April 21, 1936. W. F. OLIVER 2,038,055

FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

Filed Dec. 12, 1931 7 Sheets-Sheet 1

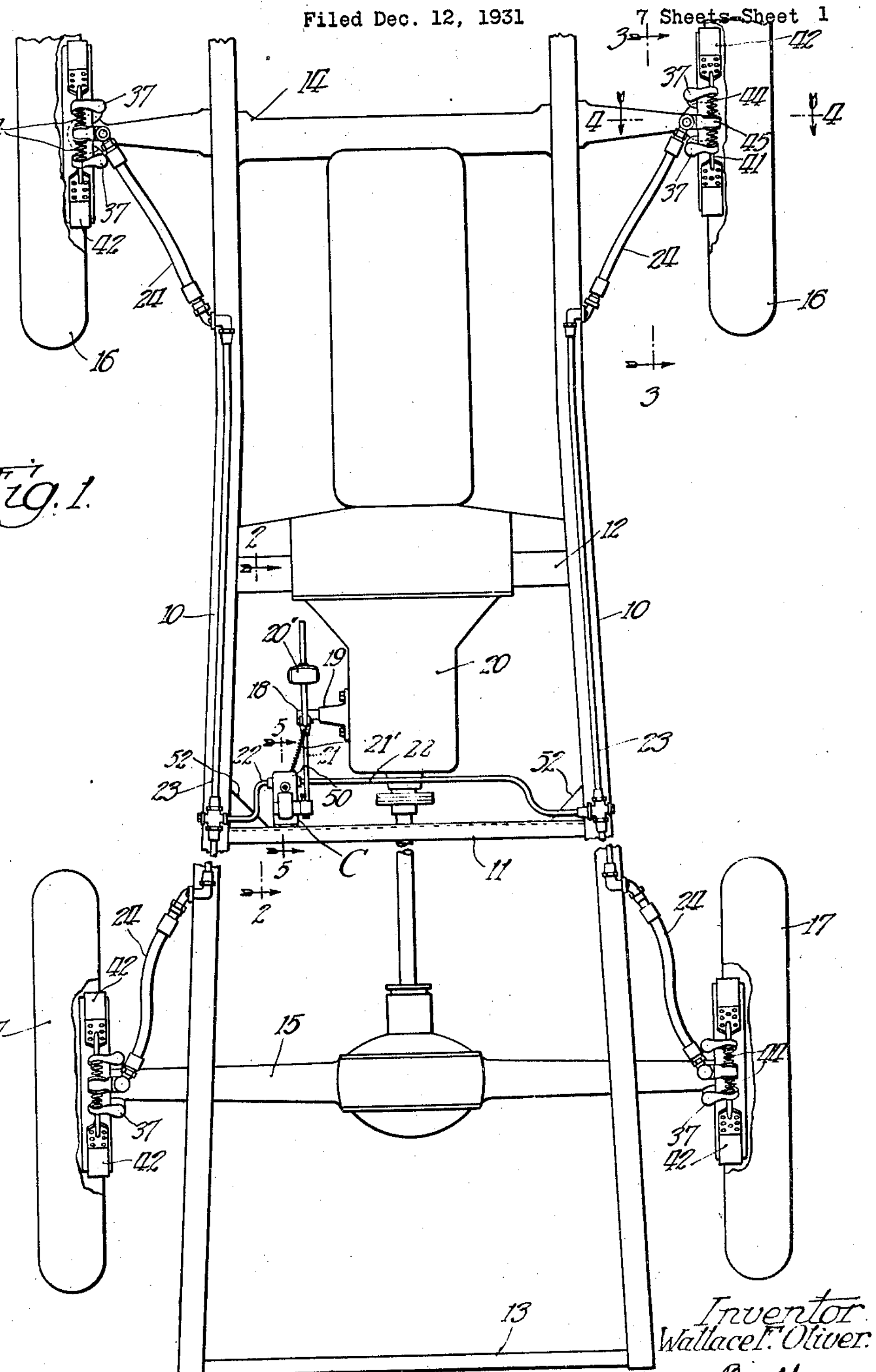

Fig. 1.

Inventor
Wallace F. Oliver.
Williams, Bradbury, McCaleb & Hinkle Attys.

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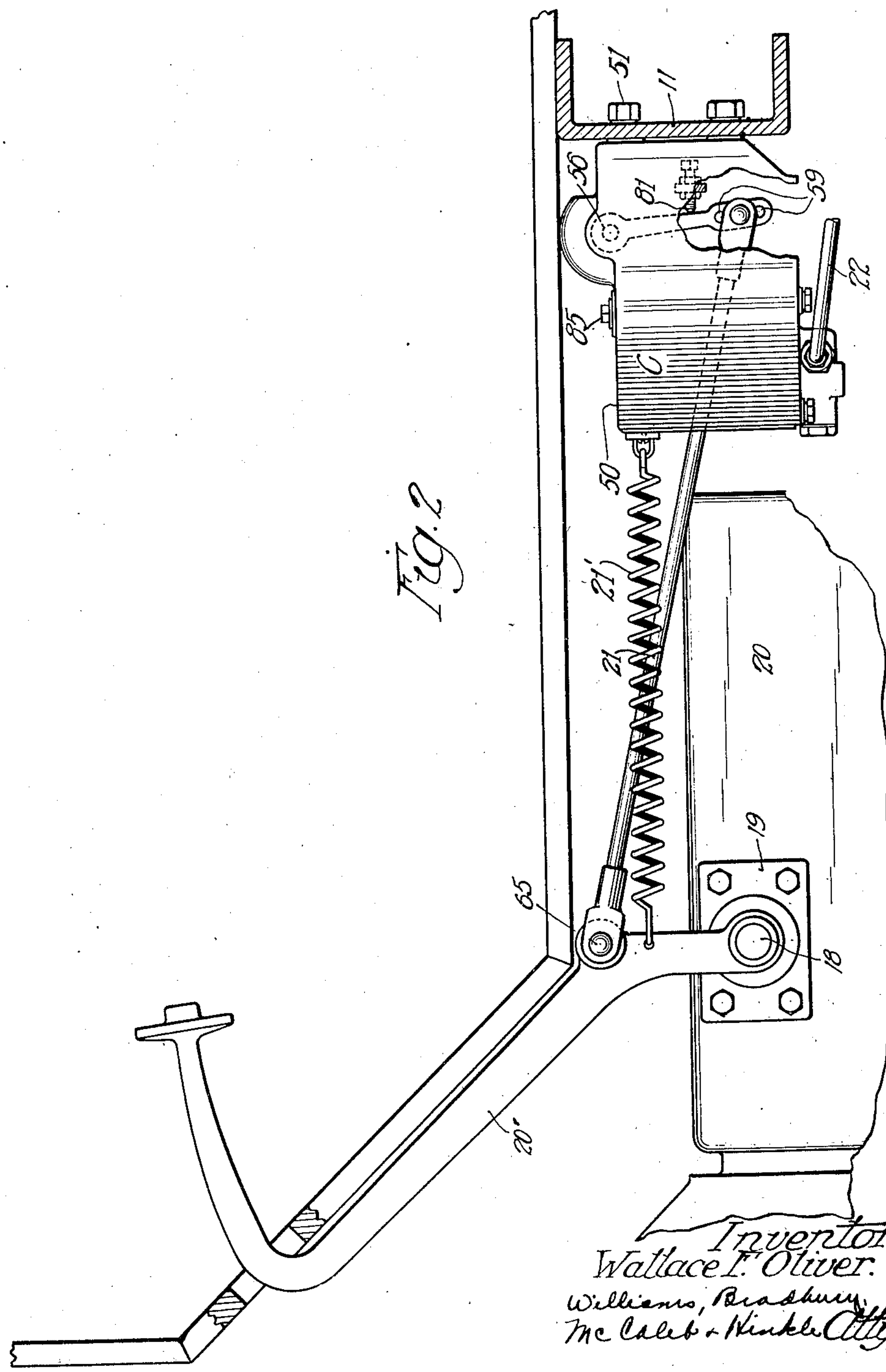

