, 1925, and given Serial No. 506.

Our invention relates to a power actuator, adapted especially for use in connection with automotive vehicles propelled by an internal combustion engine, and most conveniently operated by suction from a suction passage of the engine between the throttle valve and the engine cylinder, or cylinders, as for example, by means of a connection with the intake manifold of the engine. In our prior application for Letters Patent of the United States filed December 22, 1923, Serial No. 682,346, we have disclosed a power actuator of this general type connected with the intake manifold of the internal combustion engine by means of a pipe or passage in which are located an adjustable regulating valve or other restricting means, a check valve, and a storage space, or tank, and comprising a cylinder, a double acting piston therein, and reversing valve mechanism for applying differential pressures on opposite faces of the piston, and said actuator being combined with a foot lever, or other part to be actuated in such manner that the latter can be operated by the actuator under the control of the foot lever while the operator may add his physical power to the power of the actuator when desired, or in case of failure of the actuator, may positively operate the actuated part by physical power applied to the foot lever, or other operator operated part.

The regulating valve or other restricting device prevents such large volumes of air being drawn into the intake manifold as to be likely to dilute the explosive charges passing therethrough, so as to stall the engine when idling while the storage space or storage tank provides a large space in which a partial vacuum or rarification is maintained at all times, while the engine is running, by withdrawing the air therefrom in comparatively small quantities, and insures the instantaneous withdrawal of the necessary amount of air from the actuator cylinder when the reversing valve mechanism is moved to open position, to insure the instantaneous and effective operation of the actuator.

According to our invention, we dispense with any extraneous storage space, or storage tank, in the suction line extending to the intake manifold exterior to the actuator cylinder, and maintain a condition of partial vacuum or rarification within the actuator cylinder itself, on both sides of the piston, which is made to supply the necessary storage space. Thereby we obtain a number of important and advantageous results in the construction, installation and operation of the power actuator. In the first place, the tank, which is a bulky element, is entirely done away with and the construction is correspondingly simplified and rendered less expensive. As a partial vacuum is maintained within the actuator cylinder on both sides of the piston therein, when the device is in normal or inoperative position, when the reversing valve mechanism is moved into a position to effect the operation of the actuator, one end of the cylinder on one side of the piston is connected with the intake manifold or other vacuum producing means, the other end of the cylinder on the outer side of the piston being connected with the atmosphere, and the immediate result is that the atmospheric air rushes into the end of the cylinder to which it is admitted, and effects the operation of the piston in the desired direction and to the desired extent without any appreciable quantity of air being actually withdrawn from the cylinder and admitted to the intake manifold or other suction means, thereby eliminating the drop in the suction or rarification, which would result were the cylinder full of air and this air admitted during the application of the brakes. The maximum suction is therefore immediately available. The restricting valve properly adjusted to prevent stalling the motor while idling would restrict the passage of this air over some extended time, thereby delaying the exertion of the full force of the

vacuum, where our present invention is not employed. The air admitted on the other side of the piston is not being withdrawn until the valve mechanism is reversed and the piston is moved in the opposite direction. This is particularly advantageous in the application of the actuator to the brake mechanism of automotive vehicles such as automobiles, trucks and motor buses, for example, as when the brake is applied the actuator is operated without any material admission of air to the intake manifold, and therefore without any possibility of injuriously affecting the explosive mixture or of stalling the engine, and when the valve mechanism is reversed to effect the release of the brakes, by operating the piston in the opposite direction, the atmospheric air admitted for the purpose of obtaining the previous application of the brakes can be gradually withdrawn to the intake manifold, under the control of the regulating valve, so as to prevent interference with the operation of the engine, while securing the effective release of the brake mechanism. If the motor should stall, due to the admission of this air when the brakes are being released, it would be a matter of far less importance than the stalling of the motor when the brakes are being applied. It is not so important that the movement of the piston in a direction to release the brakes shall be as rapid as the movement of the piston in the direction to apply the brakes. As a matter of fact, a very slight movement of the piston in the direction to release the brakes would be sufficient to release them, and for this reason continued application and releasing of the brakes without allowing the piston to come to the "at rest" position may be effected with comparatively small amount of air being drawn into the intake manifold, and the piston may be permitted to return to its normal position after an application of the brakes more slowly than it would be desirable to have it moved in the opposite direction. Furthermore, when the piston comes to the "at rest" position after an application of the brakes, there is a partial vacuum in the rear of the cylinder. Therefore, the only air to be exhausted is the amount admitted to the forward end of the cylinder to effect the releasing of the brakes, which is considerably less than the total amount of air that could be contained in the cylinder, were it not for our invention, which continually keeps at least one end of our cylinder under vacuum, the total amount of air in the cylinder would have to be exhausted after each operation of the brakes.

