Aug. 13, 1946. S. SCHNELL 2,405,759

COMBINED AIR HYDRAULIC PRESSURE ACTUATING SYSTEM

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FIG.1.

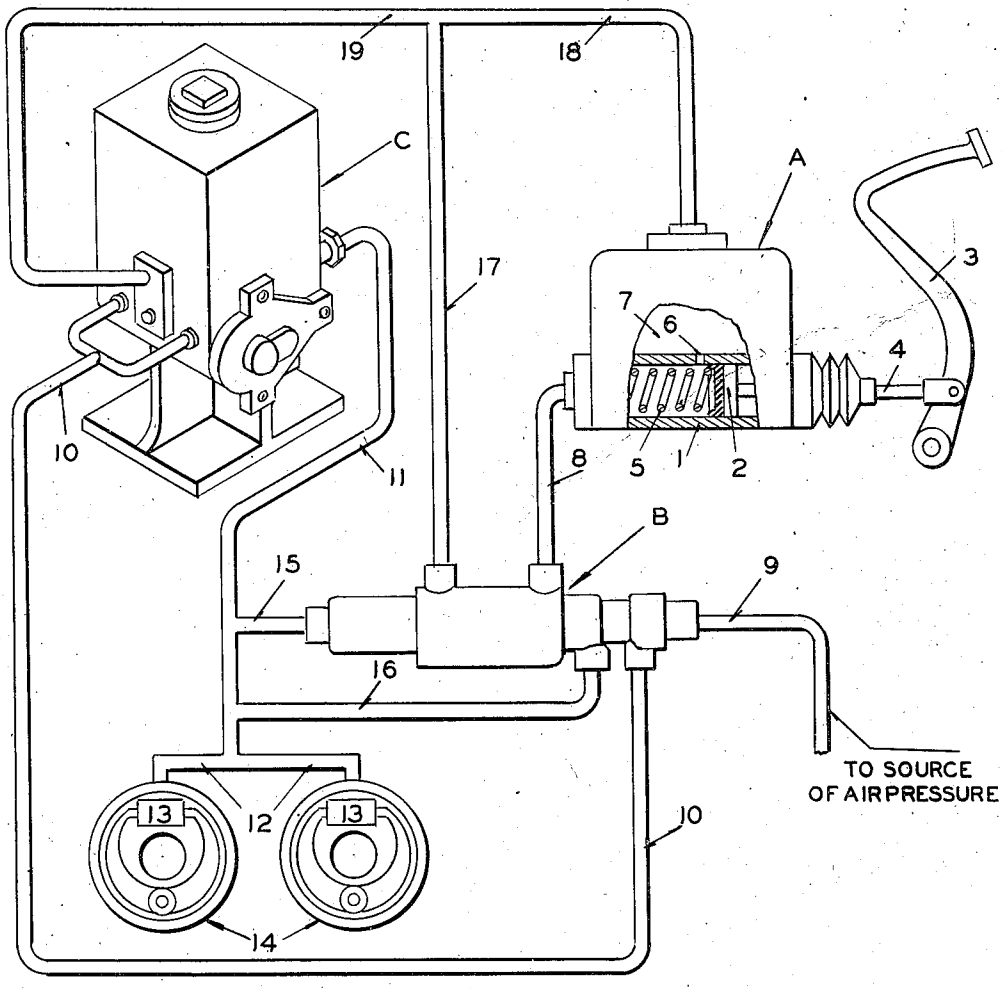
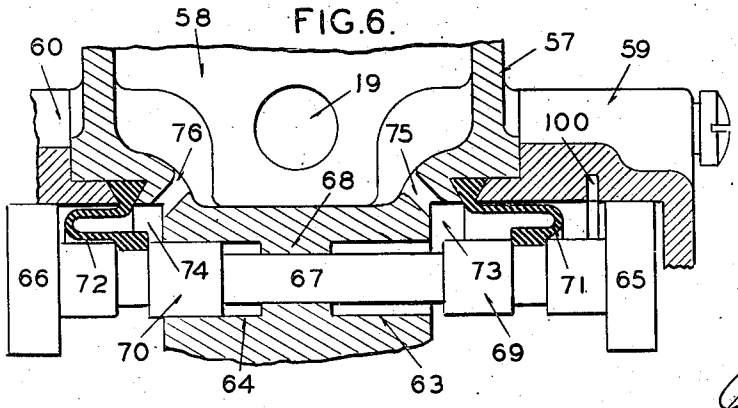


FIG.6.



