

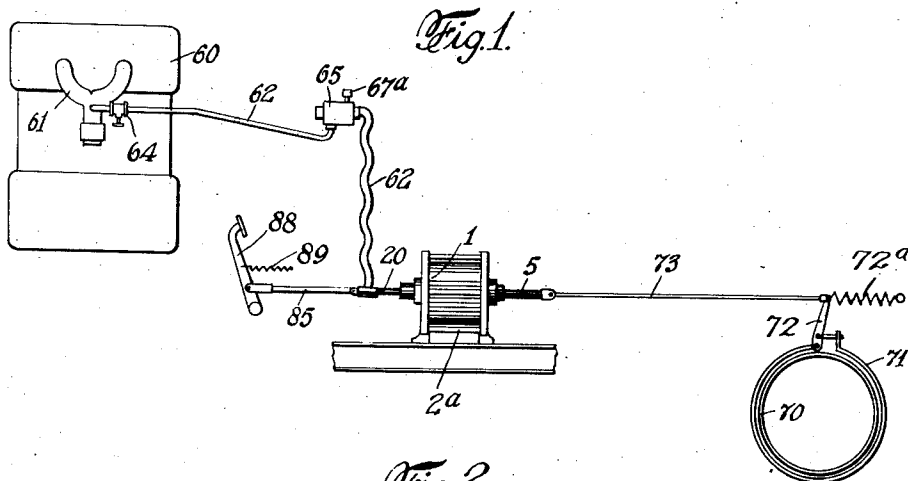
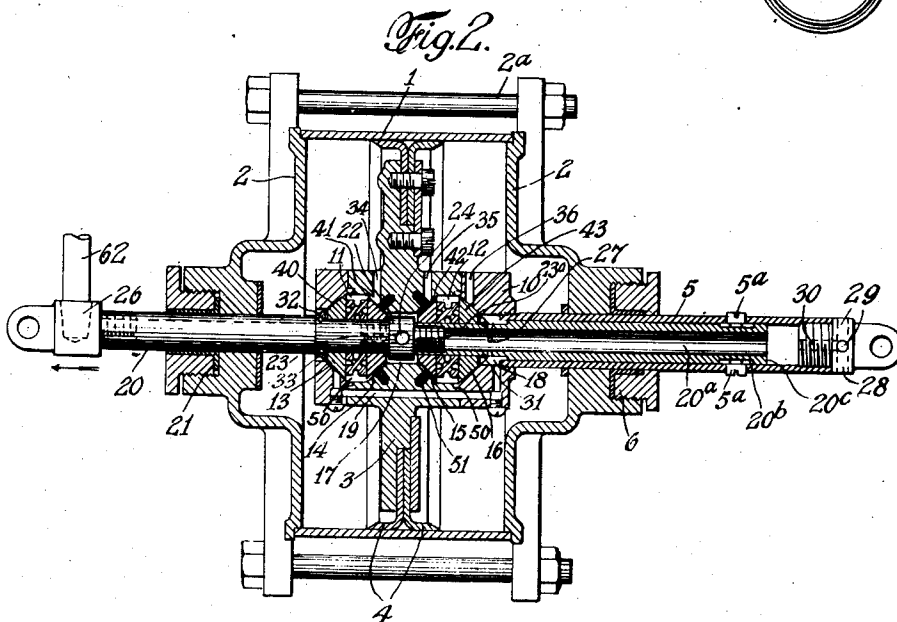
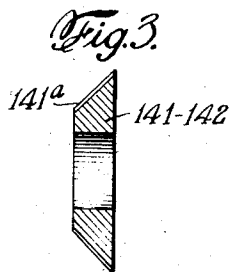
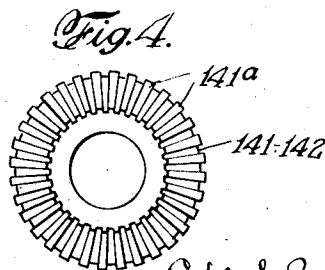
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C. S. BRAGG ET AL

1,879,598

POWER ACTUATOR

Original Filed Jan. 5, 1925 4 Sheets-Sheet 1



Caleb S. Bragg ^{INVENTOR}
Victor M. Klesath
BY
Louis Preston Whitaker
ATTORNEY

Sept. 27, 1932.

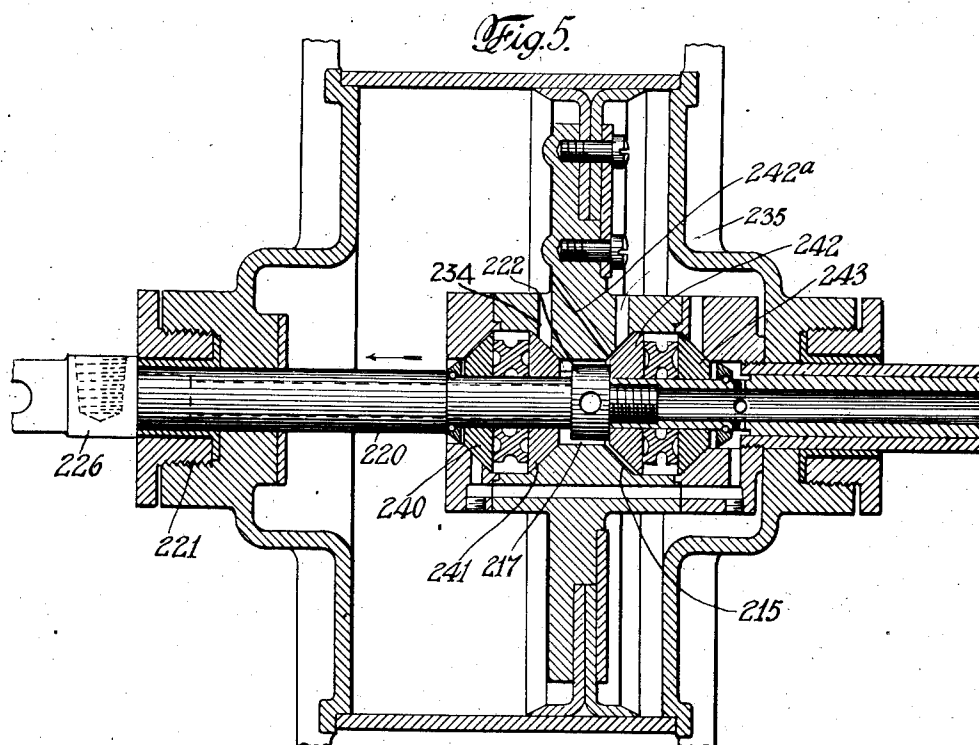
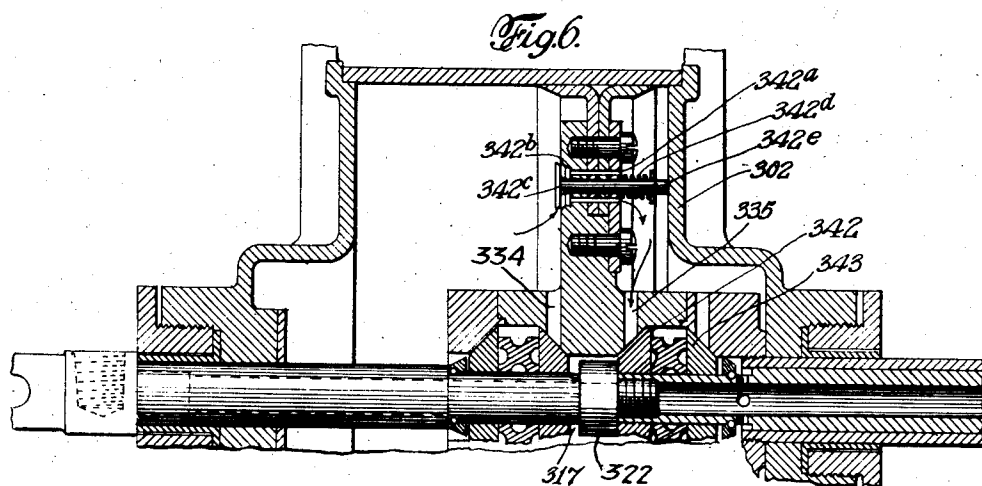
C. S. BRAGG ET AL