Fig. 2

Inventor:
Wallace F. Oliver.
Williams, Bradbury, McCaleb & Hinkle Attys.

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FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

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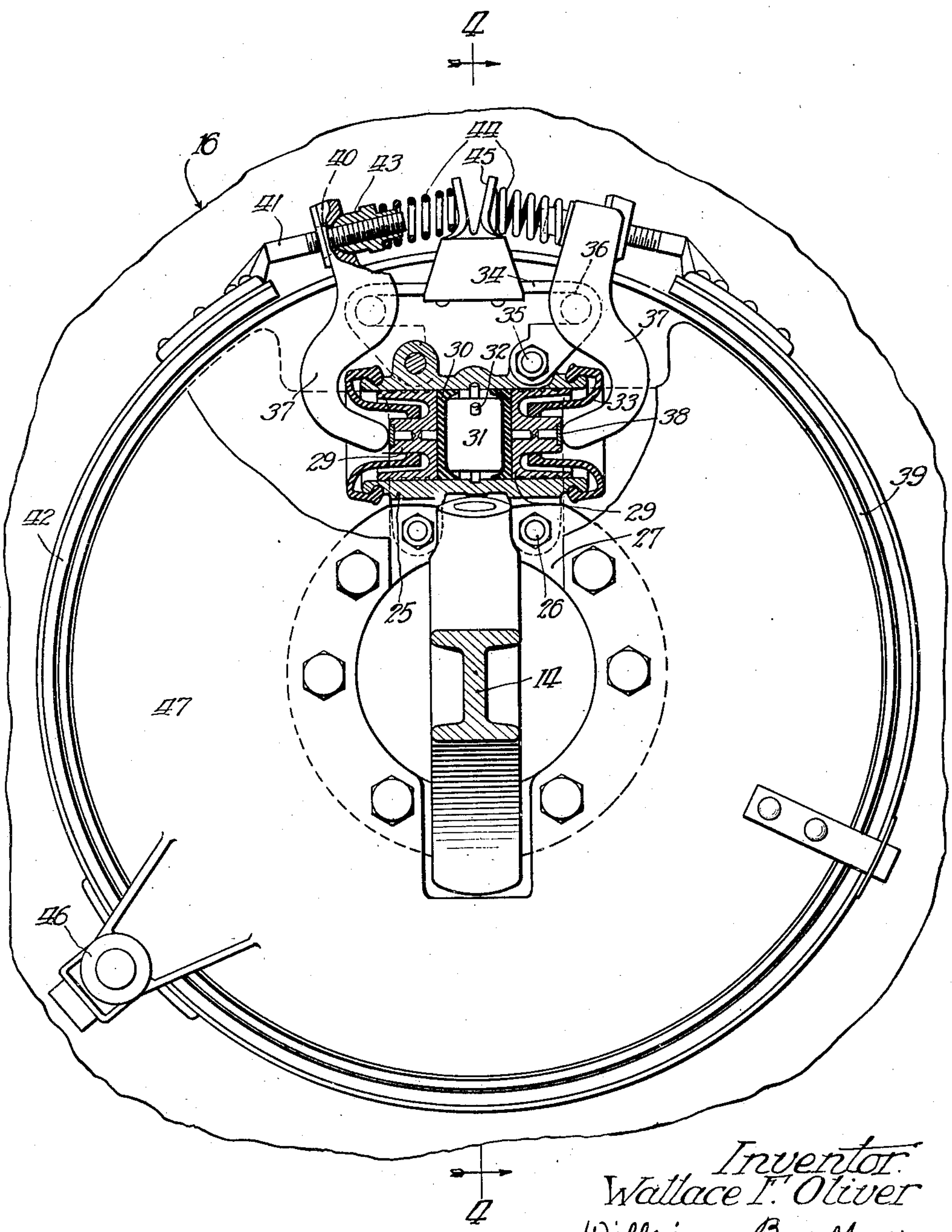
Fig. 3.



Inventor:
Wallace F. Oliver
Williams, Bradbury, McCaleb & Hinkle Attys.