Our invention therefore enables us to simplify and decrease the cost of the apparatus, and at the same time insures the most efficient operation of the actuator without prejudice to the continuous and efficient operation of the internal combustion engine from the suction passage of which the necessary power or suction for the operation of the actuator is derived.

In our former application above referred to, these features are broadly claimed, together with one of the specific embodiments for carrying our invention into effect, and the present application is directed specifically to another specific embodiment for carrying the invention into effect disclosed in our previous application above referred to, but not specifically claimed therein, but which is specifically claimed in this application.

Referring to the accompanying drawings,

Fig. 1 represents a diagrammatic view of an installation in which our improved power actuator is connected with the internal combustion engine of an automotive vehicle for the operation of the brake mechanism thereof.

Fig. 2 is an enlarged sectional view illustrating one form of our improved actuator having one embodiment of our present invention therein, a portion of the piston rod and valve actuating sleeve being broken away and showing the piston in normal retracted position.

Fig. 3 is a detail sectional view of the terminal portions of the piston rod and valve actuating sleeve omitted from Fig. 2.

Fig. 4 is a detail sectional view of a portion of the construction shown in Fig. 2.

In Fig. 1 of the accompanying drawings, we have shown diagrammatically an installation suitable for use in an automotive vehicle in which one of our improved actuators is shown as interposed in the connections between a foot lever, 88, and brake mechanism for the vehicle, diagrammatically represented at 70, 71 and 72, indicating a brake drum, brake band and brake lever. It will be understood that the brake mechanism will be provided with the usual retracting means for restoring it and assisting in restoring the piston of the actuator to the retracted or normal position, said means being indicated diagrammatically in Fig. 1, by the spring, 74. 60 represents an internal combustion engine for propelling the vehicle, and provided with an intake manifold, indicated at 61, and communicating with the carburetor, 61^a, to which is connected a pipe, 62, between the throttle valve, indicated at 61^b, and the engine cylinders, in which pipe are located preferably an adjustable regulating valve, or restricting valve, 64, check valve 65, and a vent valve, 67^a, normally closed, and opening outwardly. The pipe, 62, communicates with one of our improved power actuators, the cylinder of which is indicated at 701, in Fig. 1, the said pipe having a flexible portion connected to a hollow valve actuating sleeve, indicated at 720, and communicating with the reversing valve mechanism. The sleeve, 720, is con-

nected to a link, 85, with the foot lever, 88, which is provided with the usual retracting spring, 89, and the piston rod, 205, of the actuator is connected by a link, 73, with the brake lever, 72.

In Fig. 2 we have shown one form of our improved actuator embodying our present invention. In this figure, 701, represents the actuator cylinder closed at both ends by heads, 702, connected by bolts, indicated at 702ª, in Fig. 1, or otherwise. 703 represents the double acting piston provided with oppositely disposed gaskets, 704. 705 represents a hollow piston rod which extends through a stuffing box, 706, in one end of the cylinder, and is connected at its inner end with the piston, 703. The hub, 710, of the piston is provided with two valve chambers, 711 and 712 respectively, each of which is provided with two valve seats preferably conical and coaxial with the axis of the piston. The valve chamber, 711, is provided with seats, 713 and 714, and the valve chamber, 712, is provided with valve seats, 715 and 716. The piston hub is provided with an outlet chamber, or suction chamber, indicated at 717, which communicates with each of the valve chambers through the valve seats, 714 and 715. The piston hub is also provided with a higher pressure chamber, 718, in this instance communicating with the atmosphere and with the valve seat, 716, and by a lateral passage, 719, with the valve seat, 713. The valve actuating part, in this instance, the sleeve, 720, passes through a stuffing box, 721, in the cylinder head at the opposite end of the cylinder from the stuffing box, 706, the said sleeve extending longitudinally through the piston hub and valve chambers, and through the hollow piston rod, 705, and being longitudinally movable to effect the operation of the reversing valves. The valve sleeve may be made conveniently in two parts, 720 and 720ª, if desired, and as herein shown, is provided with a pair of oppositely disposed poppet valves in each valve chamber, the said valves being preferably formed of molded rubber and frictionally engaging the sleeve, so that the sleeve may move through the valve while forming an air-tight joint therewith. The valves are indicated at 740, 741, 742 and 743, the valves, 741 and 742 being suction valves, and the valves, 740 and 743 being air inlet valves. The valves are yieldingly held in engagement with their seats, preferably by an elastic cushioning device interposed between the pairs of valves, and indicated at 750. The actuating sleeve is provided with suitable means for opening one valve of each pair when the sleeve is moved in either direction. In this instance the sleeve is shown provided with a fixed collar, 722, located adjacent to the suction valve, 741, and a collar, 722ª, which is movable longitudinally of the sleeve, 720, by means of connecting rod, 744, extending through the hollow sleeve, 720, and connected at its forward end to an actuating part adapted to be brought into operation when the parts have reached their normal or retracted positions as illustrated in Fig. 2. The valve sleeve is also provided with collars, 731 and 732, for operating the air inlet valves.

