

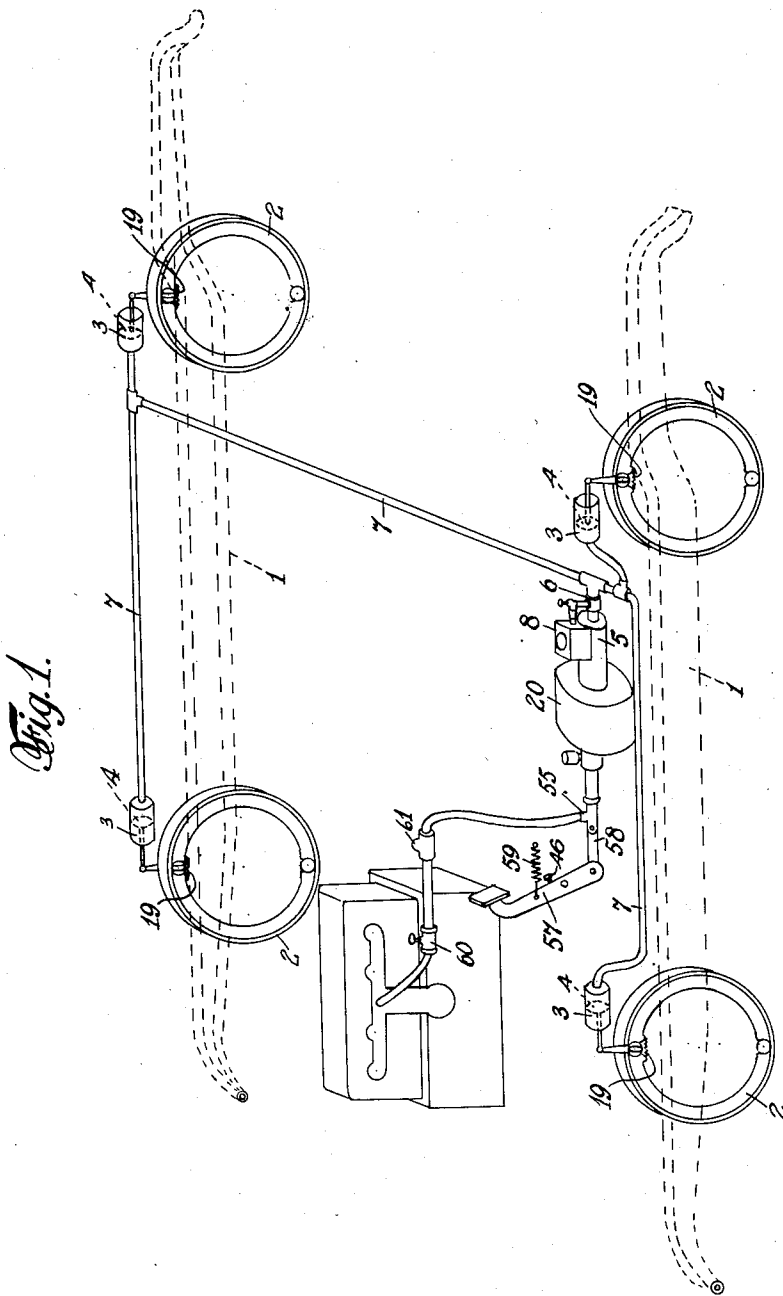
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C. S. BRAGG ET AL.

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HYDRAULICALLY ACTUATED BRAKE MECHANISM