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FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

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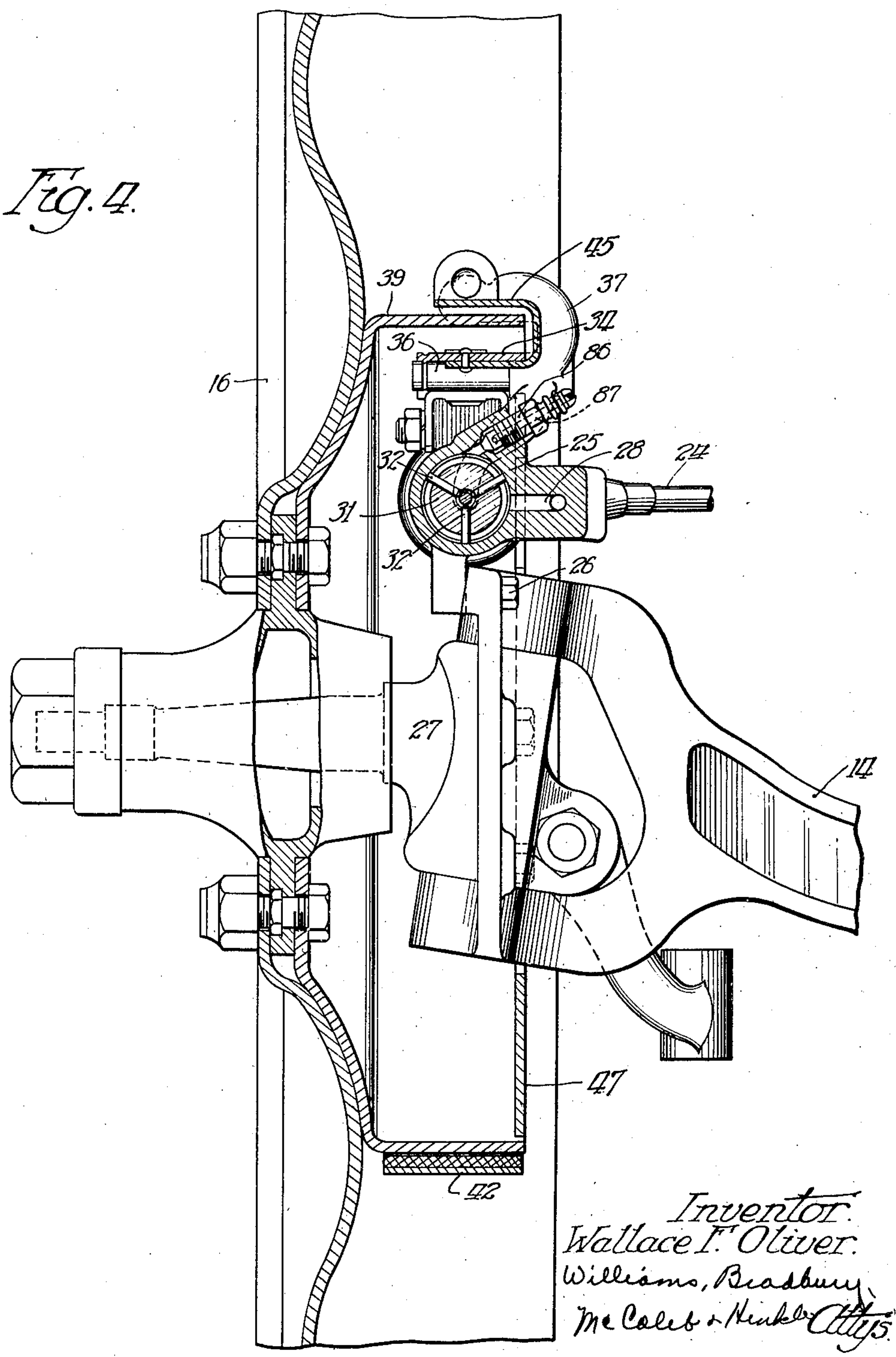
Fig. 4.



Inventor
Wallace F. Oliver
Williams, Bradbury, McCaleb & Hinkle Attys.

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FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

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Fig. 5.

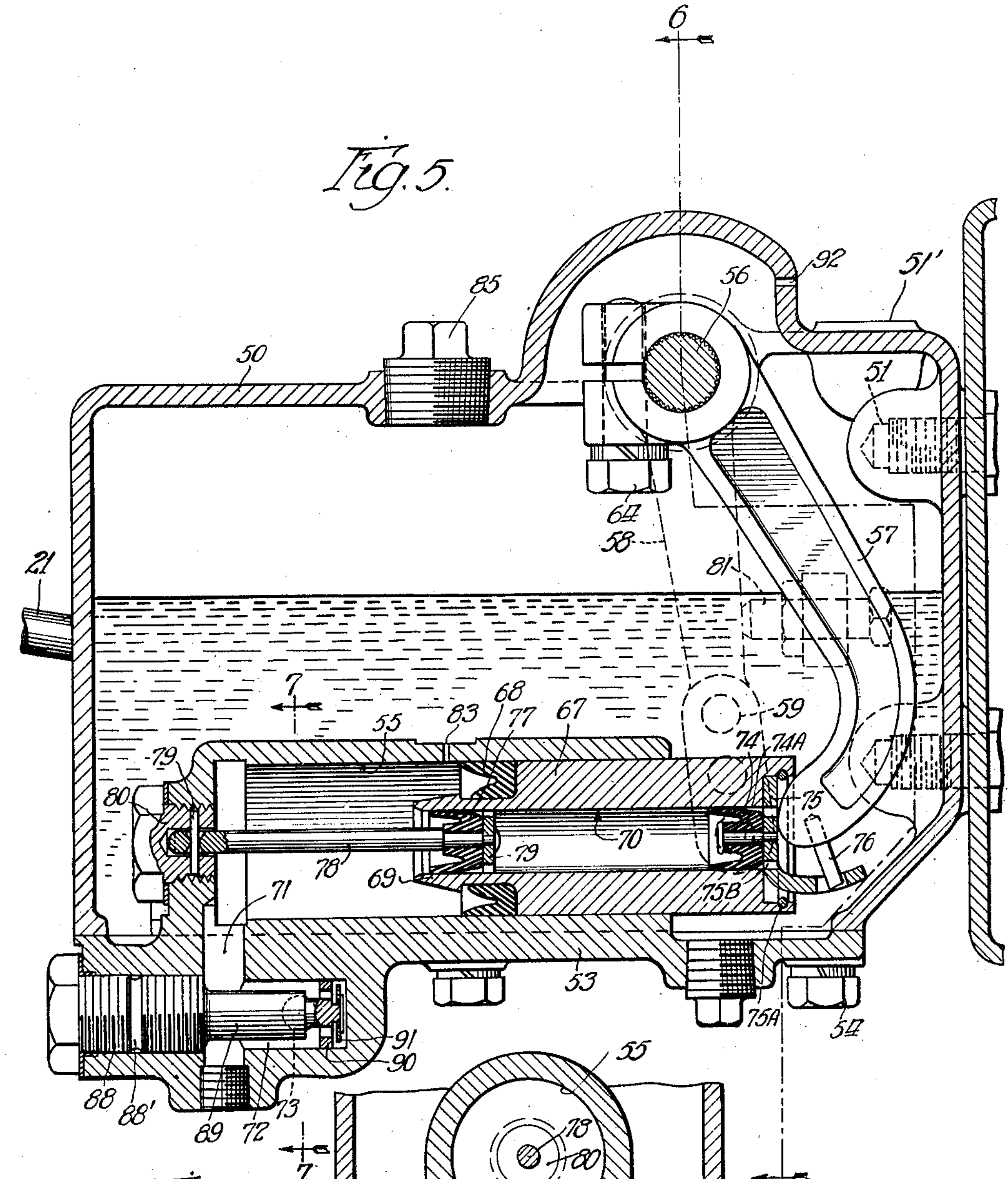
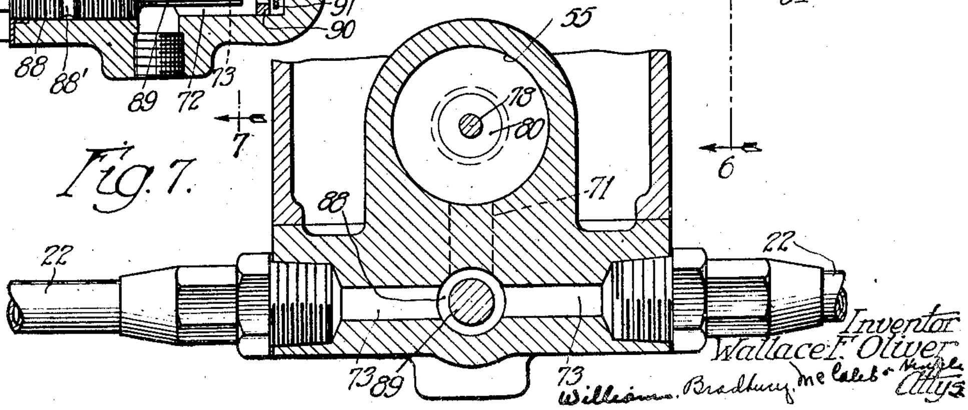