INVENTOR
S. SCHNELL

BY

ATTORNEY

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FIG.2.

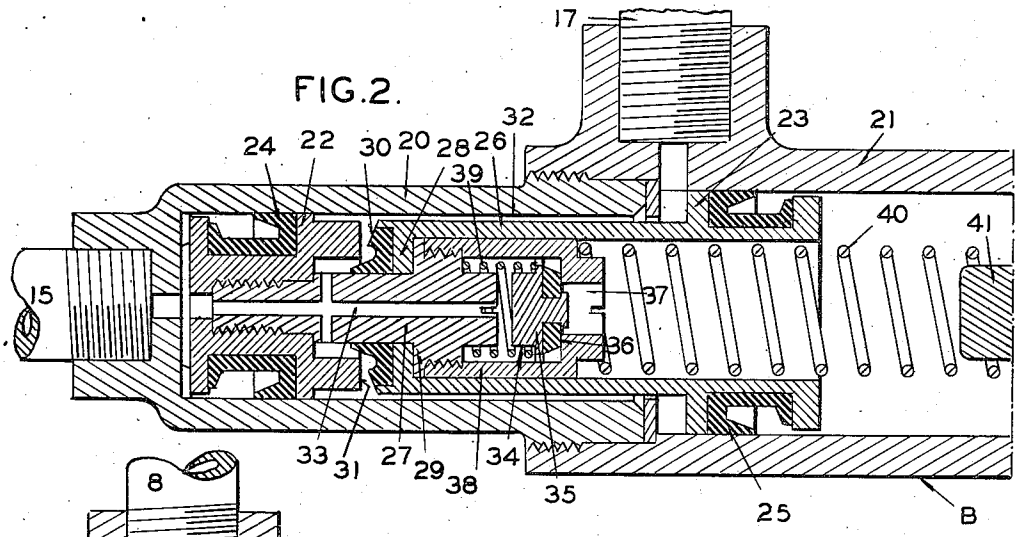
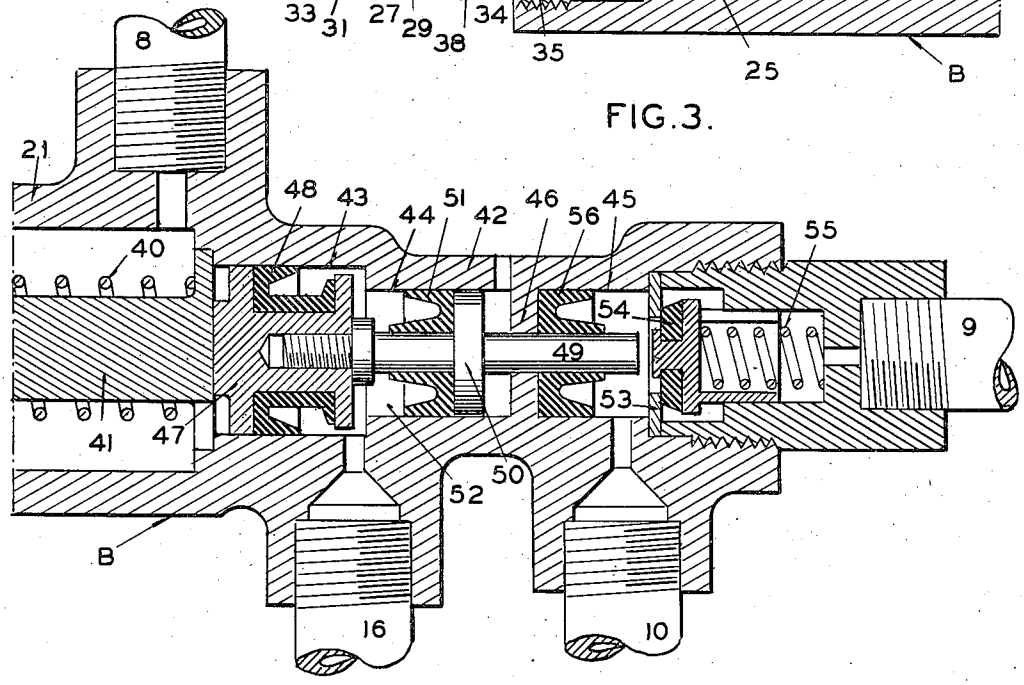