Original Filed Aug. 20, 1925 2 Sheets-Sheet 1



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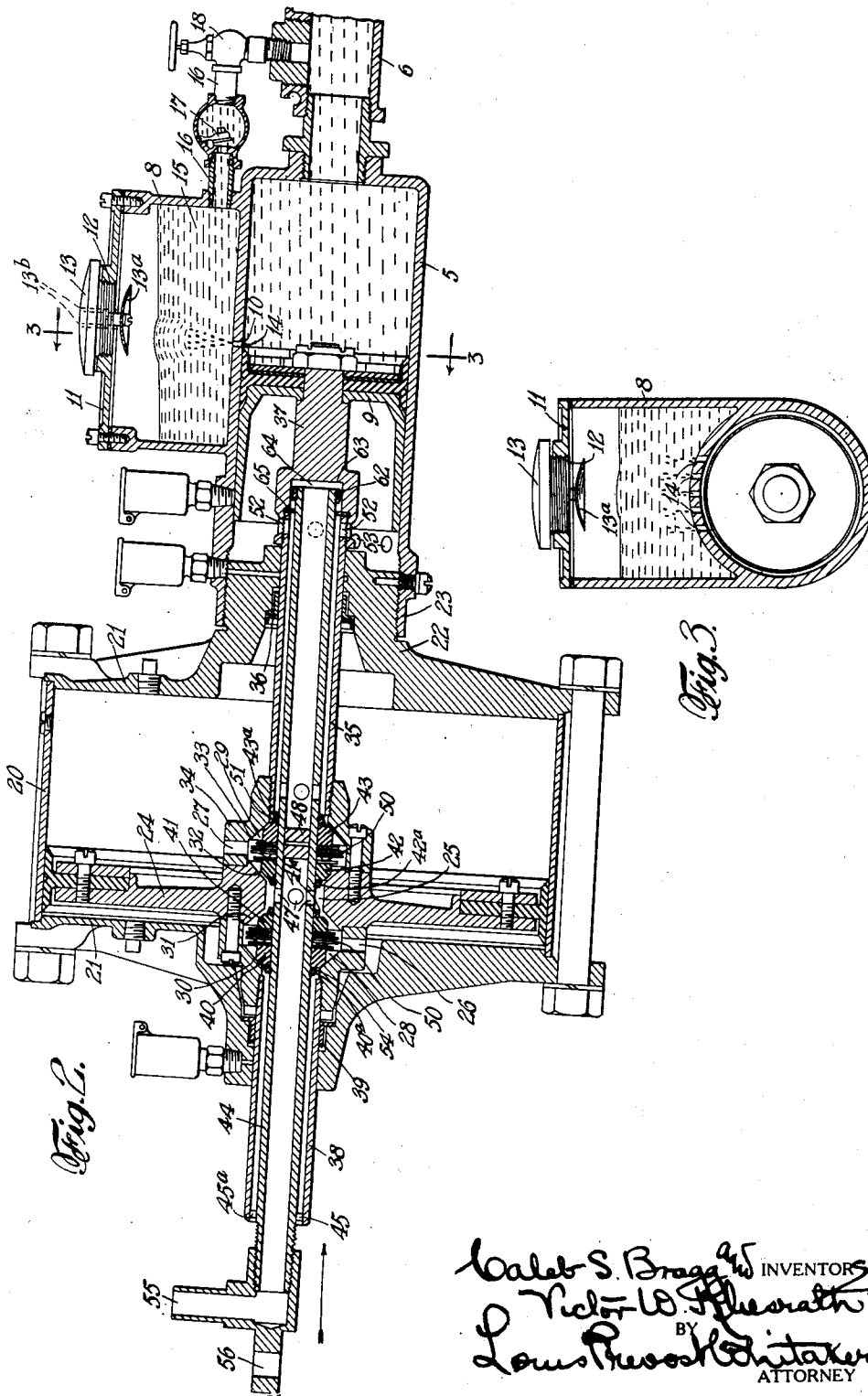
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HYDRAULICALLY ACTUATED BRAKE MECHANISM

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2 Sheets-Sheet 2



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HYDRAULICALLY-ACTUATED BRAKE MECHANISM

Application filed August 20, 1925, Serial No. 51,300. Renewed October 13, 1928.

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

Our invention consists in an improved hydraulic brake system, operatable either by the physical power of the operator, or by means of a power actuator operated in any desired manner under the control of the operator, the power being supplied, for example, by suction from the intake manifold of an internal combustion engine, our improved system being especially adapted for use in connection with one or any number of brake mechanisms thereof.

In the operation of hydraulic brake mechanisms, it is important and necessary that the system be kept full of oil at all times, which necessitates the addition of oil from time to time to make up deficiencies caused by leakage or otherwise. It is also important to provide means for eliminating air occluded in the oil in order that the full force of the main hydraulic piston may be applied through the line or lines to the auxiliary hydraulic pistons which actuate brake mechanisms, through a non-compressible medium. To this end the main hydraulic cylinder is preferably supported in a slightly inclined position, so that when the main hydraulic piston is retracted, the portion of the cylinder adjacent thereto will be the highest portion, and we provide said cylinder at this point with a port or ports communicating with the oil reservoir in such manner that a large body of oil of greater diameter horizontally than said port or ports is maintained immediately adjacent thereto, said port or ports being located adjacent to the main hydraulic piston, so that they will remain open when the said piston is in retracted or off posi-

tion, but will be closed by the first portion of the movement of the piston.

In the arrangement of the various cylinders actuated by the main hydraulic cylinder, it is preferable to locate them below the level of the main cylinder, so that the port or ports above mentioned shall be not only at the highest point of the main hydraulic cylinder, but also at the highest point of the hydraulic system. It follows from this arrangement that any occluded air in the system will gradually find its way to the port or ports above mentioned, or be collected in the main hydraulic cylinder, closely adjacent thereto, so that the first movement of the main hydraulic piston will force out such collected air through said port or ports into the large body of oil in the oil reservoir, permitting it to escape in bubbles to the surface thereof. It also follows that when the main hydraulic piston returns to its normal or off position in a short period of time, as for example after an application and release of the brakes, and opens the communicating port or ports above referred to, clean oil, free from air, will enter the main hydraulic cylinder to supply any deficiency therein caused by the displaced air or oil, thus keeping the system automatically filled at all times, while providing for the discharge of occluded air.