Fig. 7.



Inventor
Wallace F. Oliver
Williams, Bradbury, McCaleb & Hinkle
Attys

April 21, 1936. W. F. OLIVER 2,038,055

FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

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Fig. 6.

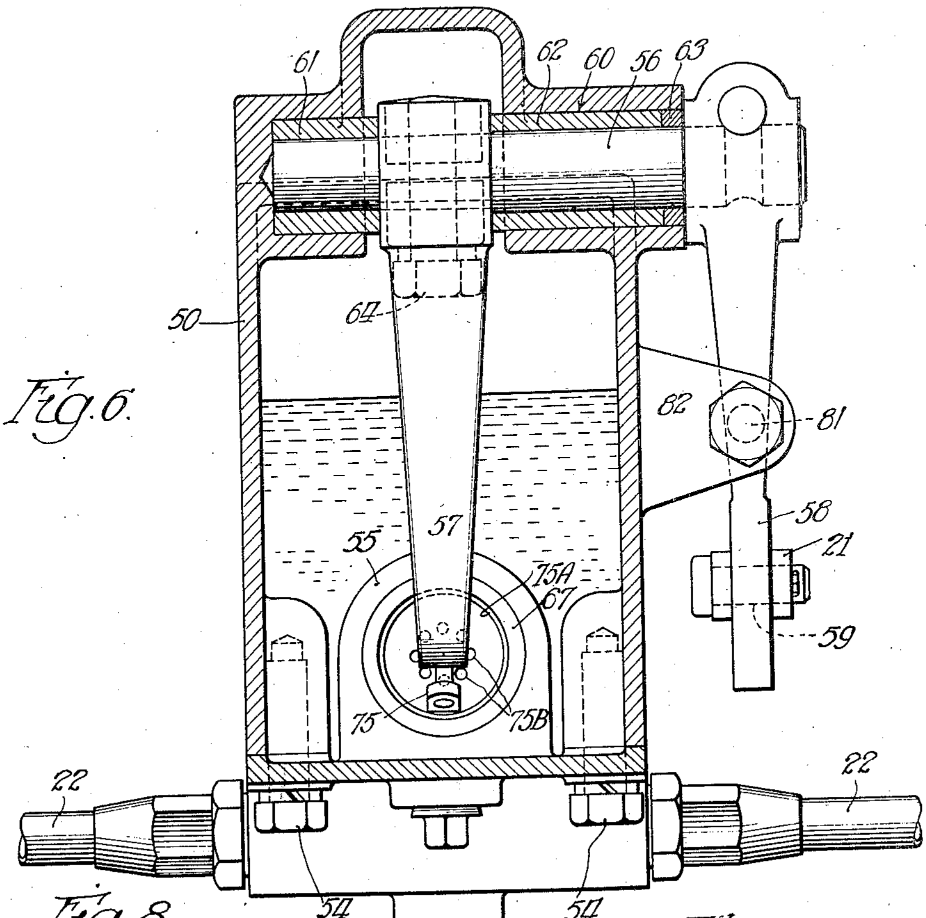


Fig. 8.

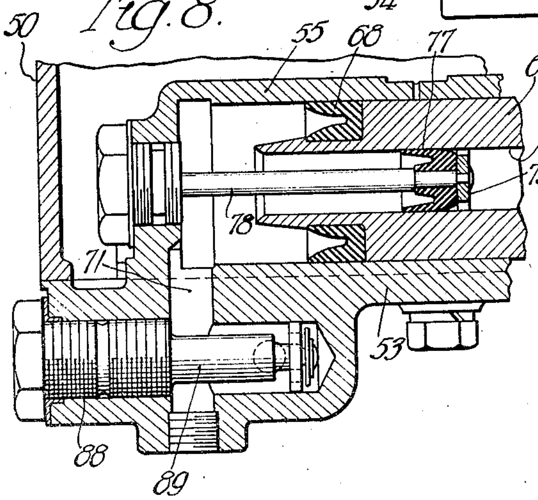
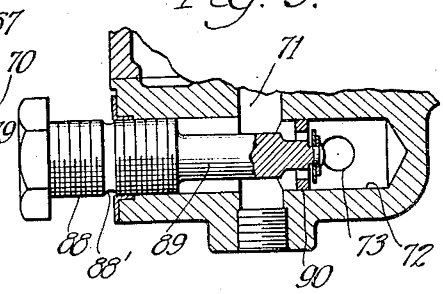


Fig. 9.



Inventor:
Wallace F. Oliver.
Williams, Bradbury,
McCaleb & Hinkle. Attys.