FIG.3.



INVENTOR
S. SCHNELL

BY

ATTORNEY

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FIG.5.

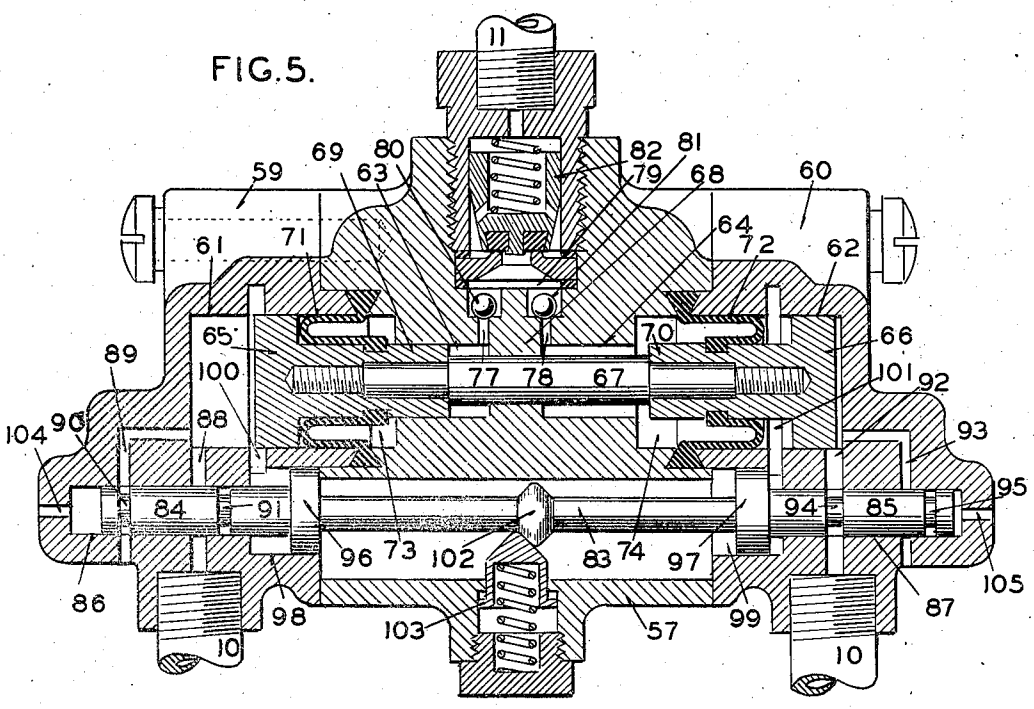
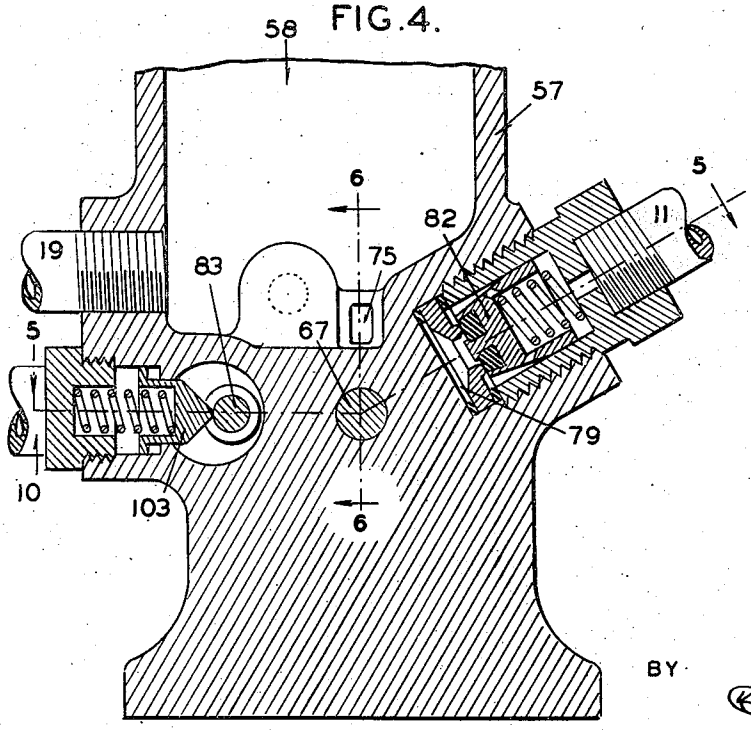