Our invention also provides convenient means for effecting the original filling of the system, or the bleeding of the same, at any time when necessary or desirable, as in the case of repair or adjustment of any of the hydraulic cylinders or connections. To this end we provide an oil reservoir which may be the same oil reservoir previously mentioned, or a separate reservoir, as preferred, either independent of or connected with the first mentioned reservoir, and connected to the hydraulic line extending from the main hydraulic cylinder to the cylinder or cylinders operated thereby, and preferably closely adjacent to the main hydraulic cylinder,

by a pipe or passage in which is located a check valve for preventing the return of oil to the reservoir, and a shut off valve by means of which this connecting pipe or passage may be closed when desired. By this means, the system may be filled initially, or at any time, and may also be bled whenever necessary, by opening the shut off valve and operating the main hydraulic piston which will draw oil from the reservoir on the return stroke of the main hydraulic piston, and on the power stroke thereof, will force it into the lines, the check valve preventing the return of the oil to the reservoir, and this operation may be repeated until the system is filled or bled. It is to be understood that the portion of the system to be filled or bled is open to atmosphere during the power stroke of the main piston, but is closed to atmosphere as by the fingers of the operator during the return stroke thereof. The shut off valve may be closed when the system is filled or bled so as to prevent oil being drawn into the main hydraulic cylinder on the return movement of the piston after the application of the brake mechanism, as this would tend to prevent the proper release of the brake mechanism. We may, however, employ this initial filling mechanism in conjunction with the automatic filling mechanism previously referred to, with which it directly cooperates, in which case the shut off valve may be omitted, if desired, provided one oil reservoir is used or connections made between reservoirs, if more than one is employed, as any surplus oil drawn in past the check valve in the communicating pipe or passage on the return movement of the main hydraulic piston, would be displaced through the previously mentioned ports or port connecting the main hydraulic cylinder with the oil reservoir, into said oil reservoir by the force of the retracting springs of the brake mechanism acting through the pistons which operate the brakes upon the oil in the system, and thereby returned to the reservoir.

It will be seen that the venting aperture which establishes a free and unobstructed communication in both directions between the liquid reservoir and the pressure cylinder and the entire hydraulic system connected therewith, enables the reservoir to act as an expansion tank into which and from which the liquid can pass to accommodate the contraction and expansion of the liquid of the entire system.

In the accompanying drawings which show an installation in an automotive vehicle embodying our present invention,

Fig. 1 is a diagrammatic view illustrating the chassis of an automotive vehicle, the hydraulic brake mechanism therefor, and a power actuator for operating the main hydraulic piston, operated by suction from the

intake manifold of an internal combustion engine under the control of the operator.

Fig. 2 is an enlarged sectional view of the actuator, the main hydraulic cylinder and piston and the oil reservoir and its connections with the system.

Fig. 3 is a vertical section on the line 3—3 of Fig. 2.

Referring to Fig. 1, 1 represents the chassis of an automotive vehicle, which is provided in this instance with four wheel brake mechanisms, indicated generally at 2, 2, 2, 2; the brake mechanisms themselves form no part of our present invention and may be of any usual or desired type. A hydraulic cylinder and piston are provided for the operation of each brake mechanism, the said brake cylinders being indicated diagrammatically at 3, 3, 3, 3, and the pistons at 4, 4, 4, 4, connected in any desired manner with the brakes which they control, so that the movements of these pistons will simultaneously apply or release the brakes connected therewith. 5 represents the main hydraulic cylinder shown on an enlarged scale in Figures 2 and 3, and connected with each of the cylinders, 3, 3, 3, 3, by a main pipe indicated at 6, and branch pipes, 7, 7, 7, 7, constructed in any usual or desired manner. In this instance we have shown an oil reservoir, indicated at 8, which is arranged to provide for both the initial filling or bleeding of the system, and also for automatically maintaining the system filled, and for venting the system of air, and for compensating for the expansion and contraction of the liquid under changes of temperature. As indicated in Fig. 2, the main hydraulic cylinder is preferably supported in an inclined position, so that the end occupied by the main hydraulic piston, 9, when in retracted position, as shown in Fig. 2, is higher than the outer end of the cylinder, 5, so that a small space, indicated at 10, in Fig. 2, may be provided at the highest point of the cylinder, forward of the piston, 9, where particles of occluded air may collect when the piston is in off position. The system is so arranged that this point is the highest point of the entire system and therefore as the pressure cylinder is at all times in free and unobstructed communication with pipe, 6, and through it with every part of the system, all air occluded in the oil throughout the entire system will gradually and eventually work to this point.