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POWER ACTUATOR

Original Filed Jan. 5, 1925

4 Sheets-Sheet 2



Caleb S. Bragg ^{jr} INVENTORS
Victor W. Hysmith
Louis Brewster Whitaker
ATTORNEY

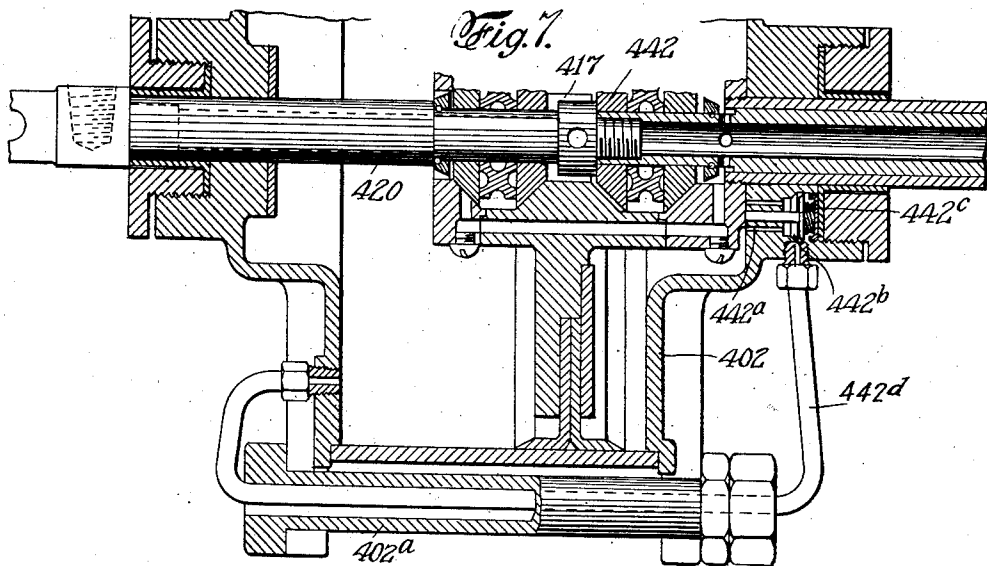
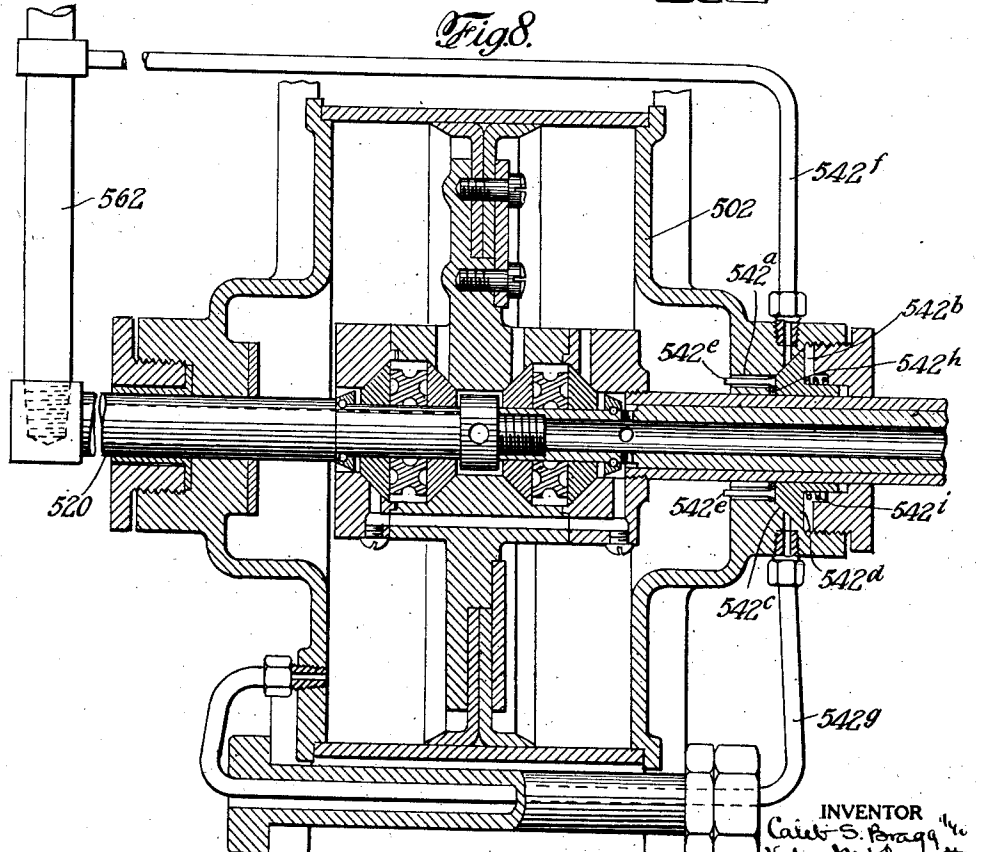
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C. S. BRAGG ET AL

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POWER ACTUATOR

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INVENTOR
Caird S. Bragg, Jr.
Victor M. Kluessath
BY
Louis Prevost Whitaker
ATTORNEY

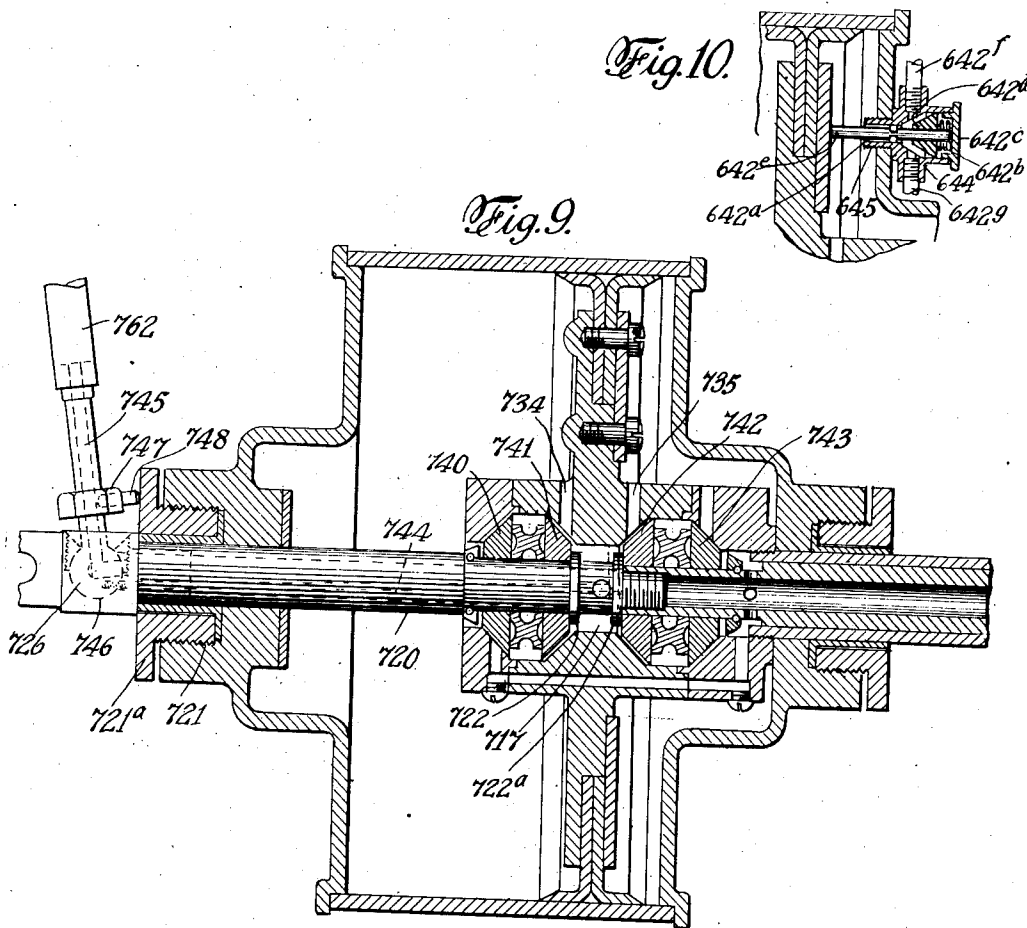
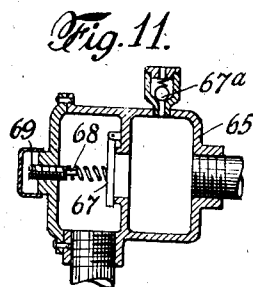
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C. S. BRAGG ET AL