FIG.4.



INVENTOR
S. SCHNELL

BY

ATTORNEY

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COMBINED AIR HYDRAULIC PRESSURE ACTUATING SYSTEM

Steve Schnell, Kirkwood, Mo., assignor to Wagner Electric Corporation, St. Louis, Mo., a corporation of Delaware

Application December 3, 1942, Serial No. 467,743

3 Claims. (Cl. 60—52)

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My invention relates to fluid pressure actuating systems and more particularly to one in which both air and liquid under pressure are employed.

One of the objects of my invention is to provide an improved fluid pressure actuating system in which an air pressure operated hydraulic system is caused to be controlled to develop high hydraulic pressures by the employment of manually-developed low hydraulic pressures.

Another object of my invention is to produce an improved fluid pressure actuating system in which an air pressure operated pump is employed to develop high hydraulic pressures and wherein the operation of the pump is controlled by the relationship between manually-developed low hydraulic pressure and the pump-developed higher hydraulic pressure.

Still another object of my invention is to provide in the type of system above referred to, means for permitting the actuated device of the system to be operated solely by manually-developed hydraulic pressure in the event of failure of the air pressure operated pump.

Other objects of my invention will become apparent from the following description taken in connection with the accompanying drawings in which Figure 1 is a schematic view of a fluid pressure actuating system embodying my invention, parts being shown in section; Figures 2 and 3 are sectional views showing details of the control valve mechanism, Figure 2 showing one end portion and Figure 3 the other end portion; and Figures 4, 5, and 6 are sectional views showing details of the air pressure operated pump, Figure 4 being a vertical sectional view taken on a line through the center of the pump and Figures 5 and 6 being sectional views taken on the lines 5—5 and 6—6, respectively, of Figure 4.

Referring in detail to the drawings and first to Figure 1, there is schematically shown a fluid pressure system embodying my invention and employed in actuating brakes but it is to be understood that such a system can be employed in actuating any desired device. The system comprises essentially a master cylinder device A of well-known construction, a control valve mechanism B, and an air-operated pump C.