The oil reservoir, 8, is located above the main hydraulic cylinder, 5, and may be conveniently formed integrally therewith, as shown in Figs. 2 and 3, being provided preferably with a removable cover plate, 11, having a filling aperture, 12, closed by a removable cap, 13, provided with the usual vent holes, 13^b, in the cap, said cap having a part extending into the reservoir and provided with a baffle plate or deflector, 13^a, to prevent the oil from splashing out of the vent

holes, 13^b, in the cap. The hydraulic cylinder, 5, is provided with a venting compensating and filling aperture, or apertures, indicated at 14, located in the wall of the cylinder at the highest point and just forward of the piston, 9, when in retracted position, so that any air collecting in the space indicated at 10, may bubble up through the holes, 14, and the large body of oil indicated at 15, in the oil reservoir, to the surface thereof. It will also be seen that the first movement of the hydraulic piston, 9, in the direction of the arrow in Fig. 2, will have the effect of forcing out some oil and any air in the space indicated at 10, which air will be forced upward through the body of oil in the reservoir, 8, so that the natural operation of the hydraulic piston, 9, will free the system from occluded air. It will also be seen that on the return stroke of the piston, 9, under the power of the actuator, a slight rarification will be produced within the cylinder, 5, and as soon as the piston, 9, uncovers the apertures or ports, 14, oil from the large body of oil, 15, in the reservoir, will be sucked or will flow in to replace the oil previously forced out of holes, 14, or any oil lost, and automatically keep the system full. It is important and desirable that the port or ports, 14, should communicate directly with a large body of oil of greater diameter horizontally than the port or ports, instead of with a pipe of small diameter, so that the air bubbles which are forced from the hydraulic cylinder by the forward movement of the piston, 9, will pass at once to the surface of the oil in the reservoir and not be drawn back into the cylinder upon the return of the piston, 9, when oil is admitted to the cylinder from the reservoir, to keep the system full. We therefore prefer to mount the oil reservoir directly upon or very closely adjacent to the hydraulic cylinder, 5. We wish it to be understood, however, that good results may be obtained by providing a communicating pipe or passage of large diameter between the oil reservoir and the port or ports, 14, if it should be desired to locate the oil reservoir at a distance from the cylinder, 5, so that a large body of oil is provided, into which the air bubbles may be forced and pass rapidly to the surface of the oil in the reservoir. In such instance, however, such pipe or passage of large diameter would constitute a part of the reservoir, rather than a connection between the reservoir and the port or ports, 14.

In a hydraulic braking system, it is necessary to fill the system with oil either at the factory when the system is assembled or each time it is necessary to disassemble the system, in whole or in part, for repairs. To take care of the latter case, it is usual to provide hydraulic brake systems with a separate oil pump other than the pump or plunger used to

build up the pressures and supply the liquid to apply the brakes. We propose to eliminate such extra pump in our system and to supply the necessary oil for filling the system from an oil reservoir, which may be the oil reservoir, 8, as shown in Fig. 2. In this instance, the reservoir, 8, is shown connected by a short pipe line, indicated at 16, with the main hydraulic power line, 6, and in the pipe or passage, 16, we provided, preferably, a check valve indicated at 17, arranged to prevent the return of oil to the reservoir through the pipe, 16, and a hand operated cut off valve, indicated at 18, for the purpose of closing communication between the pipe, 6, and the reservoir, through the pipe, 16, when desired. When it is desired to fill the system or bleed the hydraulic lines, the shut off valve, 18, is opened and the main hydraulic piston, 9, is moved in the direction of the arrow its full length, forcing the oil into the branch lines, 7, connected with the pipe, 6. The ends of the lines are then closed by the fingers, or otherwise, while the piston, 9, is retracted, either by hand or power, as hereinafter described. Oil will be drawn from the reservoir, 8, through the check valve, 17, pipe, 16, and the adjacent portion of pipe, 6, into the main hydraulic cylinder, 5. The piston, 9, is again moved outwardly in the direction of the arrow in Fig. 2, forcing the oil into the branch lines, and this operation is repeated until the entire system, including the main hydraulic cylinder, 5, the main pipe, 6, branch lines, 7, and the hydraulic brake actuating cylinders, 3, are filled. On the forward stroke of the piston, 9, the check valve, 17, will obviously close, and prevent the return of oil into the reservoir, and insure it being forced into the system.

The purpose of the shut off valve is to prevent oil being sucked into the system when the brakes have been released, after they have been applied for the operation of the main hydraulic piston, either by hand or by power, as hereinafter described. It will be understood that the brakes are both positively applied and positively released by their respective pistons, 4. On the return stroke of the main hydraulic pistons, 9, a partial vacuum is created in the main cylinder, 5, which withdraws the oil from the brake applying cylinders, 3. If the shut off valve, 18, were open during such retracting movement of the main hydraulic piston, 9, some oil would be sucked into the cylinder, 5, from the reservoir, through the pipe or passage, 16, and this would prevent the brakes from being completely released, if the port or ports, 14, were not provided for the automatic filling of the system, and we therefore prefer, in any case, to provide the shut off valve, 18, in the pipe or passage, 16; where, however, as shown in Fig. 2, the port or ports, 14, are provided in the main hydraulic cylinder, the shut off valve

could be dispensed with, if desired, where the pipe, 16, and ports, 14, are connected to a common reservoir or reservoirs, as any oil sucked into the cylinder through the check valve on the return stroke of the piston, would be forced out of the cylinder, 5, through the port or ports, 14, as soon as the latter are uncovered by the piston, 9, by the action of the retracting springs with which the brake mechanisms are provided, as a matter of common practice, such springs being indicated for example, at 19 in Fig. 1. We prefer, however, as before stated, to provide the shut off valve, 18, so that it can be used, if desired.