Communication between the suction pipe, 62, and the suction chamber, 717, is effected in this instance through the hollow valve sleeve, which is provided with a fitting, 726, at its outer end, to which the pipe, 62, is connected. The fixed collar 722, is so located with respect to a stop carried by the sleeve, 720, in this instance provided by the engagement between the inner end of the fitting or collar, 726, and the adjustable collar, 721ª, of the adjacent stuffing box, that when the piston returns to its normal or retracted position, as shown in Fig. 2, the sleeve will be arrested in such position that the fixed collar, 722, will slightly unseat the valve, 741, permitting communication between the vacuum chamber, 717, of the cylinder on the forward side of the piston through the port or passage, 734. The movable collar, 722ª, is capable of being moved longitudinally with respect to the valve actuating sleeve by means of a connecting rod, 744, extending through the hollow sleeve, 720, connected to the collar, 722ª at its inner end, and connected at its forward or outer end to an actuating part, adapted to be brought into operation when the parts have reached their normal or retracted position. In this instance we have shown the vacuum pipe, 62, connected to the sleeve by a fitting, indicated at 745, having a ball terminal, 746, secured in a spherical socket in the stop collar, 726, of the valve actuating sleeve, so as to permit the fitting, 745, to have a slightly rocking movement longitudinally of the sleeve, 720. On this fitting, 745, is located an adjustable collar, 747, which may be in the form of a nut engaging a threaded portion on the exterior of the fitting, 745, and provided with a stop pin, 748, which engages a part of the cylinder, in this instance the valve, 721ª, of the stuffing box, 721, so as to rock the fitting, 745, in the direction of the arrow, Fig. 2, when the valve sleeve is restored to its retracted or normal position, by the retracting spring of the foot pedal. In this instance the forward end of the connecting rod, 744, is screwed into the ball, 746, in such manner that the rocking movement imparted to the fitting, 745, will move the collar section, 722ª, in a direction toward the valve, 742 far enough to slightly unseat the valve, and thus establish communication between the vacuum chamber, 717, and that portion of the cylinder in rear of the piston. When the valve actuating sleeve is moved forward to actuate

the brake mechanism, the opening of the valve, 73, will effect a compression of the cushioning device, 750, and close the valve, 742, restoring the movable collar section, 722ª, and connected parts, as the projection, 748 is released.

The specific details of the poppet valve mechanism herein shown and described form no part of our present invention, as the same is disclosed and claimed in our former application for Letters Patent of the United States, filed November 22, 1924, and given Serial No. 751,481.