The master cylinder device A comprises a cylinder 1 in which a piston 2 is reciprocable, said piston being actuated by a pedal 3 connected thereto by a piston rod 4. The piston is biased to an inoperative position by a spring 5 and when in this position, it uncovers a port 6 for placing the portion of cylinder 1 ahead of the piston in communication with reservoir 7. The outlet of

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the master cylinder is connected by a conduit 8 to the control valve mechanism B. This control valve mechanism B is connected by a conduit 9 to a source of air pressure such as an air storage tank and air compressor (not shown). This air pressure source is adapted to be connected to a conduit 10 leading from the control valve mechanism B to the pump C to thus provide air pressure to operate said pump. The outlet of pump C is connected by a conduit 11 and branch conduits 12 to the fluid motors 13 for actuating the brake assemblies 14. The conduit 11 is also connected by branch conduits 15 and 16 to the control valve mechanism B. In addition to the various conduits just described, there is provided a hydraulic pressure releasing conduit 17 which leads from the control valve mechanism B to conduits 18 and 19, the former being connected to reservoir 7 of the master cylinder device and the latter to the reservoir of pump C.

Referring now to Figures 2 and 3, the control valve mechanism B will be described in detail. This mechanism comprises two cylinders 20 and 21 screwed together in axial alignment, cylinder 20 being smaller than cylinder 21. Within cylinder 20 is a piston 22 and within cylinder 21 is a piston 23, these pistons being provided with suitable packing cups 24 and 25, respectively. Piston 23 carries a cylindrical extension 26 extending into cylinder 20 toward piston 22 and received in this extension is an extension 27 carried by piston 23. Extension 26 is provided with a flange 28 for cooperation with a flange 29 on extension 27 in order to limit the extent of separation of the two pistons. Surrounding extension 27 is an annular valve element 30 carried by extension 26, said valve element being adapted to cooperate with an annular valve seat 31 carried by piston 22. The extension 26 is of somewhat smaller diameter than cylinder 20 in which it projects, thus establishing a chamber 32 which is in constant communication with the previously referred to conduit 17 leading to the reservoirs of the master cylinder and pump. When valve element 30 is unseated, chamber 32 communicates with a passage 33 extending through extension 27 and forming a by-pass through the pistons. The outer end of cylinder 20 is connected to conduit 15 coming from pump C. The cylinder 21 to the right of large piston 23 communicates with the right end of passage 33 through a check valve 34 comprising an element 35 cooperating with a seat 36 surrounding an opening 37 in a cup-shaped element 38 carried by extension 27. The element 35 is normally seated by a spring

39. This check valve prevents fluid from flowing from passage 33 and the left end of cylinder 20 to cylinder 21.

Piston 22 is biased to the left end of cylinder 20 by means of a spring 40 of predetermined strength, said spring being interposed between extension 27 and a member 41 engaging the right end of cylinder 21. The previously referred to conduit 8 leading from the master cylinder device A communicates with the right end of cylinder 21, thus permitting fluid to flow from said master cylinder device to cylinder 21 and past the check valve 34 if such fluid is under sufficient pressure to unseat the check valve against any pressure which may be acting thereon in addition to spring 40.

The right end of cylinder 21 carries an integral extension 42 provided with axially aligned bores 43, 44, and 45 with bore 43 being larger than the other bores. Bore 45 is separated from bore 44 by a wall 46. Within bore 43, which opens into cylinder 21, there is positioned a piston 47 having a sealing cup 48. This piston carries a stem 49 which extends through bore 44, an opening in wall 36, and into bore 45. Integral with this stem is a piston 50 positioned in bore 44 and having a sealing cup 51 associated therewith. The sealing cups 48 and 51 are adapted to confine fluid in a chamber 52 between pistons 47 and 50, said chamber being connected to branch conduit 16 previously referred to and in constant communication with the outlet of the pump and the fluid motors of the brakes. Bore 45 has connected thereto conduit 9 leading from the source of air pressure and conduit 10 leading to the pump. A valve seat 53 is provided at the outer end of the bore and cooperating therewith is a valve element 54 biased to seated position by a spring 55. This valve 54 controls the flow of air under pressure from conduit 9 to conduit 10 and is adapted to be unseated against the action of its spring by stem 49. A sealing cup 56 seals the stem where it passes through wall 46.