We wish it to be understood that the power for operating the main hydraulic piston, 9, may be physical power of the operator, exerted through an ordinary foot lever or hand lever, or otherwise, or it may be supplied as indicated in the accompanying drawing, by power. In the present instance, we have shown an arrangement wherein the main hydraulic piston, 9, may be operated by power under the control of the operator, the power being supplied from the intake manifold of the engine, or directly by the physical power of the operator on failure of power for any reason. For this purpose we have shown, in connection with the main hydraulic cylinder, 5, a power actuator substantially of the kind illustrated in our former application for Letters Patent of the United States, filed December 22, 1923, Serial No. 682,346, although the specific valve mechanism for the actuator herein shown differs somewhat from that shown in our former application above referred to. This valve mechanism, however, forms no part of the present invention. As previously stated, the actuator comprises a cylinder, 20, closed at both ends by heads, 21, one of which is shown provided with a threaded extension, 22, engaged by an internally threaded portion, 23, on the hydraulic cylinder, 5, so that the cylinders, 20, and 5, are connected and maintained in co-axial relation. The actuator cylinder is provided with a piston, 24, the hub, 34, of which is provided with a hollow piston rod, 35, extending through a stuffing box, 36, into the hydraulic cylinder 5, where it is connected with the piston, 9, thereof, in any desired manner, in this instance by means of a stud, 37, connecting the piston rod, 35, with the head of the main hydraulic piston, 9. The opposite end of the piston hub, 34, of the actuator, may also be provided with a hollow sleeve, 38, extending through a stuffing box, 39, in the adjacent head, 21. The piston hub, 34, is also provided with a suction chamber, 25 adapted to be placed in communication with the actuator cylinder on both sides of the piston by means of ports, indicated at 26 and 27, for example, communicating with valve chambers, 28 and 29, respectively, on opposite sides of the suction chamber, 25.

The valve chamber, 28, is provided with conical valve seats, indicated at 30 and 31, engaged by oppositely disposed valves, 40 and 41, yieldingly pressed in opposite directions by a cushioning device, 50. The valve chamber, 29, is provided with valve seats, 32 and 33, engaged by valves, 42 and 43, respectively, yieldingly pressed in opposite directions by a cushioning device, 50.

44 represents a longitudinally movable valve actuating sleeve extending through the sleeve, 38, the hub of the piston, 24, and through the hollow piston rod, 35, the outer end of the sleeve, 38, being provided with a collar, indicated at 45, forming a guide for the sleeve, 44, and provided with air inlet apertures, 45^a. This valve actuating sleeve passes through all of the valves, 40, 41, 42 and 43, and is provided with collars, indicated at 40^a, 41^a, 42^a and 43^a, secured thereto, for actuating these valves, the said collars being so arranged that when the sleeve is in its normal or off position, in which it will be arrested by the engagement of the foot lever with the usual stop, 46, when the latter is returned to normal or retracted position, the valves, 41 and 42, will be held off their seats, while the valves, 40 and 43, will be held seated. The sleeve, 44, is provided with a plurality of apertures, indicated at 47, communicating with the suction passage, 25, beyond which the interior of the sleeve is provided with a plug, indicated at 48, separating the opposite end portions of the sleeve.

The piston hub, 34, is provided with an air chamber, 51, at its inner end (at the right, Fig. 2), communicating with the atmosphere by means of apertures indicated at 52, in the portion of the hollow piston rod, 35, which extends into the hydraulic cylinder, 5, the latter being provided with one or more breathing apertures, indicated at 53, communicating with the atmosphere in rear of the piston, 9. The opposite end of the hub, 34, of the actuator piston, is also provided with an air chamber, 54, communicating with the atmosphere through the space between the sleeve, 38, and the sleeve, 44, by means of apertures, 45^a.

The valve actuating sleeve, 44, is connected by a suction pipe or passage, 55, with the intake manifold of the engine, and said pipe or passage is preferably provided with an adjustable regulating valve, 60, and a check valve, 61, between the regulating valve, 60, and the actuator. The said valve actuating sleeve is also provided with an attaching device or eye, 56, by which it is connected to a suitable operator operated device. In this instance, I have shown a foot lever, 57, mounted on the chassis, 1, and connected by a link, 58, with the valve actuating sleeve, the said foot lever being provided with a retracting spring, 59.