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POWER ACTUATOR

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Caleb S. Bragg ^{and} Victor M. Klierath
INVENTORS
BY
Louis H. Whitaker
ATTORNEY

UNITED STATES PATENT OFFICE

CALEB S. BRAGG, OF PALM BEACH, FLORIDA, AND VICTOR W. KLIESRATH, OF SOUTHBEND, INDIANA, ASSIGNORS TO BRAGG-KLIESRATH CORPORATION, OF LONG ISLAND CITY, NEW YORK, A CORPORATION OF NEW YORK

POWER ACTUATOR

Application filed January 5, 1925, Serial No. 506. Renewed November 27, 1931.

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

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, the said actuator being combined with a foot lever, or other operator operated part, and with a brake mechanism 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 present 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 other side of the piston being connected with the atmosphere, and the immediate result is that the atmospheric air rushes in to 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.

Referring to the accompanying drawings which illustrate a number of different embodiments of our invention, selected by us for purposes of illustration.

Fig. 1 is a diagrammatic view representing an installation of our improved power actuator in connection 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 form of our present invention embodied therein.

Figs. 3 and 4 are respectively a sectional view and a plan view of a form of poppet valve which may be employed in the actuator illustrated in Fig. 2 for carrying our present invention into effect.

Fig. 5 is an enlarged sectional view of our improved power actuator showing a modification of our present invention embodied therein.

Fig. 6 is a partial sectional view of our improved power actuator showing another modification of our present invention embodied therein.

Fig. 7 is a partial sectional view of our improved power actuator showing another modification of our present invention embodied therein.

Fig. 8 is an enlarged sectional view of our power actuator showing still another modification of our present invention embodied therein.

Fig. 9 is a similar sectional view of our improved actuator, showing another modification of our present invention embodied therein.

Fig. 10 is a partial sectional view illustrating a slight modification of the construction illustrated in Fig. 8.

Fig. 11 is an enlarged detail view of a check valve and vent valve which are advantageously employed between the actuator and the intake manifold.

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. 60 represents an internal combustion engine for propelling the vehicle, and provided with an intake manifold, indicated at 61, to which is connected a pipe, 62, in which are located preferably an adjustable regulating valve, or restricting valve, 64, a check valve, 65, and a vent valve, 67^a, normally closed and opening outwardly, a convenient form of

said vent and check valves being shown in Fig. 11, and hereinafter described. The pipe, 62, communicates with one of our improved power actuators, the cylinder of which is indicated at 1 in Fig. 1, the said pipe having a flexible portion connected to a hollow valve actuating sleeve, indicated at 20, and communicating with the reversing valve mechanism. The sleeve, 20, is connected by a link, 85, with the foot lever, 88, which is provided with the usual retracting spring, 89, and the piston rod, 5, of the actuator is connected by a link, 73, with the brake lever, 72. The brakes are retracted by the usual tension spring 72^a.

In Fig. 2 we have shown one form of our improved actuator embodying our present invention. In this figure, 1, represents the actuator cylinder, closed at both ends by heads, 2, connected by tubular bolts, 2^a, and nuts. 3 represents the double acting piston provided with oppositely disposed gaskets, 4-4. 5 represents a hollow piston rod which extends through a stuffing box, 6, in one end of the cylinder, and is provided at its inner end with threaded portions screwed into the hub of the piston, or otherwise connected thereto. The hub, 10, of the actuator piston is provided with two valve chambers, 11 and 12, respectively, each of which is provided with two valve seats, preferably conical and concentric to the axis of the piston. The valve chamber, 11, is shown as provided with the conical valve seats, 13 and 14, and the valve chamber, 12, is similarly provided with valve seats, 15 and 16. The piston hub is provided in this instance with an outlet chamber, or suction chamber, indicated at 17, which communicates with each of the valve chambers through the valve seats, 14 and 15. The piston hub is also provided with a higher pressure chamber, 18, in this instance communicating with the atmosphere, and which communicates with the valve seat, 16, and by a lateral passage, 19, with the valve seat, 13, at the opposite end of the piston hub. 20 represents the valve actuating part, consisting in this instance of a valve sleeve passing through a stuffing box, 21, in the cylinder head at the opposite end of the cylinder from the stuffing box, 6, said sleeve also extending longitudinally through the piston hub, the chambers thereof, and through the hollow piston rod, 5, and being movable longitudinally with respect thereto, to effect the operation of the reversing valves. The valve sleeve is preferably made in two parts, 20 and 20^a, connected by threaded projections, 23 and 23^a, of a centrally located collar, 22, in the suction chamber, 17. The collar, 22, is provided with one or more lateral passages, 24, communicating with the interior of the sleeve section, 20, through a longitudinal passage in one of the plugs, indicated in dotted lines in Fig. 2. The sleeve

sections, 20 and 20^a, are thus connected for joint movement, but are not in communication with each other. The valve sleeve section, 20, is provided adjacent to its outer end with a lateral passage, 26, to which the pipe, 62, is connected and the outer end of the sleeve section, 20, is provided with an attaching eye to which the link, 85, extending to the foot lever is connected. The sleeve section, 20^a, is provided with apertures, 27, communicating with the atmosphere, or higher pressure chamber, 18, and the outer end of the sleeve section, 20^a, which extends through the hollow piston rod, is open and communicates with the interior of the piston rod, which is provided with means for admitting atmospheric air thereto. In this instance the piston rod, 5, is shown provided with a plug, 28, provided with lateral air inlet apertures, 29, communicating with the longitudinal apertures, 30, and the plug, 28, is also provided with an eye for enabling it to be attached to the connecting rod, 73. The suction chamber, 17, is adapted to be connected with the cylinder on opposite sides of the piston by means of a port or ports, 34, in the valve seat, 14, and a port, or ports, 35, in the valve, 15. The valve seat, 13, communicates with the cylinder on one side of the piston through the annular passage, 33, and the valve seat, 16, is provided with a port, or ports, 36, communicating with the cylinder on the opposite side of the piston. Each of the valve chambers, 11 and 12, is provided with a pair of oppositely disposed poppet valves, preferably conical, engaging the opposite valve seats, the said valves being preferably formed of molded rubber, and being loose on the valve actuating sleeve, although said valves may be formed of other material if preferred. The valves are indicated at 40, 41, 42 and 43. Each of these valves is held seated by yielding means, and means are also provided for sealing the opening in the valve through which the valve actuating sleeve passes. In the present instances we have shown a rubber cushioning device, 50, of elastic rubber interposed between the valves, 40 and 41, and between the valves 42 and 43, said cushioning devices fitting tightly on the outer surfaces of the valves and valve actuating sleeve, and serving the combined purpose of retracting spring and sealing means for the adjacent valves. The actuating sleeve is provided with suitable means for opening one valve of each pair when the valve sleeve is moved in either direction. As shown in Fig. 2, this function is performed by the collar, 22, located centrally between the valves 41 and 42, and end collars, 31 and 32, respectively, mounted on the valve sleeve outside of the valves, 43 and 40, respectively.