Referring now to Figures 4, 5, and 6, the air-operated pump C will be described in detail. The pump is enclosed in a casing 57 having a liquid reservoir 58 in the upper part thereof. The lower part of the casing has secured thereto on opposite sides like members 59 and 60 in which cylinders 61 and 62 are axially aligned. These cylinders are on the outside of like smaller cylinders 63 and 64 positioned in casing 57 and axially aligned with said cylinders 61 and 62. Within cylinders 61 and 62 are pistons 65 and 66 connected together by a rod 67 extending through cylinders 63 and 64 and a wall 68 between said cylinders. An extension of piston 65 provides a piston 69 for cylinder 63 and an extension of piston 66 provides a piston 70 for cylinder 64. The extent of reciprocable movement of all the pistons is such that when the pistons are moved to the right, piston 69 will be moved into cylinder 63 to compress the liquid therein and piston 70 will be withdrawn from cylinder 64 so that liquid can flow into said cylinder 64 and when the pistons are moved to the left piston 70 will be moved into its cylinder 64 to compress the liquid therein and piston 69 will be withdrawn from cylinder 63 to permit liquid to enter said cylinder. Separating pistons 65 and 69 is a diaphragm 71 and separating pistons 66 and 70 is a diaphragm 72. These diaphragms form chambers 73 and 74 which are connected to reservoir 58 by passages 75 and 76 shown in Figure 6. The inner end of cylinder 63 is provided with an outlet 77 and the inner end of cylinder 64 is provided with an outlet 78. These outlets communicate with a common chamber 79 which is connected to the previously referred to conduit 11 leading to the fluid motors of the brakes. The outlets 77 and 78 are controlled by ball check valves 80 and 81, respectively, and a one-way spring biased valve 82 permits flow of liquid from chamber 79 to conduit 11 but not its return.

Pistons 65 and 66 are caused to be alternately acted upon by air under pressure which is controlled by a suitable automatically-operated valve means. This valve means, as best shown in Figure 5, comprises a rod 83 having valve elements 84 and 85 on its opposite ends for reciprocation in bores 86 and 87. A passage 88 intersects bore 86 for placing a branch of conduit 10 in communication with cylinder 61. Another passage 89 intersects the bore 86 for placing cylinder 61 in communication with the atmosphere. In one position of valve element 84 an annular groove 90 permits passage 89 to be opened while the valve element closes passage 88. In the other position of the valve element an annular groove 91 in the valve element permits passage 88 to be opened while passage 89 will be closed by the valve element. In a like manner valve element 85 controls the admission of air to cylinder 62 and its exhaust therefrom. A passage 92 connects another branch of conduit 10 with cylinder 62 and a passage 93 connects the cylinder with the atmosphere. Annular grooves 94 and 95 in the valve element control communication through the passages.

The valve rod 83 also carries integral pistons 96 and 97 reciprocable in cylinders 98 and 99, respectively. A passage 100 connects cylinder 98 with the central part of air cylinder 61 and a passage 101 connects cylinder 99 with the central part of air cylinder 62. The arrangement is such that passage 100 will be opened when the piston is at the right end of its travel and passage 101 will be opened when piston 66 is at the left end of its travel. The central part of the valve rod 83 is provided with an annular ridge 102 for cooperation with a detent 103, said ridge and detent providing means for holding the valve rod in either of its extreme positions of reciprocation, thus preventing centering of valve elements 84 and 85. Small holes 104 and 105 in the ends of bores 86 and 87 act to provide dashpot means for rod 83.