In the form of actuator herein shown, the

valves, 41, 42, of the reversing valve mechanism being normally held in open position, the actuator cylinder, 20, is connected on both sides of the actuator piston with the suction pipe or passage, 55, thus maintaining a partial vacuum on both sides of the piston. If the operator presses his foot on the foot lever, the valve sleeve, 44, will be moved in the direction of the arrow at the left of Fig. 2, thus opening the valve, 42, further, closing the valve, 41, and opening the valve, 40. This connects the actuator cylinder in rear of the piston (to the right in Fig. 2) with the suction chamber, 25, and connects the air inlet chamber, 54, with the cylinder on the opposite side of the piston, causing the piston to move to the right in Fig. 2, and imparting a similar movement to the main hydraulic piston, 9. As the actuator cylinder in rear of the piston was already exhausted, the movement of the actuator piston to apply the brakes will not withdraw any material quantity of air from the actuator cylinder, and the operation of the engine will not be affected. The first portion of the movement of the piston, 9, closes the port or ports, 14, as before described, having previously forced out any occluded air through said port or ports, and the oil in the main hydraulic cylinder, 5, will then be forced through the pipe, 6, and branch pipes, 7, into the brake actuating cylinder or cylinders, 3, and apply the brakes. The movement of the piston overtakes the movement of the valve actuating sleeve, 44, as soon as the movement of the latter stops, and restores the actuator to a balanced condition by closing the valve, 40, and opening the valve, 41. When the foot lever is released, the retracting spring effects its return movement, causing the valve sleeve to move in a direction opposite to that of the arrow at the left in Fig. 2, closing the valve, 42, and opening the valve, 43, to admit atmospheric air in rear of the piston, while the forward portion of the actuator cylinder is connected with the suction pipe, and restoring the parts to normal or off position, thereby retracting the main hydraulic piston, 9, and releasing the brakes. During the return movement of the actuator piston, the air previously admitted forward of the piston to apply the brakes, will be withdrawn through the suction pipe, 55, and will be distributed gradually into the intake manifold of the engine, by the regulating or restricting valve, 60, so as not to interfere with the operation of the engine.

We also prefer to provide means, permitting lost motion, for connecting the operator operated device, or foot lever, with the actuator piston, so that the operator may add his physical force to that of the actuator when desired, and so that the operator may operate by his physical force the actuator piston and the hydraulic piston in case of failure of

power, or whenever it may otherwise become desirable. In this particular instance we have shown the valve actuating sleeve, 44, provided with an enlargement or collar, 62, located between a shoulder, 63, in a recess, 64, in the stud, 37, into which said valve sleeve extends, and a ring or collar, 65, carried by said stud, sufficient lost motion being provided between the collar, 62, and the shoulder, 63, and ring or collar, 65, to permit of the operation of the reversing valve mechanism. When the brakes have been fully applied by the actuator and main hydraulic piston in the manner previously described, the operator may, by still further depressing the foot lever, bring the end of the sleeve, 44, into engagement with the shoulder, 63, and apply his physical force to the hydraulic piston, 9. In case of failure of power for any reason, it will also be seen that the operator may, by this means, directly actuate the main hydraulic piston, 9, in either direction, by means of the foot lever and its retracting spring.

It is to be understood that in carrying our invention into effect the main hydraulic piston is double acting, that is to say, is positively operated in both directions. As before stated, it may be operated in both directions manually or may be operated in one direction manually, or by power, and in the opposite direction by a retracting spring, or it may be operated in both directions by power. In the embodiment of our invention which we have selected for purposes of illustration, and have shown and described therein, the main hydraulic piston is arranged to be normally operated in both directions by the double acting piston of our power actuator and on failure of power it may be operated in one direction manually and in the other by a retracting spring, but we do not limit ourselves to the specific operating means.

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

1. In a hydraulic brake system, the combination with a main hydraulic cylinder and a main hydraulic piston therein, said cylinder being provided with a venting port adjacent to the position of the piston when in retracted position, of an oil reservoir located above said cylinder and communicating therewith, so as to provide a large body of oil of greater diameter, horizontally, than said port, immediately adjacent thereto, into which occluded air may pass directly to the surface of the oil in the reservoir, to prevent said air from being returned to the cylinder, a hydraulic actuating cylinder and piston, pipe connections between said main hydraulic cylinder and the actuating cylinder, and operator operated means for controlling the movement of said main hydraulic piston, said oil reservoir being provided with a

passage communicating with the main hydraulic cylinder adjacent to its discharge end, to provide for the filling or bleeding of the hydraulic system, and a check valve for preventing the return movement of the liquid through said passage, whereby any excess oil drawn through said passage on the return movement of the main hydraulic piston, in normal operations thereof, may be expelled through said port and returned to the reservoir.

2. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, said cylinder being provided with a port adjacent to the position of the piston when in retracted position, an oil reservoir communicating with said port and located above the said cylinder, a hydraulic brake actuating cylinder, a piston therein, brake mechanism operatively connected therewith, and retracting means for said brake mechanism, and pipe connections between said main and actuating cylinders, said reservoir being provided with a communicating passage extending therefrom to the main hydraulic cylinder adjacent to the discharge end of the same, for filling or bleeding the system, and a check valve in said passage for preventing the return of the liquid to the reservoir through said passage, whereby any liquid drawn into the system through said passage, by the return stroke of the main hydraulic piston in normal operations thereof, will be expelled through said port, when the piston is in off position, by the retracting means for said brake mechanism.

3. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, said cylinder being provided with a port adjacent to the position of the piston when in retracted position, an oil reservoir communicating with said port and located above the said cylinder, a hydraulic brake actuating cylinder, a piston therein, brake mechanism operatively connected therewith, and retracting means for said brake mechanism, and pipe connections between said main and actuating cylinders, said reservoir being provided with a communicating passage extending therefrom to the main hydraulic cylinder adjacent to the discharge end of the same, for filling or bleeding the system, and a check valve in said passage for preventing the return of the liquid to the reservoir through said passage, and a shut off valve in said passage for preventing the passage of any liquid therethrough during the normal operations of the main hydraulic piston.

4. In a hydraulic brake system, the combination with a main hydraulic cylinder, a main hydraulic piston working therein, said cylinder being provided with a venting and filling port on its upper side, adjacent to the position of the piston when in retracted po-

sition, and adapted to be closed by the first part of the active stroke of the piston, a liquid reservoir located above said cylinder and communicating with said port by means providing a body of oil of greater horizontal diameter than said port, adjacent thereto, to permit the escape of occluded air through said liquid to the surface of the liquid in the reservoir, and prevent said air from being drawn back into said cylinder in maintaining the system in filled condition, a hydraulic brake actuating cylinder, a piston therein, brake mechanism connected with said piston, pipe connections extending from the main hydraulic cylinder to said brake actuating cylinder, a pipe connecting said reservoir with the system adjacent to the discharge end of said main hydraulic cylinder, for filling or bleeding the system, a check valve in said pipe for preventing the return of liquid therethrough to the reservoir, a shut off valve in said connecting pipe, and means for operating the main hydraulic piston.

5. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, a brake actuating hydraulic cylinder and piston, brake mechanism connected with said latter piston, and pipe connections from the main hydraulic cylinder to said brake actuating cylinder, a liquid reservoir, said reservoir being provided with a passage extending therefrom and communicating with the main hydraulic cylinder adjacent to the discharge end thereof, for filling or bleeding the system, a check valve in said passage for preventing the return of liquid therethrough to the reservoir, and a shut off valve in said passage.

6. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, a brake actuating hydraulic cylinder and piston, brake mechanism connected with said latter piston, and pipe connections from the main hydraulic cylinder to said brake actuating cylinder, a liquid reservoir, a pipe connecting said reservoir with the pipe connections extending from the main hydraulic cylinder to the brake actuating cylinder, and connected thereto adjacent to the discharge end of the main hydraulic cylinder, a check valve in said pipe for preventing the return of liquid therethrough to the reservoir, and a shut off valve in said pipe.

7. In a hydraulic brake system, the combination with a main hydraulic cylinder, and a main hydraulic piston therein, said cylinder being provided with a venting compensating and filling port adjacent to the position of the piston when in retracted position, a liquid reservoir located above said cylinder and communicating with said port and with the atmosphere above the liquid level in the reservoir to provide for venting the entire system connected with said cylinder, and compensating for the expansion and contraction

of the liquid therein, a hydraulic actuating cylinder and piston, pipe connections between said main hydraulic cylinder and actuating cylinder, constructed to afford free communication at all times in both directions, operator operated means for controlling the movement of said main piston actuator, said reservoir being provided with a liquid passage extending therefrom and connected to the system between the position of the main hydraulic piston when substantially at the end of its power stroke, and the brake actuating piston, and independently of the said port, to provide for filling the system without regard to the position of the main hydraulic piston in its cylinder, and a check valve in said passage to prevent the return of liquid therethrough to the reservoir.

8. In a hydraulic brake system, the combination with a main hydraulic cylinder, and a main hydraulic piston therein, said cylinder being provided with a venting compensating and filling port adjacent to the position of the piston when in retracted position, a liquid reservoir located above said cylinder and communicating with said port and with the atmosphere above the liquid level in the reservoir to provide for venting the entire system connected with said cylinder, and compensating for the expansion and contraction of the liquid therein, a hydraulic actuating cylinder and piston, pipe connections between said main hydraulic cylinder and actuating cylinder, constructed to afford free communication at all times in both directions, said reservoir being provided with a liquid passage extending therefrom and connected to the system between the position of the main hydraulic piston when substantially at the end of its power stroke, and the brake actuating piston, and independently of said port, to provide for filling the system without regard to the position of the main hydraulic piston in its cylinder, and a check valve in said passage to prevent the return of liquid therethrough to the reservoir, a power actuator provided with a double acting piston, connections between said double acting actuator piston and the main hydraulic piston for moving the latter in both directions, controlling valve mechanism for the power actuator, and an operator operated part connected with said controlling valve mechanism.