It follows from this construction that as soon as the engine is started, the suction produced in the intake manifold will exhaust the air from the cylinder of the actuator on both sides of the piston, and maintain the piston submerged in vacuum when retracted. If it is desired to apply the brakes, the foot lever is actuated to move the sleeve, 720, in the direction of the arrow, Fig. 2, permitting the suction valve, 742, to close, and further opening the suction valve, 741, and opening the air inlet valve, 743. This continues the action of the cylinder forward of the piston with the suction chamber, 717, and admits atmospheric air in rear of the piston, moving the piston forward in a direction to apply the brakes, but no appreciable amount of air will be drawn into the intake manifold through the pipe, 62, as that portion of the cylinder is already exhausted. The forward movement of the piston will follow any extent of the forward movement of the brake lever, 88, and when the brake lever stops, the piston will continue to move forward until the air inlet valve, 743 closes, so as to hold the piston and brakes. Where continued applications of the brakes are desired, a slight release of the foot lever will open the suction valve, 742, producing a partial or entire equalization of pressures on opposite sides of the piston, which will permit the brakes to relieve themselves and slightly retract the piston under the action of the retracting means for the brake mechanism indicated at 74 in Fig. 1. A slight forward movement of the pedal lever will again close the suction valve, 742, and open the valve, 743, admitting air in rear of the piston, and a number of successive applications of the brakes can be made without admitting material quantities of air into the intake manifold. When the foot is removed from the foot lever, 88, the lever will be moved rearwardly by its retracting spring, opening the suction valve, 742, effecting an equalization of pressures within the cylinder on both sides of the piston and permitting the brakes to relieve themselves, and the further reverse movement of the sleeve, 720, will close the suction valve, 741, and open the air inlet valve, 740, admitting atmospheric air to the cylinder forward of the piston through the opening, 733, controlled by said valve, thus returning the piston to normal position. The piston will be arrested by engagement of its hub with the end of the cylinder. The valve actuating sleeve will be arrested by the engagement of the collar, 726, with the valve, 721ª, this opening the suction valve, 741, closing the air inlet valve, 740, and holding the suction valve, 741, in open position. At the same time the engagement of the pin, 748, with the follower or other stationary part of the cylinder, will effect the opening of the suction valve, 742. When, as before stated, the parts come to rest, the suction chamber, 717, will, therefore, be in communication with the cylinder on both sides of the piston and will exhaust the air previously admitted to effect the reverse movement of the piston, leaving it again submerged in vacuum. The exhaustion of air from the cylinder therefore only takes place during and after the return stroke of the piston, and this air is delivered gradually to the intake manifold by the restricting valve, 64, so that the operation of the engine will not be interfered with, and the eduction of the air may be retarded as much as desired, as the first movement of the piston rearwardly will relieve the pressure of the brakes, and it is not important that the piston should move rearwardly as quickly as it moves forwardly to apply the brakes.

The withdrawal of the air may, therefore, be distributed over a great or less period of time, according to the adjustment of the valve, 64, so as to avoid the undue dilution of the explosive charges or the feeding of too small an amount of hydrocarbon fuel, and the piston is left submerged in vacuum and ready for immediate and effective operation to apply the brakes at any moment. As the degree of suction in the suction passages of the engine varies from time to time, we interpose the check valve, 65, in the pipe, 62, so that after the cylinder is subjected to the greatest amount of suction, the condition of rarification so produced will remain, and as the brakes are usually operated at intervals, the greatest possible rarification will ordinarily exist in the cylinder of the actuator at all times, ready to effectively apply the brakes in the manner before described.

We prefer to connect the valve actuating sleeve, 720, 720ª, with the piston by means providing for a limited amount of lost motion, sufficient to permit the operation of the valves, so that after this lost motion is taken up, the physical power of the operator can be directly applied to the piston and the brake mechanism connected therewith, to enable the operator to add his physical force to that of the actuator, or to operate the brakes by his physical force alone if the power should fail for any reason, the lost motion permitting the movement of the valves in any case, and serving when power

fails to vent the cylinder. In the present instance, as shown in Fig. 3, the section, 720[a], of the valve sleeve is provided with a recessed portion, 720[b], and a collar, 720[c], and a piston rod, 705, is in this instance provided with set screws, 705[a], extending into said recess (or recesses) 720[b], so that when the sleeve is moved forward by the foot lever to apply the brakes, and the piston has followed, applying the brakes to the full capacity of the actuator, the operator may, by pushing the foot lever, 88, further forward until the rear edge of the recess, 720[b], will apply his physical force to the piston and thereby to the brake mechanism, in addition to the power of the actuator. It also follows from this construction that, should the power of the actuator fail for any reason, the operator may apply his physical force to the piston and brake mechanism to apply the brakes, the first forward movement of the valve actuating sleeve, to take up the lost motion, moving the valves into position to vent the cylinder forward of the piston and admit air in rear of the piston to permit this movement. In like manner, when the foot lever is released, the retracting spring will move it rearwardly and shift the valve actuating sleeve so as to vent the cylinder (in case of failure of power) and the forward end of the recess, 720[b].

It will be noted that a vacuum is continuously maintained in the actuator cylinder on both sides of the piston when it is in normal position, and the engine is in operation, so that the cylinder itself acts as a storage space and no additional tank or other extraneous storage space is required. As we have termed it, the piston is normally maintained submerged in vacuum.