From the above description of the details of the pump it is seen that when the parts thereof are in the positions shown and air under pressure is admitted to conduit 10 from the source of pressure, air pressure can act to move pistons 65 and 66 to the left, as viewed in Figure 5, by operating on piston 66, cylinder 61 being open to atmosphere. As pistons 65 and 66 move to the left, the liquid compressing piston 70 will enter its bore 64 and compress the liquid trapped therein and force it out into conduit 11. As pistons 65 and 66 reach the left hand end of their travel, passage 101 will be uncovered, permitting air under pressure to act on piston 97 of the valve stem to shift it to the left, as viewed in Figure 5. This will cause air under pressure to be admitted to cylinder 61 and cylinder 62 exhausted to atmosphere. Pistons 65 and 66 will then be shifted back to the right and the liquid in cylinder 63 compressed by piston 69. This will force another change of liquid under pressure into conduit 11. When piston 65 uncovers passage 100, the valve rod will again be shifted to

the right, causing a return of pistons 65 and 66 to the left and repeating the cycle just described. During the withdrawal of pistons 69 and 70 from their cylinders, the ball valves 80 and 81 will be seated to prevent fluid returning to the cylinder, notwithstanding there may be some suction in the bores as the pistons are withdrawn. The volume of the chamber in which the liquid is compressed is so small and the compressing pistons have such a short stroke that the suction created during withdrawal of the compressing pistons will not be great enough to resist withdrawal. Thus it is seen that no inlet valves are required for permitting liquid to enter the compressing chambers during the withdrawal of the compressing pistons from their cylinders.

With reference to the operation of the improved system, it will be assumed that the ratio between the effective areas of pistons 22 and 23 in the control valve mechanism is two to one and that the ratio of the areas of pistons 47 and 50 is such that the hydraulic pressure necessary in chamber 52 to cause closing of valve 54 after being opened will be approximately twice that of the pressure developed by the master cylinder and effective on piston 47 to open valve 54. Other piston area ratios can be embodied in the control valve mechanism if desirable.

If it is desired to apply the brakes, the master cylinder is operated and hydraulic pressure is developed in cylinder 21. This manually-developed pressure will move piston 23 to the left to seat valve element 30 and then cause unseating of the check valve 34 to permit fluid to begin to build up in the fluid motors of the brakes. When the hydraulic pressure in cylinder 21 is great enough to move piston 47 to the right, the air inlet valve 54 will be opened and air can then flow under full pressure from the source to the pump and cause the pump to begin to operate. The pistons of the pump will be reciprocated rapidly and hydraulic pressure will be quickly built up since the liquid being acted upon is substantially incompressible. The hydraulic pressure developed by the pump will be effective in conduit 11 and also in the brake fluid motors and thus cause the brakes to be applied by hydraulic pressure above that established by the initial hydraulic pressure caused by operation of the master cylinder. When the hydraulic pressure in the brake motors becomes twice that developed by the master cylinder device, sufficient pressure will be effective in chamber 52 to cause movement of piston 47 to the left, thus permitting the air inlet valve 54 to become closed. The piston, in moving to the left, pushes the operator's foot acting on the pedal 3 slightly rearwardly. The hydraulic pressure being developed by the master cylinder is not changed, however, as the manual force is not decreased. The pump will now cease operation. If additional pressure is desired in the fluid motors of the brakes, the master cylinder may be operated to cause additional manually-developed hydraulic pressure in cylinder 21, thus causing movement of piston 47 to the right and the re-opening of the air inlet valve 54. The pump will again operate to develop additional hydraulic pressure in the brake fluid motors and when the pressure becomes twice that of the master cylinder developed pressure, the pump will again cease to operate.

If it should be desired to release some of the hydraulic pressure in the brake fluid motors, this can be accomplished by decreasing the master cylinder developed pressure. Such decrease of the master cylinder developed pressure will result in a drop in the pressure in cylinder 21 and movement of pistons 22 and 23 to the right as a unit by the hydraulic pressure acting on piston 22. A drop in the hydraulic pressure in the fluid motors will now take place. The hydraulic pressure in the fluid motors, however, will always remain twice that of the manually-developed hydraulic pressure due to the ratio of the areas of pistons 22 and 23.