9. In a hydraulic brake system, the combination with a main hydraulic cylinder, a main hydraulic piston working therein, said cylinder being provided with a venting and filling port on its upper side, adjacent to the position of the piston when in retracted position, and adapted to be closed by the first part of the active stroke of the piston, a liquid reservoir located above said cylinder and communicating with said port by means providing a body of oil of greater horizontal di-

ameter than said port, adjacent thereto, to permit the escape of occluded air through said liquid to the surface of the liquid in the reservoir, and prevent said air from being drawn back into said cylinder in maintaining the system in filled condition, a hydraulic brake actuating cylinder, a piston therein, brake mechanism connected with said piston, pipe connections extending from the main hydraulic cylinder to said brake actuating cylinder, a pipe connecting said reservoir with the system adjacent to the discharge end of said main hydraulic cylinder, for filling or bleeding the system, a check valve in said pipe for preventing the return of liquid therethrough to the reservoir, a shut off valve in said connecting pipe, and means for positively moving the main hydraulic piston in both directions.

10. In a hydraulic brake system, the combination with a main hydraulic cylinder, a main hydraulic piston working therein, said cylinder being provided with a venting and filling port on its upper side, adjacent to the position of the piston when in retracted position, and adapted to be closed by the first part of the active stroke of the piston, a liquid reservoir located above said cylinder and communicating with said port by means providing a body of oil of greater horizontal diameter than said port, adjacent thereto, to permit the escape of occluded air through said liquid to the surface of the liquid in the reservoir, and prevent said air from being drawn back into said cylinder in maintaining the system in filled condition, a hydraulic brake actuating cylinder, a piston therein, brake mechanism connected with said piston, pipe connections extending from the main hydraulic cylinder to said brake actuating cylinder, a pipe connecting said reservoir with the system adjacent to the discharge end of said main hydraulic cylinder for filling or bleeding the system, a check valve in said pipe for preventing the return of liquid therethrough to the reservoir, a shut off valve in said connecting pipe, a power actuator provided with a double acting piston, connected with the main hydraulic piston for operating the latter in both directions, and operator operated means for controlling the power actuator piston.

11. In a hydraulic brake system, the combination with a main hydraulic cylinder, a main hydraulic piston working therein, said cylinder being provided with a venting and filling port on its upper side, adjacent to the position of the piston when in retracted position and adapted to be closed by the first part of the active stroke of the piston, a liquid reservoir located above said cylinder and communicating with said port by means providing a body of oil of greater horizontal diameter than said port, adjacent thereto, to permit the escape of occluded air through

- said liquid to the surface of the liquid in the reservoir, and prevent said air from being drawn back into said cylinder in maintaining the system in filled condition, a hydraulic brake actuating cylinder, a piston therein, 5 brake mechanism connected with said piston pipe, connections extending from the main hydraulic cylinder to said brake actuating cylinder, a pipe connecting said reservoir 10 with the system adjacent to the discharge end of said main actuator a hydraulic cylinder for filling or bleeding the system, a check valve in said pipe for preventing the return of liquid therethrough to the reservoir, a shut 15 off valve in said connecting pipe, a power actuator provided with a double acting piston, connected with the main hydraulic piston for operating the latter in both directions, and operator operated means for controlling the power actuator piston, operatively 20 connected with said actuator piston by means permitting lost motion to effect the operation of the main hydraulic piston in both directions in case of failure of power.
12. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, a brake actuating cylinder and piston, brake mechanism connected with the latter piston, and pipe connections connecting 25 the main hydraulic cylinder and said brake actuating cylinder, of a liquid reservoir communicating with the main hydraulic cylinder when the piston is in released position, said reservoir being provided with a 30 passage extending therefrom and communicating with the main hydraulic cylinder for filling or bleeding the system, and means for controlling said passage.
13. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, a brake actuating cylinder and piston, brake mechanism connected with the latter piston, and pipe connections connecting 35 the main hydraulic cylinder and said brake actuating cylinder, of a liquid reservoir, said main hydraulic cylinder being inclined and provided with ports at the highest part capable of communicating with the reservoir when the piston is in released or 40 off position, said reservoir being provided with a passage extending therefrom and communicating with the main hydraulic cylinder for filling or bleeding the system, and a check valve in the passage for preventing the return flow of liquid there- 45 through to the reservoir.
14. In a hydraulic brake system, the combination with a main hydraulic cylinder and piston, a brake actuating cylinder and piston, brake mechanism connected with the latter piston, and pipe connections connecting 50 the main hydraulic cylinder and said brake actuating cylinder, of a power actuator including a cylinder and a piston, a direct connection from the piston of the actuator to the piston in the main hydraulic cylinder, valve mechanism for controlling differentials of fluid pressure to opposite sides of the actuator piston, an operator operated 55 part, and a connection between said operator operated part and the piston in said main hydraulic cylinder by means providing lost motion, said connection serving to control said valves.
- In testimony whereof we affix our signatures.
- CALEB S. BRAGG.
VICTOR W. KLIESRATH.

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