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FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

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Fig. 10.

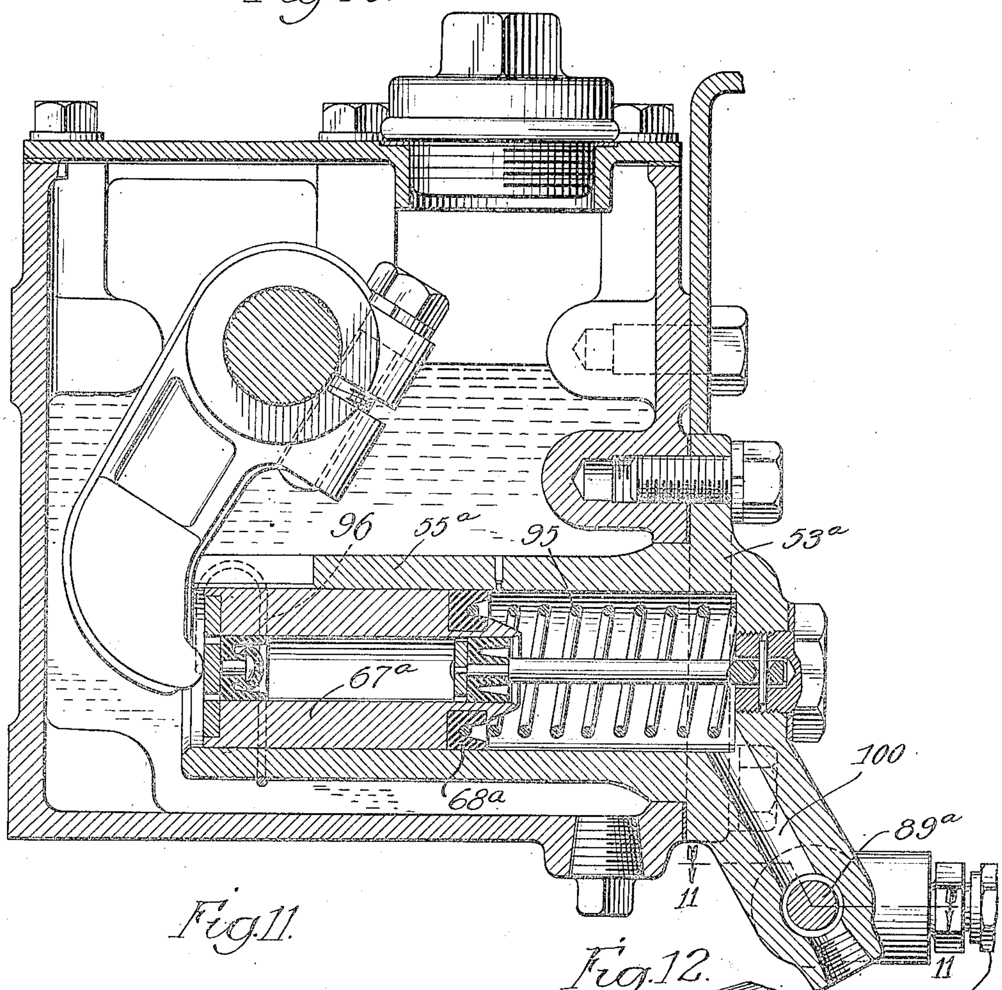


Fig. 11.

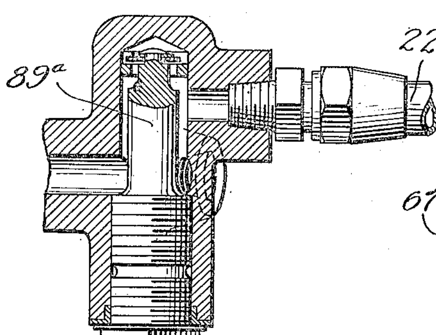
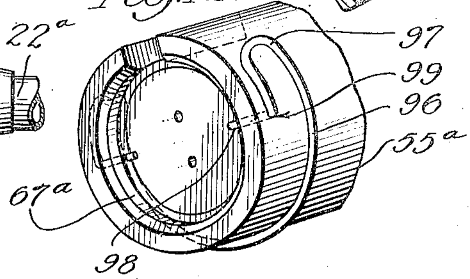


Fig. 12.



Inventor:
Wallace F. Oliver
By Williams, Bradbury, McCaleb & Hinkle.
Attys.

UNITED STATES PATENT OFFICE

2,038,055

FLUID BRAKING APPARATUS AND COMPRESSOR THEREFOR

Wallace F. Oliver, Detroit, Mich., assignor to Hydraulic Brake Company, Los Angeles, Calif., a corporation of California

Application December 12, 1931, Serial No. 580,573

13 Claims. (Cl. 60—54.6)

My invention is concerned with improvements in hydraulic braking apparatus of the type in which a liquid is caused to flow to and from braking positions in the setting and releasing of brakes.

One object of my invention is an improved means of maintaining a constant amount of liquid in the system, compensating for volumetric losses by contraction or leakage, and relieving any volumetric excess caused by the replenishing means or by heat expansion. Maintaining a constant liquid volume for the system is desirable, for otherwise the brakes may either drag or develop dangerous slack.

I accomplish this end by embodying the replenisher in the compressor as an integral part thereof, the compressor mechanism being arranged to pump a surplus of liquid into the system with each application of the brakes, the excess liquid being discharged back into a reservoir after the application has been completed.

Another object is the simplification of the operation of initially filling the system with liquid, which I secure by a check valve readily insertable between the compressor and the rest of the system thereby transforming the compressor into a pump.

In addition, I contemplate an improved design of compressor unit which, without material changes, is adapted more or less universally for all commercial makes of automobiles so that the compressor unit can be standardized and incorporated in the standard makes of automobiles without necessitating structural redesigning of the automobile. In this connection I contemplate in addition, a compressor and replenisher which can be installed in its entirety on the chassis of an automobile entirely independently of the body, thereby simplifying the manufacturer's assembly problems.

A still further object is to make available to the driver some kind of alarm indicating that the reserve supply of liquid is about exhausted, before the brakes are actually unusable, and especially before the reserve liquid has been so far depleted that it will be necessary, in replenishing the reserve, to "bleed" the line to exhaust any air which may have been introduced.

The foregoing and many other objects, features and advantages of my invention are set forth in further detail in the following description which explains what I consider a preferred embodiment of my invention. My invention, of course, is not inherently confined to the particular form, system or combinations shown, but many changes may be made without departing from the spirit or scope of my invention.