If, after reducing the hydraulic pressure in the brake fluid motors, it is desired to re-establish the pressure at the value it had before reduction, this can be done by merely re-establishing the master cylinder developed hydraulic pressure which was effective prior to its reduction. Increase in the master cylinder developed pressure causes pistons 22 and 23 to move to the left, thereby acting as compounding pistons to increase the pressure in the brake fluid motors. This re-establishment of the pressure in the brake fluid motors is accomplished without the necessity of any pump operation and without any greater manual force than was necessary to establish the brake fluid motor pressure by operation of the pump. It is noted that piston 47 will not be moved because as the pressure in cylinder 21 is increased, there will be an increase in the pressure in chamber 52.

When it is desired to release the brakes, the master cylinder piston is fully retracted. This will result in the opening of valve element 30 and release of hydraulic pressure in the brake fluid motors to the reservoirs of the master cylinder device and the pump. Release of the brakes will also occur without full retraction of the master cylinder piston. The valve element 30 will become unseated when the piston is retracted to such an extent that the pressure in cylinder 21 will no longer be able to maintain said valve element 30 seated against the action of the brake fluid motor pressure working in connection with spring 40. The value of spring 40 will determine the point at which total release will take place. In practice the value is so calculated that release will take place when the brake fluid motor pressure is such as to cause the brake shoes to be held in engagement with the drum.

In the event there should be failure of the pump, the brakes, nevertheless, can be applied by manually-developed hydraulic pressure due to the check valve 34. The pressure in the fluid motors, however, will be only that developed by the master cylinder device. Also, no lowering of such brake fluid motor manually-developed pressure can take place until the master cylinder developed pressure is reduced by one-half due to the ratio of the areas of pistons 22 and 23.

Being aware of the possibility of modifications in the particular structure herein described without departing from the fundamental principles of my invention, I do not intend that its scope be limited except as set forth by the appended claims.

Having fully described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a fluid pressure actuating system, a fluid motor, a manually-operated pressure developing means, a hydraulic pressure developing pump having its outlet connected to the motor, check valve means associated with the outlet and preventing return of liquid to the pump, a source of air pressure, means for operating the pump by the air pressure, valve means for connecting the

source to the means for operating the pump to thereby cause pump developed hydraulic pressure to be effective in the motor, means operable by the manually-developed hydraulic pressure for opening the valve means, means for closing the valve means by hydraulic pressure developed by the pump, a release valve, and means for controlling the closing and opening of the release valve by the manually-developed hydraulic pressure.

2. In a fluid pressure actuating system, a fluid motor, a hydraulic pressure developing pump having its outlet connected to the motor, check valve means for preventing return of liquid to the pump, a source of air pressure, means for operating the pump by the air pressure, valve means for connecting the source to the means for operating the pump, a manually-operated hydraulic pressure developing means for opening the valve means, means for closing the valve means by hydraulic pressure developed by the pump when said pressure is greater than the manually-developed pressure and there exists a predetermined ratio between the two, means for actuating the fluid motor by manually-developed hydraulic pressure in the event the pump should fail to develop hydraulic pressure, and valve means controlled by the manually-developed hydraulic pressure for relieving the hydraulic pressure in the motor, said

last named valve means being subject to pressure in the motor tending to open it.

3. In a fluid pressure actuating system, a fluid motor, a hydraulic pressure developing pump having its outlet connected to the motor, check valve means for preventing return of liquid to the pump, a source of air pressure, means for operating the pump by the air pressure, valve means for connecting the source to the means for operating the pump to thereby cause pump-developed hydraulic pressure to be effective in the motor, manually-operated hydraulic pressure developing means comprising a master cylinder device, means for opening the valve means by the hydraulic pressure developed by the master cylinder device, means for closing the valve means by pump-developed hydraulic pressure which is greater than the manually-developed hydraulic pressure, reservoir means for the pump and the master cylinder device, and means for connecting the fluid motor to the reservoir means when the master cylinder device releases the manually-developed hydraulic pressure to thereby release the hydraulic pressure effective in the motor said last named means operable independently of the pump and maintaining the operation of the pump as it was prior to the release.

STEVE SCHNELL.