The specific details of the poppet valve mechanism herein shown and described,

form no part of our present invention, as the same is illustrated, described and claimed in our former application for Letters Patent of the United States, filed November 22, 1924, and given Serial No. 751,481 and in our application filed January 31, 1925, and given Serial No. 5,947.

From the foregoing it will be noted that when the valve actuating sleeve is moved in either direction, one of the centrally located valves 41 or 42, and one of the end valves, 40 or 43, will be opened simultaneously, thereby placing one end of the cylinder in communication with the suction chamber, 17, and the other end of the cylinder in communication with the atmosphere, and causing a corresponding movement of the piston in the same direction as that in which the valve actuating sleeve is moved. Conversely, the movement of the valve sleeve in the opposite direction reverses the valve mechanism and affects the movement of the piston in the opposite direction.

According to our present invention, in which no suction tank is employed, and the interior of the cylinder is maintained at all times, when the valve mechanism is in normal position, and while the engine is running, in a state of rarification or partial vacuum, on both sides of the piston, this may be conveniently accomplished in the construction illustrated in Fig. 2 and previously described, by providing means for preventing the suction valves, 41 and 42, on opposite sides of the suction chamber, 17, from being held normally in closed position by their retracting means, to wit, the cushions, 50—50. This may be accomplished in a number of different ways. In Fig. 2, for example, we have shown the valve seats, 14 and 15, provided with springs, indicated at 51, which are calibrated so that they are slightly stronger than the retracting spring members or cushions, 50—50, when the latter are in their normal conditions, but so that the springs, 51, will yield to permit the adjacent valves to be firmly seated when the adjacent retracting, or cushioning means, 50, is compressed. It follows from this construction that whenever the suction valves, 41 and 42, are simultaneously opened, there will be an equalization of pressures in the portions of the cylinder on opposite sides of the piston, and as soon as the engine is started, the suction produced in the intake manifold will exhaust the air from the cylinder, 1, of the actuator, since the suction chamber, 17, will communicate with the cylinder on both sides of the piston through the "cracked" valves, 41 and 42, held very slightly open, that is to say, just off of their seats by the opposing springs, 51. If, now, it is desired to apply the brakes, the foot lever is actuated so as to move the valve sleeve, 20, in the direction of the arrow in Fig. 1, thereby by further opening the valve, 41 com-

pressing the retracting cushioning device, 50, between the valves, 43 and 42, and forcing the valve 42, to seat by overcoming the springs, 51 in the seat and opening valve, 43. The opening of the valve, 41, connects the cylinder forward of the piston with the suction chamber, 17, and suction pipe, 62, and the opening of the valve, 43, places the portion of the cylinder in rear of the piston in communication with the atmosphere. Air will therefore rush in to the previously exhausted space in rear of the piston and move the piston forward, and apply the brakes, but no appreciable amount of air will be drawn into the intake manifold through the pipe, 62, as the portion of the cylinder forward of the piston is already exhausted. There is, therefore, no effect produced on the explosive charges of the engine when the brake is operated. When the movement of the valve sleeve is reversed by the release of the foot lever, 88, the valves will be first returned to normal position shown in Fig. 2, with valve, 43, closed, and valves, 41 and 42, opened, which will effect an instantaneous equalization of pressures between the portions of the cylinder on opposite sides of the piston, and transfer a part of the air admitted in rear of the piston to effect the power stroke over to the forward side. As the valve actuating sleeve, 20, moves further, in the direction contrary to the arrow shown in Fig. 2, the valve, 41, will be forced to its seat, overcoming the springs, 51, therein, the air inlet valve 40 will be opened, and valve, 42, will be opened further. This places the suction chamber, 17, in communication with the portion of the cylinder in rear of the piston, and simultaneously places the portion of the cylinder forward of the piston in communication with the atmosphere. The remaining air will be exhausted from the rear portion of the cylinder through the suction passages, and the additional air admitted to the forward side of the piston will move the piston rearwardly. The air exhausted from the cylinder can be delivered gradually to the intake manifold by properly regulating the restricting valve, 64, in the pipe, 62, so that the operation of the engine shall not be interfered with, and the education 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 move rearwardly as quickly as it moves forwardly to apply the brakes. The withdrawal of the air may, therefore, be distributed over a greater 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. The equalization of pressures on opposite sides of the piston, which takes place when both of the suction valves are simultaneously opened, in the

first place permits the retracting spring of the brake mechanism to immediately start the movement of the piston rearwardly, and as a portion of the air in the rear of the piston is transferred to the forward side by this equalization, there is that much less air to be exhausted from the rear side of the piston, and that much less air to be admitted on the forward side of the piston, to positively return the piston to its normal position, and therefore the return of the piston and brake mechanism to normal position is expedited, while the amount of air transferred to the intake manifold is minimized. When the piston is restored to normal position, the piston hub will engage the adjacent end of the cylinder, and the valve actuating sleeve, 20—20^a, will be arrested by the part, 26, engaging the adjustable follower with which the stuffing box, 21, is provided, and the valves, 41 and 42, will be held slightly off their seats by the springs, 51, thus placing both sections of the cylinder on opposite sides of the piston in communication with each other, thereby equalizing the pressures, and also placing both ends of the cylinder in communication with the suction chamber, 17, and the evacuation of the air from the cylinder will continue without any tendency of the piston to move forward until the same degree of rarification exists in the cylinder on both sides of the piston. This leaves the piston in condition 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.

As will be seen, there is a certain amount of lost motion between the valve actuating sleeve, 20—20^a, and the piston and hollow piston rod, and we prefer to provide means for limiting this lost motion so that after it is taken up, the physical power of the operator can be directly applied to the piston and parts connected therewith. In the present instance we have shown the sleeve section, 20^a, provided with a recessed portion 20^b, and a collar, 20^c, and the piston rod provided with oppositely disposed set screws, 5^a, extending into the recess, or recesses, 20^b, so that when the sleeve, 20—20^a, is moved forward by the foot lever to apply the brakes and the piston has followed by applying the brakes to the full capacity of the actuator, the operator may, by pushing the foot lever, 88, forward until the rear end of the recess, 20^b, engages the screws, 5^a, apply his physi-