In the attached drawings to which the description refers,

Figure 1 is a plan view of a skeleton chassis of an automobile equipped with the improved hydraulic braking system of my invention;

Figure 2 is a vertical elevation from the side which may be considered as taken on the line 2—2 of Figure 1, and shows the compressor unit and the brake pedal linkage;

Figure 3 is an elevation of the inner side of the right front wheel brake assembly taken on the line 3—3 of Figure 1, the wheel cylinder being broken into longitudinal section;

Figure 4 is a transverse vertical section of the same brake mechanism as Figure 3, and is taken on the lines 4—4 of Figures 1 and 3;

Figure 5 is a longitudinal vertical section through the compressor unit, which may be considered as taken on the line 5—5 of Figure 1;

Figure 6 is a transverse vertical section of the compressor unit taken on the somewhat irregular line 6—6 of Figure 5;

Figure 7 is a fragmentary transverse section similar to Figure 6, but taken along the line 7—7 of Figure 5 and forwardly of the sections of Figure 6;

Figure 8 is another fragmentary view of the compressor showing the compressor at the time the brakes are fully applied;

Figure 9 is a fragment of Figure 5 showing the check valve moved to a position between the compressor and the rest of the system to transform the compressor into a pump for filling the system.

Figure 10 is a view similar to Figure 5 (but looking toward the left hand side of the automobile, rather than toward the right hand side as in Figure 5), showing a modified form of the compressor unit.

Figure 11 is a detailed section taken on the line 11—11 of Figure 10 showing the check valves of Figures 5, 8, and 9 as applied to a modification of Figure 10; and

Figure 12 is a detailed perspective of one end of the master cylinder of Figure 10 showing the mounting of the spring wire stop member for the piston.

In Figure 1, I have indicated an automoblie chassis comprising a frame formed from side channels 10 and cross channels 11, 12, and 13, front and rear axles 14 and 15 and front and rear wheels 16 and 17. A brake pedal pivot shaft 18 is supported with the aid of a bracket 19 from the transmission housing 20 (see also Figure 2).

The shaft 18 pivotally supports the brake pedal 20' which though a link rod 21 actuates a compressor unit indicated generally at C. The brake pedal is returned to normal under the influence of a light spring 21'.

A pair of conduits 22 preferably of copper or brass tubing, lead laterally from the compressor C and connect with similar conduits 23 which extend longitudinally of the chassis along or within the side channels 10 of the frame to points fifteen inches or so short of the front and rear axles. From these points the conduits are continued with the aid of suitable fittings as flexible but non-expansible hoses 24 preferably of the type shown in patents to Malcolm Loughead No. 1,457,781 and No. 1,468,601.

The outer ends of these hoses connect with cylinder blocks 25 which are secured by bolts 26 to the steering spindles 27, in the case of the front wheels, and to the rear axle housing in the case of the rear axles.

Referring now to Figures 3 and 4 which show the right front wheel brake construction which is typical of all of the wheel brakes, the hose 24 communicates through passages 28 with the interior of the cylinder 25 midway between its ends. A pair of opposed pistons 29 are slidably mounted in the bore of the cylinder 25 and carry cup washer packings 30 preferably of vulcanized rubber which abut the faces of the pistons but which are not attached thereto. The pressure of the fluid in the system is relied upon to hold the packings against their pistons. In order to cut down the volume of fluid in the system, a solid cylindrical filler 31 is centrally suspended between the proposed packings by radial pins 32 and serves as an abutment to limit the inward movement of the pistons 29. A molded rubber apron 33 may be slipped over each end of the cylinder 25 and also fitted over the central boss of the corresponding piston to exclude water and dirt.

A pivot bracket 34 stamped from sheet steel is secured by bolts 35 to the upper side of the cylinder block 25. In the ends of the bearing slots formed by the bracket 34 the pivot shanks 36 of the actuating levers 37 are journaled. The lower ends of these levers are goose-necked around the shell-like ends of the cylinder block 25 and abut the central bosses of the pistons 29. These bosses preferably carry hardened steel inserts 38 for engagement by the levers 37. The upper ends of the levers 37 are goose-necked over the brake drum 39 of the wheel 16 and are provided with holes 40 for the passage of shanks 41 riveted to the ends of the brake band 42. The shanks are screw-threaded to receive adjusting nuts 43 against which the upper ends of the levers bear in contracting the brake band.

The ends of the bands are normally urged apart and the levers 37 rotated to push the pistons 29 in by means of compression springs 44 surrounding the shanks 41 and interposed between the adjusting nuts 43 and a stationary stamped metal abutment 45 extending upwardly from the bracket 34. The band is anchored against rotation and adjustable radially by the usual bracket 46 supported from the mud plate 47 and preferably located nearer one end of the band so as to give a greater self wrapping or "servo" action for the brake.

The fluid medium used in the braking system is a non-compressible liquid preferably a half-and-half mixture of castor oil and alcohol. In the application of the wheel brakes, the liquid at all times completely fills the system and when the master compressor C is actuated by the brake pedal 20, pressure is built up on the fluid throughout the system, which pressure serves to move the pistons 29 apart. This rocks the levers 37 and contracts the bands upon the drums against the pressure of the return springs 44. As the brake pedal is released the fluid pressure in the system is lessened and the return springs return the pistons 29 to their normal positions.

For a detailed understanding of the master compressor C, attention is invited to Figure 2 and to Figures 5 to 9 inclusive. The compressor is enclosed in a box-like housing 50 open at its bottom side and is supported in the installation shown by cap screws 51 passing through the web of the rearwardly opening cross member 11 of the chassis frame. This supporting cross member in the usual motor car construction is fairly heavy, and as will be noted the compressor is mounted near its connection to the lateral channel 10 of the frame which, especially when re-enforced by the gusset plate 52 (Figure 1), makes an unusually firm support for the compressor. However, the compressor need not be supported in this particular manner and I provide another pair of bosses 51' in the rearward end of the top wall of the housing 50 for the reception of the cap screws 51 when the design of the automobile chassis frame is such as to make an attachment from the upper side more desirable. It is in fact one of the features of my improved compressor that it can be supported in almost any desired manner by providing similar tapped bosses wherever required about the housing 50, and if all of the bosses are formed in the housing, a given compressor can be interchangeable for many different makes of automobiles.