What we claim and desire to secure by Letters Patent is:—

1. In a power actuator, the combination of a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism, means for connecting said reversing valve mechanism with sources of high and low fluid pressure, a longitudinally movable valve operating part provided with valve engaging devices fixed in relation thereto, for operating certain of said valves, an operator operated part connected with said valve operating part, a retracting spring operatively connected with said valve operating part, means for arresting said valve operating part when the piston is in retracted position, in position to hold one of said valves open to connect the cylinder on one side of the piston with the low pressure source, means carried on said valve actuating part and, movable independently with respect to said valve actuating part for operatively engaging another of said valves, and means for arresting said independently movable valve engaging means part when the piston is in normal retracted position to effect the opening of said other valve and place the cylinder on the opposite side of the piston in connection with the low pressure source.

2. In a power actuator, the combination of a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism, means for connecting said reversing valve mechanism with a source of suction and with the atmosphere, a longitudinally extending valve actuating part movable with the piston and extending through apertures in said valves, and provided with means for opening a suction valve, and an air inlet valve when moved in either direction including a fixed collar attached to said valve actuating part for engaging one of the suction valves, and a movable collar on said valve actuating part and movable with respect thereto for engaging the other suction valve, means for arresting said sleeve in position to hold one of said suction valves open when the piston is in normal retracted position, a movable part carried by said valve actuating part and movable with respect thereto, and operatively connected with said movable collar, a retracting spring operatively connected with said valve actuating part, and means for effecting a relative movement of said movable part with respect to the valve actuating part when the piston is in retracted position to open the other of said suction valves, and maintain the piston submerged in vacuum when retracted.

3. In a power actuator, the combination of a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism located in the hub of the piston, and comprising suction and inlet valves, means for connecting the suction valves with a source of suction, means for connecting the air inlet valves with the atmosphere, yielding means for normally seating said suction and inlet valves, a longitudinally extending valve actuating sleeve through apertures in said parts and provided with means for opening a suction valve and an air inlet valve when moved in either direction, said means including a fixed collar attached to said valve actuating part adjacent to one suction valve and a movable collar carried by said valve actuating part and movable longitudinally thereon and located adjacent to the other suction valve, means for arresting said sleeve in position to hold the suction valve adjacent to said stationary collar in partially open position, a movable part carried by said sleeve, and movable relatively with respect thereto, a connection from said movable part extending longitudinally of said sleeve to said movable collar, a retracting spring operatively connected with said valve actuating part, and means for effecting a relative movement of said movable part and said movable collar with respect to the sleeve for positively

opening the other suction valve when the piston is in normal retracted position, to maintain the piston submerged in vacuum when retracted.

4. In a power actuator, the combination of a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism located in the hub of the piston, and comprising suction and inlet valves, means for connecting the suction valves with a source of suction, means for connecting the air inlet valves with the atmosphere, a longitudinally extending valve actuating sleeve through apertures in said parts and provided with means for opening a suction valve and an air inlet valve when moved in either direction, said means including a fixed collar attached to said valve actuating part adjacent to one suction valve and a movable collar carried by said valve actuating part and movable longitudinally thereon, and located adjacent to the other suction valve, means for arresting said sleeve in position to hold the suction valve adjacent to said stationary collar in partially open position, a movable part carried by said sleeve, projecting laterally therefrom and movable relatively with respect to the sleeve, a connection between said movable part and said movable collar extending longitudinally through said sleeve, a retracting spring operatively connected with the valve actuating part and means for effecting a movement of said movable part and said movable collar with respect to said sleeve, when the piston is in normal retracted position for positively opening the other of said suction valves, to maintain the piston submerged in vacuum when retracted.

5. In a power actuator, the combination of a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism located in the hub of the piston, and comprising two pairs of oppositely disposed coaxial valves, each pair including a suction valve and an air inlet valve, yielding means interposed between the valve of each pair for seating the same, means for connecting the suction valves with a source of suction, means for connecting the air inlet valves with the atmosphere, a valve actuating part extending longitudinally through one end of the cylinder through said valves and provided with means for opening a suction valve and an air inlet valve when moved in either direction, including a fixed collar attached to said valve actuating part adjacent to one suction valve and a movable collar carried by said valve actuating part, and movable longitudinally thereon, and located adjacent to the other suction valve, an operator operated part connected with said valve actuating part, a retracting spring operatively connected with said valve actuating part, a stop carried by the valve actuating part for engaging a part connected with the cylinder, when the piston is in normal retracted position, to enable said fixed collar to hold its adjacent suction valve in open position, a movable part carried by said valve actuating part and movable with respect thereto, connections between said movable part and said movable collar, said movable part being provided with a portion adapted to engage a part connected with the cylinder when the piston is in retracted position for shifting said movable collar and opening the other of said suction valves, whereby said movable collar and the suction valve adjacent thereto will be restored to normal position by the adjacent yielding seating means when the piston is moved away from retracted position.