cal force to the piston and piston rod of the actuator, 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, by moving the foot lever, 88, forward and bringing the rear end of the recess, 20^b, into engagement with the screws, 5^a, may apply his physical force to the piston, and thence to the brake mechanism, the valves having been set to permit this movement and admit air in rear of the piston, and to vent the cylinder forward of the piston. The operator can therefore, by his physical power, apply the brakes almost as effectively as if the actuator was not present, except for the necessity of overcoming the slight friction of the parts of the actuator. In like manner, when the foot lever is released, the retracting spring, 89, 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, 20^b, will engage the screws, 5^a, and move the piston and piston rod rearwardly to release the brake. We prefer to employ in the vacuum pipe line, 62, a check valve of the type illustrated in Fig. 11, in which the valve is normally held closed by a spring preferably capable of adjustment as set forth in our former application before referred to. Thus, in Fig. 11, the check valve casing is provided with a hinge valve, 67, provided with a spring, 68, holding it in closed position with a predetermined pressure, which may be obtained by calibrating the spring, but we prefer to provide the spring with an adjusting screw, 69, as indicated in Fig. 11, by which its tension may be set to provide the desired resistance. When starting the engine at cranking speeds, even with the throttle practically closed, as customary, there is little rarification in the manifold, but some air would be exhausted from the actuator cylinder, either simultaneously with the mixture from the carburetor diluting it, or if the throttle were tightly closed, that air might be exhausted before any suction through the carburetor takes place, and result in either case in delay in obtaining an explosive mixture. With this form of check valve, the valve, 67, will remain closed when the engine is being started, thus preventing the dilution or delay of the explosive charge, and the valve, 67, will not open until the engine is running at operative speed. We also prefer to provide in the suction line to the actuator cylinder, an outwardly opening vent valve which may be conveniently located in the casing of the check valve, as indicated at 67^a. The object of this vent valve is that, if the foot lever is operated when the engine is not running and the throttle and inlet valves of the motor are closed, and there is not sufficient rarification in the cylinder to

operate the power actuator, the forward movement of the piston by the foot lever would have to compress the air to be expelled from the cylinder, not only to the extent necessary to overcome the spring, 68, and open the check valve, but to force it out through the closed throttle, and this pressure would have a retarding effect on the operation of the brake mechanism by the physical force of the operator to increase the amount of physical force required of the operator. With the vent valve, 67^a, which is preferably a ball valve, held closed by a very light spring, the vent valve will be held closed during normal operations of the parts by the presence of a partial vacuum in the vacuum line, but if, under the circumstances above noted, any pressure is produced between the vent valve and the piston of the actuator, the vent valve, 67^a, will instantly open, thus venting the cylinder and the suction line, so that the actuator may be readily moved and the brake mechanism operated without material resistance.

The check valve and vent valve herein shown, are not specifically claimed herein as they form the subject matter of another application for Letters Patent of the United States, filed by us (June 10, 1926), and given Serial No. 114,934.

Other means than the springs, 51, may be employed for keeping the suction valves, 41 and 42, slightly off their seats when in normal position, for the purpose hereinbefore described. For example, we may provide the valve seats, 14 and 15, and the conical faces of the suction valves which engage the same, the one with slight corrugations of sufficient depth to prevent the valves from making an air tight engagement with their seats under the normal action of the retracting devices therefor, the said valves being made as before stated preferably of a yielding or elastic material, such as molded rubber, so that when subjected to slightly greater pressure, as by the compression of the retracting means, the valves will be forced into air tight engagement with their respective seats. In Figs. 3 and 4 we have shown, for example, a form of valve, indicated at 141—142, formed of molded rubber or other elastic material and having its beveled surface provided with minute corrugations, 141^a, shown somewhat exaggerated in Figs. 3 and 4, which will be sufficient to hold the valves from seating under normal conditions when the parts of the actuator are in the normal or off position, but will flatten out and permit either valve to make an air tight connection with its conical seat when subjected to slightly greater pressure in the operation of the reversing valve mechanism, as hereinbefore described. The operation of the parts with this type of valve will be the same as that previously described.

In Fig. 5 we have shown another modified form of our improved actuator in which the results hereinbefore mentioned are obtained in a slightly different manner. In this form of device the cylinder, piston and reversing valve mechanism of the actuator are constructed substantially as illustrated in Fig. 2, and previously described, except that the springs, 51, for unseating the suction valves are omitted, and the corresponding parts are given the same reference numerals in Fig. 5, with 200 added, and need not be particularly described. In this form of our invention, the central collar, 222, in the vacuum chamber, 217, is so located with respect to the stop, 226, formed by the engagement of the plug or collar on the valve actuating sleeve, 220, with the adjustable follower of the stuffing box, 221, that when the parts are returned to their normal positions by the retracting springs of the foot lever and brake mechanism, the piston will be arrested by the engagement of its hub with the end of the cylinder and the valve actuating sleeve, 220, will be in such position that the central collar, 222, will hold the valve, 242, in this instance at the right hand side of the vacuum chamber, 217, as shown in Fig. 5, slightly off of its seat, by reason of the relative positions of the central collar, 222, and the fitting, 226, which forms a shield to arrest the return movement of the sleeve, 220, under the action of the retracting spring of the foot lever, while the collar, 232, permits the seating of the air inlet valve, 240. This valve, 242, will have been previously opened to connect the suction chamber with the portion of the cylinder in rear of the piston, and as the piston comes to rest, the valve does not completely close so that there will be a rarification or partial vacuum continuously maintained at the rear of the piston, to the right in Fig. 5. In this instance we have shown a passage, 242^a, extending from the valve seat, 215, for the valve, 242, through the piston to the forward side thereof (to the left in Fig. 5). This passage may be made by drilling the piston with a drill of small diameter so that air will not pass through this passage with sufficient rapidity to interfere with the operation of the piston in the reverse direction, or to the right in Fig. 5, when the valve, 242, is open. When, as before stated, the parts come to rest the suction chamber, 217, will therefore be in communication with the cylinder in rear of the piston by the unseated position of the valve, 242, and will also be connected with the cylinder forward of the piston by the passage, 242^a, and will slowly exhaust the air, which is in that portion of the cylinder, admitted through the valve, 240, to effect the reverse movement of the piston. When the valve actuating sleeve, 220, is moved forwardly in the direction of the arrow, Fig. 5, the valve, 130

242, will entirely close, thus sealing the passage, 242^a, and also the passage, 235, before the valves 241 and 243 are opened, to apply the brakes.

The form of our invention shown in Fig. 5 is not specifically claimed herein as it forms the subject matter of a divisional application, filed by us August 30, 1926, and given Serial No. 132,366.

In Fig. 6 we have shown another slight modification of our invention in which the corresponding parts are given the same numerals as in Fig. 2, with 300 added. In this instance the valve, 342, is held off its seat in the normal position of the parts, in exactly the same manner as in the construction shown in Fig. 5, thus insuring a rarification or partial vacuum in that portion of the cylinder in rear of the piston, or to the right in Fig. 6, with which the vacuum chamber, 317, communicates by the passage, 335, and an additional valve is employed for establishing communication between the opposite ends of the cylinder. In order to insure the evacuation of the portion of the cylinder on the other side of the piston, the main body of the piston is in this instance provided with an aperture or passage therethrough indicated at 342^a, having a valve seat, 342^b, at the end adjacent to the forward face of the piston, to receive a valve, 342^c, normally held in closed position by a spring, 342^d, engaging the valve stem, 342^e. The valve stem, 342^e, projects from the rear face of the piston (to the right in Fig. 6) sufficiently to engage a fixed portion of the cylinder, as the head, 302, when the piston reaches its normal or retracted position, and thereby compress the spring, 342^d, and open the valve, 342^c, thus establishing communication between the two ends of the cylinder on opposite sides of the piston, and as the valve, 342, is "cracked" the air introduced into the cylinder on the forward side of the piston to insure its retraction, or return to normal position, will be exhausted as soon as the piston comes to rest, thus maintaining partial vacuum at all times within the cylinder on both sides of the piston when the parts are at rest and the engine is in operation.