The closure plate 53 which forms the bottom of the housing 50 is clamped with a fluid tight seal against the bottom edge of the housing by a number of cap screws 54. The housing together with the bottom closure plate 53 forms a liquid reservoir and the compressor cylinder 55 is preferably cast integrally with the plate 53 on its upper side so that the cylinder is mounted wholly within the housing 50. In order to minimize the possible leakage of fluid from the reservoir, I bring the compressor actuating crank through the housing wall at the highest level of the reservoir and above the level to which liquid can be poured into it. This compressor actuating crank comprises a horizontally disposed shaft 56, a downwardly extending inner arm 57 and a downwardly extending outer arm 58, the latter having three radially spaced holes 59 at its lower end. The shaft 56 is mounted in a transverse bore 60 in the upper part of the housing 50 and is journaled by bushings 61 and 62. The bore 60, it will be noted does not extend entirely through both side walls of the housing but only through the right wall (Figure 6) so that the only possible leakage of fluid would be along the bushing 62, and such fluid leakage is further prevented by a packing 63. The bushing 61 abuts the inner end of the bore 60, and together with the bushing 62 serves to space the inner arm 57 centrally of the housing and especially centrally in respect to the cylinder 55. Both arms of the crank are of course non-rotatably secured to the shaft 56 and one of the arms, the inner arm 57 in the drawings, is adjustable with relation to the shaft by a serration of the shaft 56 and by the clamping screw 64.

The brake link rod 21 carries a screw threaded clevis on each end, the forward clevis being pivoted to the brake pedal 20 by a pin 65 and the rearward clevis by a pin through one of the holes 59 of the crank arm 58. For most installations the brake pedal 20, and the location of its pivotal connection 65 with the brake rod, can be retained in the same form as when used with mechanical rear wheel brakes. The provision of the three holes 59 in the crank arm 58 gives a reasonable leverage adjustment so that the foot pressure for applying the brakes can be suited to the preferences of the individual driver.

The compressor cylinder 55 is open at its rearward end and in its bore a piston 67 is slidably mounted. At its forward end the piston 67 carries an annular packing 68 which is V- or U-shaped in section and preferably formed of vulcanized rubber. It is fixed to the piston by slipping it over the enlarged head of the centrally protruding hollow boss 69 at the forward end of the piston 67. Pressure forwardly of the piston tends to seal the packing 68 against both the boss 69 and the bore of the cylinder 55 and effectively prevents leakage past the piston even though a very high pressure is built up on the liquid.

The cylinder 55 communicates with the conduit tubes 22 leading to the brake cylinders by means of a vertical passage 71 leading downwardly from the forward end of the cylinder 55, a rearwardly extending longitudinal bore 72 and cross bores 73 in the ends of which the conduit tubes 22 are secured by conventional solderless couplings.

As thus far described the compressor acts as a compressor in the strict sense of the term, that is, the piston of the cylinder serves merely to displace the liquid and when released the return springs of the brakes push the liquid back into the compressor, there being no check valves.

However, in order to compensate for liquid losses in the system I incorporate a pump as a part of my compressor whereby an excess amount of liquid from which the system may be replenished is trapped in the system with each application of the compressor.

I prefer that such a trapping or replenishing device be combined, for the sake of economy and simplicity, with the compressor itself and to this end I provide the piston 67 of the compressor with a central bore 70. The rear of the bore 70 is connected with the reservoir of the housing through a backwardly seating check valve while in the other end of the bore there is a stationary piston which also incorporates a backwardly seating check valve,—thereby forming a pump. The check valve at the rear of the bore 70 is in the form of a vulcanized rubber packing 74 mounted on a steam 74A fixed to a disc 75 of hardened steel which is secured in the rear face of the piston 67 by a C ring 75A. (The purpose of the hardened disc 75 is to provide a wear resisting abutment for engagement by the end of the inner actuating arm 57 which inherently has a certain amount of sliding movement against the piston as it swings through its arc. Suitable perforations 75B are provided in the disc to permit the passage of liquid into the bore 70 past the check valve 74. If desired a tongue can be struck back from the disc 75 and provided with a hole into which extends loosely a pin 76 on the lower end of the arm 57, so that when, as will be later explained, the compressor is used as a pump for filling the system, the piston can be actuated positively in its rearward as well as its forward movement.)

The forward check valve and fixed piston for the pump bore 70 is formed by a vulcanized packing 77 which may be identical with the packing 74 and which is mounted at the rearward end of a small piston rod 78. The rod 78 also carries a perforated disc 79 to re-enforce the packing 77 when the latter acts as a piston. The forward end of the piston rod 78 is rather loosely held by a cross pin 79 in a plug 80 threaded into the forward end of the cylinder 55 to give the rod a limited universal movement and permit the packing 77 and disc 79 to center themselves in the bore 70 of the piston. The aperture in the end of the cylinder 55 into which the plug 80 is inserted is of sufficient diameter to permit the withdrawal of the packing 77 so that the packing rod and plug can all be assembled and inserted as a unit into the end of the cylinder.

As previously mentioned the piston 67 of the compressor is returned to its normal position of Figure 5 by the pressure of the return springs 44 at the wheel brakes. The rearward movement of the piston is limited by an adjustable stop screw 81 threaded into an ear 82 protruding from the right side wall of the housing 50, which screw engages the outer crank lever 58. In the upper wall of the cylinder 55 and just forwardly of the position assumed by the knife edge of the packing 68 when the cylinder 67 is in its normal retracted position, I provide a small relief port 83. If after the return springs 44 in the wheel brakes have returned the compressor piston 67 as far as the stop screw 81 will permit, there is still some liquid which must be displaced from the system before the return springs 44 finally push the cup packings 30 of the wheel brakes as closely together as the cylindrical fillers 31 will permit,—then this excess fluid will be forced out of the system through this small relief port 83.

The relief port 83 does not cause any appreciable loss of fluid from the system in actuating the compressor for three reasons: First, it is located so close to the packing 68 that as soon as there has been any appreciable forward movement of the piston 67, the port will be closed off; second, the port is so small that even were the system subjected to a high pressure, it would take too long a time to pass an appreciable amount of liquid; and third, the previously mentioned rubber packing 74 acts as a pump to introduce an excess amount of liquid into the system which would readily compensate for any loss through the port.

The port 83 acts to relieve the system not only of the excess liquid pumped into it by the piston packing 77 but also to relieve it from an excess volume which might develop by a general heating of the liquid in the system as for example by driving along a hot pavement in summer weather or by driving the automobile down a long hill where the heat generated by the friction of the brakes would serve to heat the liquid and expand it. The pump feature on the other hand serves with each application of the compressor to introduce a small excess amount of fluid into the system which replaces any liquid which may have been lost from the system by a slight leakage, evaporation, seepage past the piston packing 68, or otherwise.