6. In a power actuator, the combination with a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism including a vacuum chamber and suction passages extending therefrom to the cylinder on both sides of the piston, an air inlet passage and passages for connecting it with the cylinder on both sides of the piston, valves for controlling said suction and air inlet passages, and yielding means normally tending to seat all of said valves, vacuum producing means connected with said vacuum chamber, a longitudinally extending valve actuating sleeve, extending through apertures in said valves and provided with means for opening one of the suction valves and one of the air inlet valves, when moved in either direction including a collar section fixed to said sleeve, and a movable collar section located between said suction valves, a retracting spring operatively connected with said valve actuating part, a movable part on said sleeve adapted to engage a part connected with the cylinder for arresting said sleeve in position to cause the stationary collar section to hold its adjacent suction valve partially opened, and a connection between said movable part and said movable collar section for positively opening the other of said suction valves when the parts are in retracted or normal position, to maintain the piston submerged in vacuum.

7. In an automotive vehicle provided with an internal combustion engine having a suction passage, the combination with a power actuator comprising among its members a cylinder closed at both ends, a piston in said cylinder, reversing valve mechanism in the piston, including a suction chamber, passages connecting it with the cylinder on both sides of the piston, air inlet passages connected with the cylinder on both sides of the piston, suction and air inlet valves controlling said passages, and yielding means normally tending to seat said valves, of means for connecting the said sucton chamber with the suction passage of the engine, a valve actuating part provided with means for opening said valves

by the longitudinal movement of the valve actuating part, so disposed as to effect the opening of one inlet valve and one suction valve when the valve actuating part is moved in either direction with respect to the piston, the valve opening means for said suction valves being movable with respect to each other, a retracting spring operatively connected with said valve actuating part, means called into action when the piston is in normal retracted position to arrest the valve actuating part, and shift said suction valve opening means with respect to each other to maintain both suction valves in open position, and maintain the piston submerged in vacuum, an operator operated part connected with the valve actuating part, and means for connecting the piston with a part to be actuated.

8. In an automotive vehicle provided with an internal combustion engine having a suction passage and brake mechanism for the vehicle, the combination with a power actuator comprising among its members a cylinder closed at each end, a piston in said cylinder, reversing valve mechanism located in the piston, including a suction chamber, passages connecting it with the cylinder on both sides of the piston, air inlet passages connected with the cylinders on both sides of the piston, suction and air inlet valves controlling said passages, and yielding means normally tending to seat said valves, of means for connecting the said suction chamber with the suction passage of the engine, a valve actuating part extending through said valves and to the exterior of the cylinder, and provided with means for opening one of said suction valves and one of said inlet valves when moved in either direction, including a fixed part on said valve actuating part for engaging one suction valve, and a part movable with respect to the valve actuating part and carried thereby for engaging the other suction valve, means for arresting the valve actuating part in position to hold one suction valve open by said fixed opening means when the piston is in retracted position, a retracting spring operatively connected with the valve actuating part, and means for shifting said movable opening means to effect the opening of the other suction valve when the piston is in normal retracted position, to connect the portions of the cylinder on both sides of the piston with each other and with the suction passage of the engine, and maintain the piston submerged in vacuum when in retracted position, an operator operated part connected with said valve actuating part, and means for connecting the piston with the brake mechanism.