Instead of locating the additional valve in the piston itself, it may be located in the head of the cylinder and opened by the piston when it returns to its normal position to establish a communication between the two ends of the cylinder on opposite sides of the piston. Such a construction is illustrated in Fig. 7, in which the corresponding parts are given the same numerals as those in Fig. 2, with the addition of 400, to avoid unnecessary description. In this instance the valve, 442, is held off its seat when the parts are in normal position, in the same manner as indicated and previously described with reference to Figs. 5 and 6. In this instance the head, 402, of the cylinder is provided with passages, indi-

cated at 442^a, communicating with a recess, 442^b, and controlled by a valve, 442^c, the stem of which projects into the interior of the cylinder far enough to be struck by the hub of the piston when it returns to its normal or retracted position, so as to open the valve, 442^c. The recess, 442^b, is connected by a bypass or pipe, indicated at 442^b, with the opposite end of the cylinder, the pipe being conveniently carried through one of the hollow bolts, 402^a, connecting the heads of the cylinder. The effect of this construction will be, as before described, to place both ends of the cylinder on opposite sides of the piston in communication with the vacuum chamber, 417^m when the parts return to and are in normal, or retracted position, so as to maintain a partial vacuum within the cylinder on both sides of the piston at all times.

In Fig. 8, we have shown a further modification of the invention, in which the desired results are accomplished without interfering with the normal operation of the valve mechanism, that is to say, in which all four of the valves of the reversing valve mechanism are permitted to firmly seat when the parts are in normal position. In this figure, the similar parts to those previously described, are given the same reference numerals, with the addition of 500, to avoid unnecessary description, and will be identical with those previously described with reference to Fig. 2. In this instance the head, 502, of the cylinder, is provided with a passage, or passages, 542^a, communicating with a recess 542^b, in which is located a valve seat, 542^c, engaged by a movable valve, 542^d, which valve during the application of the brakes closes communication between the recess, 542^b, and the interior of the cylinder on both sides of the piston. The valve is operated by a ring, 542^e provided with one or more projections, 542^e, extending into the cylinder far enough to be struck by the piston hub when the piston returns to its normal position, so as to insure the opening of the valve, 542^d. The valve seat, 542^c, is connected by a flexible pipe, or tube, 542^f, with the suction pipe, 562, independent of its connection with the reversing valve mechanism, through the hollow valve sleeve, 520, and the valve seat, 542^c, is also connected by a pipe, 542^g, with the cylinder on the forward side of the piston in the same manner as illustrated in Fig. 7. From this construction it will be noted that when the piston moves forward the valve is seated by its frictional engagement with the piston rod, and may be maintained on its seat by a light spring 542^h. When the piston returns to its normal position, moving to the right in Fig. 8, the hub of the piston will engage the pins, 542ⁱ, and open the valve, 542^d, thereby establishing communication between the auxiliary exhaust pipe, 542^f, and both ends of the cylinder, exhausting the air from the cylinder on the

forward side of the piston, and also maintaining the partial vacuum in the cylinder at the rear of the piston, produced in returning the piston to its normal position.

In Fig. 10, we have shown another slight modification of the device illustrated in Fig. 8, Fig. 10, being a partial sectional view in which the parts illustrated in Fig. 2 are given the corresponding numerals with 600 added. In this figure the auxiliary valve, instead of being located centrally of the cylinder head, practically within the stuffing box, as illustrated in Fig. 8, is located in a separate fitting, indicated at 644, provided with a threaded portion, 645, which is screwed into an aperture in the head, 602, of the cylinder. This fitting is provided with a passage, 642^a, communicating with the interior of the cylinder and controlled by an auxiliary valve, 642^d, normally held seated by spring, 642^b, secured in position by a suitable cap, 642^c, and the fitting is also provided with a threaded aperture to receive a flexible suction pipe, 642^f, communicating with the main suction pipe, as described with reference to Fig. 8, and the fitting is also provided with a pipe, 642^e, which communicates with the other end of the cylinder on the opposite side of the piston. The auxiliary valve, 642^d, is provided with a valve stem, 642^a, which projects into the cylinder in position to be engaged by the piston when the latter returns to its normal position, so as to open the valve and establish communication between the vacuum pipe or suction pipe leading to the manifold of the engine, and both ends of the cylinder, and thereby maintaining a partial vacuum within the cylinder on both sides of the piston in exactly the same manner as previously described, with reference to Fig. 8.

The forms of our invention shown in Figs. 6, 7, 8 and 10, and not specifically claimed herein, as they form the subject matter of a divisional application, filed by us August 30, 1926, and given Serial No. 132,365.

Fig. 9 is another modification of our invention, in which the same desirable results are obtained by mechanically unseating the suction valves of the reversing valve mechanism when the parts are in retracted, or normal position. The parts shown in this figure, which correspond with parts shown and previously described in Fig. 2, have been given the same reference numerals with 700 added to avoid unnecessary description, and the parts are in their essentials identical as to construction and operation with those previously described, except as hereinafter particularly pointed out. In the construction illustrated in this figure, the central collar within the vacuum chamber, 717, instead of being made in one piece is formed in two parts. One of these parts, 722, is fast on the valve actuating sleeve, 720, and is so located

with respect to the stop collar, 726, that when the latter engages the adjustable follower, 721^a, of the stuffing box, 721, as the parts come into retracted or normal position, the collar section 722, will slightly unseat the valve, 741, permitting communication between the vacuum chamber, 717, and the cylinder on the forward side of the piston through the passage, 734. The other portion of the collar, indicated at 722^a, is movable longitudinally with respect to the valve actuating sleeve, 720, by means of a 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. In this instance we have shown the vacuum pipe, 732, connected to the valve 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 slight 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 follower, 721^a, of the stuffing box, 721, so as to rock the fitting, 745, in the direction of the arrow, Fig. 9, when the valve sleeve is restored to its retracted or normal position by the retracting spring of the foot pedal, in the manner previously described. 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, 722^a, 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 743 will effect a compression of the cushioning device 750 and closes the valve 742 restoring the movable collar section 722^a and connected parts, as the projection 748 is released. The operation of the actuator proceeds in the manner hereinbefore described. It will be seen that on the return movement of the piston, the pin, 748, will engage the stuffing box follower, 721^a, and effect the "cracking" of the valve, 742, while the sleeve, 720, will be arrested in such position as to hold the valve, 741, slightly "cracked" thereby establishing communication normally between the vacuum chamber, 717, and the cylinder on both sides of the piston, and maintaining partial vacuum therein.

The form of our invention shown in Fig. 9

is not specifically claimed herein, as it forms the subject matter of a divisional application filed by us August 30, 1926, and given Serial No. 132,467.

5 It will be noted that in all the forms of apparatus herein shown, for the purpose of illustrating various embodiments of our invention, all of which are capable of use in the general installation illustrated in Fig. 1, a vacuum is continuously maintained in the actuator cylinder on both sides of the piston when it is in its 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. In all of these forms of our invention, there is no storage tank and after the engine is started the air in the actuator cylinder, and the piping leading to the intake manifold or other suction passage of the engine is exhausted when the apparatus is in its most effective and operative condition, a partial vacuum existing in the cylinder on both sides of the piston. When it is desired to operate the brake mechanism, the pressure of the operator's foot on the foot lever, shifts the reversing valve mechanism so as to place the portion of the cylinder on one side of the piston in communication with the vacuum passage of the engine, the portion of the cylinder on the other side of the piston being placed in communication with the atmosphere, and air will instantly rush in and effect the quick and efficient application of the brake mechanism without delivering any material quantity of air to the interior of the manifold, so that the application of the brakes does not affect the operation of the engine while idling. As before stated, a comparatively slight movement of the piston effects the practical releasing of the brakes where continued applications are desired and therefore comparatively small amounts of air are admitted to the intake or suction passage until the brakes are fully released. The exhausting of the air admitted to effect the operation of the brake mechanism, and also the air subsequently admitted on the forward side of the piston to retract the piston, is effected after the release of the brakes and can be effected gradually and extended over an appreciable period, if desired, by proper adjustment of the regulating valve, 64, shown in Fig. 1, so that the operation of the engine is not materially affected and on the return of the piston to its normal position, a partial vacuum is continuously maintained in the cylinder on both sides of the piston so that the power actuator is in condition at all times while the engine is running for immediate and efficient use to apply the brakes. The check valve, 65, shown in Fig. 1, and interposed in the suction pipe, insures the exhaustion of the cylinder on both sides of the piston to the greatest extent permitted at

any time by the operation of the engine by the manipulation of the throttle valve, while the vent valve, 67^a, shown in Fig. 1, provides for the venting of the cylinder should the motor stop, or the suction fail at any time, and should it become necessary for the operator to apply the brakes by physical power.

In any of the forms of our invention herein shown, there will be an equalization of pressures on opposite sides of the piston, and both ends of the cylinder will be connected with the suction means when the parts are in normal or retracted position. In the forms of our invention illustrated in Figs. 2, 3 and 4, there will also be an equalization of pressures whenever the valve mechanism is restored to normal position, regardless of the position of the piston in the cylinder and the simultaneous opening of the two suction valves, 41 and 42, will effect an instantaneous equalization of pressures at any time, as previously described.

In carrying our invention into effect, it will be noted that the brakes may be applied by admitting air (or other higher pressure fluid), as rapidly as is desired through unrestricted ports to insure quick response of the piston and the rapid application of the brakes, and the brakes may be released by similarly admitting air as rapidly as desired through unrestricted ports to the cylinder on the other side of the piston, to equalize the pressures within the cylinders and permit the draft of the applied brakes to start an instantaneous rearward movement of the piston. The rear end of the cylinder is simultaneously connected with the suction means and it will only be necessary to withdraw a portion of the air from the cylinder in rear of the piston to restore the brake mechanism and piston to the released position, as very little power is required for this purpose in comparison to the power necessary for applying the brakes, the area of the suction connection at the restricting means may obviously be adjusted therefore so as to be of considerably less area than the maximum capacity of the atmospheric or higher pressure fluid inlet, thus enabling us to efficiently prevent material interference with the operation of the engine and stalling it if idling, without retarding materially either the application or the release of the brake mechanism.

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

1. A vacuum-balanced power actuator for automotive vehicles having an internal combustion engine having a throttle control suction passage, comprising a cylinder closed at each end, a piston in said cylinder provided with means for connecting it with a part to be operated, suction connections for connecting the actuator cylinder on both sides of the piston with a portion of the engine in which

suction is produced, connections for supplying higher pressure fluid to the actuator cylinder, valve mechanism controlling said vacuum and pressure fluid connections for connecting the actuator cylinder on both sides of the piston at the same time with said suction connections, at any point in the piston stroke, and operator operated means for moving said valve mechanism into position to disconnect either end of the cylinder from suction and connect it with higher fluid pressure to effect a movement of the piston.

2. A vacuum-balanced power actuator for automotive vehicles having an internal combustion engine having a throttle control suction passage, comprising a cylinder closed at each end, a piston in said cylinder provided with means for connecting it with a part to be operated, suction connections for connecting the actuator cylinder on both sides of the piston with a portion of the engine in which suction is produced, connections for supplying higher pressure fluid to the actuator cylinder, valve mechanism controlling said vacuum and pressure fluid connections, operator operated means for moving parts of said valve mechanism into position to disconnect either end of said cylinder from suction and connect it with higher fluid pressure to effect a movement of the piston, and means brought into operation upon the return movement of the actuator piston to released position, for automatically positioning parts of said valve mechanism to connect the cylinder on both sides of the piston with vacuum.

3. A vacuum-balanced power actuator for automotive vehicles having an internal combustion engine having a throttle control suction passage, comprising a cylinder closed at each end, a piston in said cylinder provided with means for connecting it with a part to be operated, suction connections for connecting the actuator cylinder on both sides of the piston with a portion of the engine in which suction is produced, connections for supplying higher pressure fluid to the actuator cylinder, valve mechanism controlling said vacuum and pressure fluid connections, operator operated means for moving parts of said valve mechanism to connect the actuator cylinder on both sides of the piston at the same time with the suction connections at any point in the piston stroke, and to disconnect either end of the said cylinder from suction and connect it with the higher fluid pressure to effect a movement of the piston, and means brought into operation upon the return movement of the actuator piston to released position, for automatically positioning parts of said valve mechanism to connect the cylinder on both sides of the piston with vacuum.

4. In a vacuum brake mechanism for automotive vehicles provided with an internal combustion engine having a throttle con-

trolled suction passage, the combination with a vacuum-balanced power actuator comprising a cylinder closed at both ends, a piston provided with means for connecting it with brake mechanism, suction connections for connecting the actuator cylinder on both sides of the piston at the same time with said suction passage, connections for supplying higher pressure fluid to the actuator cylinder on both sides of the piston, valve mechanism controlling said suction and pressure fluid connections, operator operated means for positioning parts of said valve mechanism to connect the actuator cylinder on both sides of the piston with said suction connections at any point in the piston stroke, and to disconnect the cylinder at one side of the piston from suction and connect it with higher fluid pressure, and means coacting with the piston for positioning parts of the valve mechanism to connect the cylinder on both sides of the piston with said vacuum connections.

5. A vacuum-balanced power actuator for automotive vehicles having an internal combustion engine having a throttle control suction passage, comprising a cylinder closed at each end, a piston in said cylinder provided with means for connecting it with a part to be operated, suction connections for connecting the actuator cylinder on both sides of the piston with a portion of the engine in which suction is produced, connections for supplying higher pressure fluid to the actuator cylinder, and a single valve mechanism movable with and with respect to the piston for controlling said vacuum and pressure fluid connections, operator operated means for moving parts of said valve mechanism into position to disconnect either end of said cylinder from suction and connect it with higher fluid pressure to effect a movement of the piston, and means brought into operation upon the return movement of the actuator piston to released position, for automatically positioning parts of said valve mechanism to connect the cylinder on both sides of the piston with vacuum.

6. A vacuum-balanced power actuator for automotive vehicles having an internal combustion engine for propelling the same, comprising a cylinder closed at each end, a piston in said cylinder provided with means for connecting it with a part to be operated, suction connections for connecting the actuator cylinder on both sides of the piston with a portion of the engine in which suction is produced, connections for supplying higher pressure fluid to the actuator cylinder, and a single valve mechanism movable with and with respect to the piston for controlling said vacuum and pressure fluid connections, operator operated means for moving parts of said valve mechanism to connect the actuator cylinder on both sides of the piston at the same time with the suction connections at any

point in the piston stroke, and to disconnect either end of the said cylinder from suction and connect it with the higher fluid pressure to effect a movement of the piston, and means brought into operation upon the return movement of the actuator piston to released position, for automatically positioning parts of said valve mechanism to connect the cylinder on both sides of the piston with vacuum.

7. In a power actuator, the combination with a cylinder closed at both ends, a piston in said cylinder, a reversing valve mechanism including a vacuum chamber and an air chamber, passages extending from said chambers to said cylinder on opposite sides of said piston, a vacuum outlet connected with said vacuum chamber, an air inlet connected with said air chamber, valves for controlling said vacuum and air passages, and means interposed between each suction valve and its seat for normally holding said suction valve in partially open position, and an operator operated part for said valve mechanism.