9. In an automotive vehicle provided with an internal combustion engine having a suction passage and brake mechanism for the vehicle, the combination with a power actuator comprising among its members a cylinder closed at each end, a piston in said cylinder, reversing valve mechanism located in the piston, including a suction chamber, passages connecting it with the cylinder on both sides of the piston, air inlet passages connected with the cylinders on both sides of the piston, suction and air inlet valve controlling said passages, and yielding means normally tending to seat said valves, of means for connecting the said suction chamber with the suction passage of the engine, a valve actuating part extending through said valves and to the exterior of the cylinder, and provided with means for opening one of said suction valves and one of said inlet valves when moved in either direction, including a fixed part on said valve actuating part for engaging one suction valve, and a part movable with respect to the valve actuating part and carried thereby for engaging the other suction valve, a retracting spring operatively connected with the valve actuating part, means for arresting the valve actuating part in position to hold one suction valve open by said fixed opening means when the piston is in retracted position, to connect the portions of the cylinder on both sides of the piston with each other and with the suction passage of the engine, and maintain the piston submerged in vacuum when in retracted position, an operator operated part connected with said valve actuating part, means for connecting the piston with the brake mechanism, and means including a provision for lost motion for connecting the valve actuating part with the piston.

10. In an automotive vehicle provided with an internal combustion engine having a suction passage and brake mechanism for the vehicle, the combination with a power actuator comprising among its members a cylinder closed at each end, a piston in said cylinder, reversing valve mechanism located in the piston, including a suction chamber, passages connecting it with the cylinder on both sides of the piston, air inlet passages connected with the cylinders on both sides of the piston, suction and air inlet valves controlling said passages, and yielding means normally tending to seat said valves, of means for connecting the said suction chamber with the suction passage of the engine, a valve actuating part extending through said valves and to the exterior of the cylinder, and provided with means for opening said valves including collars fixed thereto for engaging one suction valve and the inlet valves, and a collar movable with respect to the valve actuating part for opening the other suction valve, means for arresting said valve actuating part, in position to hold one of said suction valves in open position by a fixed collar, when the piston is in retracted position, a retracting spring operatively connected with the valve

actuating part, a movable device connected with the valve actuating part for engaging a part connected with the cylinders when the piston is in normal retracted position, and a connection from said movable part to the said movable collar for opening the other suction valve when the piston is in retracted position, to connect the portions of the cylinder on both sides of the piston with each other and with the suction passage of the engine, and maintain the piston submerged in vacuum when in retracted position, an operator operated part connected with said valve actuating part, and means for connecting the piston with the brake mechanism.

11. In a power actuator, a cylinder, a piston movable therein connected to a part to be actuated, valve mechanism for controlling differentials of pressure to opposite sides of said piston including a valve operating member and valves movable with and with respect to said member, an element carried by said valve operating member, means for limiting the movement of said member to hold one of the low pressure valves in open position when the piston is in normal retracted position, and a second element shiftable with respect to the first element, together with means for shifting said second element to open the other low pressure valve and thereby connect both sides of the piston with low pressure.

12. In a power actuator, a cylinder, a piston movable therein connected to a part to be actuated, valve mechanism for controlling differentials of pressure to opposite sides of said piston including a valve operating member and valves movable with and with respect to said member, an element connected to move with said valve operating member, means to limit the movement of said valve operating member so as to hold one of the low pressure valves open when the piston is in normal retracted position, and a second element movable on the valve operating member and engaging with the other low pressure valve to open the same when the piston is retracted, together with means for operating said second member.

13. In a power actuator, a cylinder, a piston movable therein connected with a part to be actuated, valve mechanism for controlling differentials of pressure to opposite sides of said piston including a valve operating member, and high and low pressure valves movable with and with respect to said member, valve engaging elements on said member, means for arresting said valve operating member to hold one of said low pressure valves in open position when the piston is in normal retracted position, and means for relatively separating said elements to open the other low pressure valve when the piston is retracted.

14. In a power actuator, a cylinder, a piston movable therein and connected to a part to be actuated, valve mechanism including relatively movable low and high pressure valves for controlling differentials of pressure to opposite sides of the piston, means for holding one of the low pressure valves open when the piston is in retracted position, and means automatically acting when the piston is in normal retracted position to cause relative separation of the low pressure valves to open the same and connect the cylinder on both sides of the piston with the source of low pressure.

15. In a power actuator, a cylinder, a piston movable therein, inlet and outlet passages for conveying motive fluid to and from said cylinder to actuate said piston, valves for said passages, actuating collars for said valves, means for arresting one of said collars in position to hold one of the outlet valves in open position when the piston is in normal retracted position, and means adapted to move said actuating collars relatively to each other to unseat the other of said outlet valves when the piston is in retracted position, to connect both ends of said cylinder with said outlet passage.

In testimony whereof we affix our signatures.

CALEB S. BRAGG.
VICTOR W. KLIESRATH.