8. In a power actuator, the combination with a cylinder closed at both ends, a double acting piston in said cylinder, a reversing valve mechanism including a vacuum chamber and suction passage 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, a vacuum producing means connected with said vacuum chamber, and yielding means interposed between each of said suction valves and its seat for holding said valves in partially open position when the parts are in normal position.

9. In a power actuator, the combination with a cylinder closed at both ends, a piston in said cylinder, a reversing valve mechanism including a vacuum chamber and an air chamber, passages extending from said chambers to said cylinder on opposite sides of said piston, a vacuum outlet connected with said vacuum chamber, an air inlet connected with said air chamber, valves for controlling said vacuum and inlet passages, and means acting upon said suction valves to hold the same in partially open position to connect opposite sides of the piston with the vacuum chamber and an operator operated part for said valve mechanism.

10. In vacuum brake mechanism for automotive vehicles provided with an internal combustion engine having a throttle controlled suction passage, the combination with a vacuum balanced power actuator comprising a cylinder closed at both ends, a piston therein provided with means for connecting it with a part to be actuated, 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, relatively movable valves for controlling said suction and air inlet passages, a connection from said vacuum chamber to the suction passage of the engine, means normally tending to hold said suction valves open for connecting said suction passage of the engine with said cylinder on both sides of the piston at the same time when the parts are in a position of rest, and a single operator operated part for actuating said suction and inlet valves.

11. In vacuum brake mechanism for automotive vehicles provided with an internal combustion engine having a throttle controlled suction passage, the combination with a vacuum balanced power actuator comprising a cylinder closed at both ends, a piston in said cylinder, reversing valve mechanism for the actuator 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, and valves for controlling said suction and air inlet passages, brake mechanism connected with said piston, a single operator operated part connected with said suction and inlet valves for actuating them, means for holding at least one of said suction valves open, and means establishing a connection between the ends of the cylinder on opposite sides of the piston to connect the portions of the cylinder on opposite sides of the piston with the suction passage of the engine at the same time when the parts of the actuator are in a position of rest.

12. In vacuum brake mechanism for an automotive vehicle, provided with an internal combustion engine having a throttle controlled suction passage for the explosive charges therefor, the combination with a power actuator comprising a cylinder closed at both ends, a double acting piston in said cylinder, reversing valve mechanism connected with said piston and comprising a suction chamber connected with the suction passage, suction passages for connecting said chamber with the cylinder on both sides of the piston, suction valves controlling said passages, inlet passages for connecting the cylinder on both sides of the piston with a source of higher pressure, inlet valves controlling said inlet passages, an operator operated part for controlling said suction and inlet valves and means for effecting the simultaneous opening of said suction valves when the piston is in its normal or retracted position, to equalize pressures in the cylinder and maintain a partial vacuum within the cylinder on both sides of the piston, and brake mechanism connected with the piston.

13. In vacuum brake mechanism for auto-

motive vehicles provided with an internal
 combustion engine having a throttle con-
 trolled suction passage, the combination with
 a power actuator comprising a cylinder closed
 at both ends, a piston in said cylinder, re-
 versing 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, and valves movable with respect
 to each other for controlling said suction and
 air inlet passages, means for connecting said
 vacuum chamber with said suction passage of
 the engine, and means for holding the suction
 valves unseated at the same time when the
 parts of the actuator are in normal position to
 maintain a partial vacuum within the cylinder
 on both sides of the piston.

14. In vacuum brake mechanism for an
 automotive vehicle provided with an internal
 combustion engine having a throttle con-
 trolled suction passage, the combination with
 a power actuator comprising a cylinder closed
 at both ends, a piston in said cylinder, a suc-
 tion pipe for connecting the cylinder with the
 suction passage of the engine, reversing valve
 mechanism interposed between said suction
 pipe and the cylinder, and for normally main-
 taining the cylinder on both sides of the pis-
 ton, at the same time, in communication with
 the suction pipe when the piston is in off or
 normal position, means for supplying higher
 pressure fluid to said cylinder under the con-
 trol of said reversing valve mechanism, brake
 mechanism for the vehicle connected with
 said piston, an operator operated part for
 controlling said reversing valve mechanism,
 and a check valve interposed between the re-
 versing valve mechanism and the suction pas-
 sage of the engine for maintaining in the
 cylinder on both sides of the piston the great-
 est degree of rarification produced in the suc-
 tion passage of the engine between operations
 of the actuator.

15. In a power actuator, the combination
 with a cylinder closed at both ends, a piston
 in said cylinder provided with means for con-
 necting it with a part to be operated, a single
 suction connection for connecting the cylin-
 der on both sides of the piston with a source
 of suction, controlling valve mechanism
 movable with the piston and having parts
 relatively movable with respect thereto,
 means for connecting said valve mechanism
 with a source of higher pressure, an operator
 operated part operatively connected with the
 said relatively movable portions of the valve
 mechanism, and means for connecting the
 portions of the cylinder on opposite sides of
 the piston, at the same time with said suction
 connection, when the piston is in retracted
 position, said controlling valve mechanism
 serving to disconnect the portion of the cylin-
 der on one side of the piston from said suction

connection and connect the said portion of the
 cylinder with a source of higher pressure, by
 a movement of said relatively movable parts
 of the valve mechanism with respect to the
 piston under the control of said operator
 operated part, said operator operated part be-
 ing connected with said actuator piston and
 the part to be operated, thereby, by means
 having lost motion sufficient to insure the
 operation of said relatively movable parts of
 the valve mechanism, whereby the operator
 may apply his physical power to the part to
 be operated in addition to the power of the
 actuator, or in case of failure of power.

16. In vacuum brake mechanism for an
 automotive vehicle provided with an internal
 combustion engine having a throttle con-
 trolled suction passage, the combination with
 a power actuator comprising a cylinder closed
 at both ends, a piston in the cylinder, revers-
 ing valve mechanism located in said piston,
 and comprising a suction chamber, suction
 passages for connecting it with the cylinder
 on both sides, and suction valves controlling
 said passages, inlet passages for connecting
 the cylinder on both sides of the piston with
 a source of higher pressure, inlet valves con-
 trolling said passage, said suction chamber
 being provided with means for connecting it
 with the suction passage of the engine, a lon-
 gitudinally movable valve actuating device
 extending through all of said valves and
 constructed to open one of said inlet valves,
 and one of said suction valves, when moved
 in either direction, an operator operated part
 connected with said valve actuating device,
 said suction valves being normally main-
 tained in slightly opened condition to connect
 the portion of the cylinder on opposite sides
 of the piston with each other and with said
 suction chamber, at any point in the stroke of
 the piston to equalize pressures on opposite
 sides of the piston by transfer from the high
 pressure to the low pressure side, and means
 for maintaining said suction valves in their
 normal position when the piston is in its re-
 tracted or off position, to maintain normally
 a partial vacuum within the cylinder on both
 sides of the piston.

In testimony whereof we affix our signa-
 tures.

CALEB S. BRAGG.
 VICTOR W. KLIESRATH.

Certificate of Correction

Patent No. 1,879,598.

September 27, 1932.

CALEB S. BRAGG, ET AL.

It is hereby certified that error appears in the printed specification of the above-numbered patent requiring correction as follows: Page 3, line 93, after "valve" first occurrence, insert the word *seat*, and lines 111 and 112, for "instances" read *instance*; page 4, line 22, for "affects" read *effects*; page 7, line 73, for "442^b" read *442^a*; page 9, line 109, for "far" read *for*; page 10, line 14, claim 2, for "automotive" read *automotive*; and line 115, claim 6, strike out the words "for propelling the same" and insert instead *having a throttle control suction passage*; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 14th day of March, A. D. 1933.

[SEAL.]

M. J. MOORE,
Acting Commissioner of Patents.