As the brake pedal 20 is depressed, the arm 57 swings forwardly sliding the piston 67 inwardly. Almost instantaneously the port 83 is shut off and the pressure built up in the system serves to seal the packing 68 against the bore of the cylinder 55 and also against the central boss 69 of the piston 67 while the pressure on the packing 74 seals it against the bore 70 of the piston. In effect, the entire area of the piston 67 within its perimeter becomes the piston face in displacing liquid from the cylinder toward the wheel brakes. The liquid displaced from the bore 70 by the packing 74 slips past the piston packing 77. A normal full application of the brakes would carry the piston forwardly approximately to the position indicated as a typical example in Figure 8. In the particular apparatus which I have illustrated in the drawings, the fluid system (not including the reserve of course,) contains about twenty-one cubic inches of liquid and in the normal maximum application of the brakes, the compressor displaces about 1.25 cubic inches of liquid. It will be seen from Figure 8 that the piston is then still capable of a movement a half more than the normal movement, thereby giving a fifty per cent margin of safety in the event that the brake linings become worn down, the linkage develops slack, or the reserve of liquid becomes depleted—and no other adjustment is made to compensate for it. The amount of excess liquid introduced by the displacement of liquid from the bore 70 of the piston would be about .196 cubic inches or a little less than one-sixth of the normal displacement.

When the brake pedal 20 is released following a depression to apply the brakes, the return springs 44 at the wheel brakes maintain a pressure on the liquid in the system to return the piston 67 to its rearward position. At this time the pressure forwardly of the piston packing 77 is greater than that in the bore 70. This seals the edges of the packing against the bore in which it is sliding. The fluid from the reserve in the housing 50 will flow into the bore 70 past the check valve packing 74, partly by suction created in the bore 70 and partly by the head of liquid in the reserve. When the piston 67 has receded to its normal position, the bore 70 will have been completely charged with liquid.

If one considers the packing 68, the boss 63 and the packing 74 as constituting the face of the piston 67, which they do in effect, it will be seen that the packing 77 acts as a check valve to trap a portion of the liquid displaced by the piston and prevent its return to the space from which it was displaced and instead leave it to to be discharged through the relief port 83.

When the apparatus is originally assembled and the system is to be made ready for operation, the filling plug 85 is removed from the top wall of the housing 50 and liquid is poured in to fill the housing. The relief valves 86 at the wheel brakes are opened. One of these valves 86 as shown in Figure 4 is threaded into the top of the cylinder block 25 to communicate with the upper side of the cylinder bore midway between the opposed pistons. The valve is in the form of a plug which seats against a counter-bore in the cylinder block 25 and which has a small bore 87 leading from its outer end to a cross bore adjacent its inner end. The wheel cylinder is thus relieved to atmosphere by simply turning back the valve 86 a short distance from its seat. The relief valves 86 are located at the tops of the wheel cylinder blocks 25 because they are the highest points at the extremities of the system.

It would be possible, if the pump portion of the compressor piston 67 were properly primed and if the brake pedal 20 was reciprocated fast enough, to pump the reserve fluid into the system and completely fill it. But in order to simplify this operation and make it more positive I prefer to transform the entire compressor into a pump. This necessitates interposing a check valve somewhere between the compressor cylinder 55 and the conduit lines. Instead of using valves—with their attendant danger of leakage—to by-pass the communicating passages between the cylinder and the lines through a conventional check valve, I have devised a construction which is virtually built into the compressor unit as an integral part and which avoids possibility of leakage. This consists of a cap screw 88 threaded into the bottom closure plate 53 of the compressor unit in alignment with the bore 72, the cap screw 88 having a reduced extension 89 carrying an integral perforated disc 90 which has a tight fit in the bore 72. On the extreme end of the extension 89 a disc valve 91 is loosely mounted and can seat as a flap valve against the disc portion 90 to close communication through its perforations.

As normally supported by the plug 88, the disc 90 and valve 91 are positioned at the extreme rearward or closed end of the bore 72 and beyond the intersection of the bore 72 by the cross bores 73, so that the check valve 90—91 does not affect free communication between the cylinder 55 and the conduit lines. When the compressor is to be used as a pump for filling the system, however, the cap screw 88 is unscrewed until the index groove 88′ comes flush with the outer end of the tapped hole into which the screw is threaded. (See Figure 9.) This gives a predetermined forward withdrawal to the check valve 90—91, bringing it forwardly of the point of intersection of the bore 72 and the cross bores 73 so that the check valve is then interposed between the cylinder 55 and the conduit lines. In this position the check valve seats toward the cylinder 55 preventing recession of the liquid from the lines and causing the cylinder 55 to be filled at each stroke partly through the relief port 83 and partly past the packings 77 and 74 and to a lesser extent past the packing 68. A suitable vent is provided for the housing 50 either through the filling plug 85, or preferably, as shown in Figure 5, by a small hole 92 in the vertical wall of the housing extension that provides room for the top of the arm 57, as that is well above the highest liquid level and where there is little danger of dirt being introduced.

As soon as the system becomes entirely filled, the liquid will start running out the relief valves 86 at the wheel brakes and then the operator can cease actuating the compressor, turn the screw 88 back to its normal position and close the relief valves 86.

Very minor liquid losses are almost sure to occur from time to time either due to slight leakage past the pistons of the wheel brakes or in the couplings, or to evaporation or the like, with the result that at the end of a year or two, the liquid reserve in the housing 50 will have been brought down to a level lower than the relief port. I contemplate that this will not happen in the majority of instances because the automobile driver will take the precaution of checking up on the liquid level at long intervals. Although the exposure of the port 83 to atmosphere might tend to admit some air into the cylinder 55, the effect would be overcome by the action of the pump portion of the compressor which, in delivering its excess liquid to the cylinder 55, would drive the air through the port along with the excess liquid. When the liquid level has dropped down to the perforations 75B in the disc 75 and the rear end of the piston 67, the pump will be introducing a portion of air with each application of the compressor, increasing as the liquid level falls. Even though this air will be relieved from the cylinder 55 by the relief port 83 at the completion of each stroke, the air during the stroke will be trapped in the cylinder 55 with the result that it acts somewhat as an expansion chamber to give a certain compressibility to the fluid in the system. This condition will be indicated to the operator by a "springiness" of the brake pedal 20 which will constitute a preliminary warning to him, even though he has not looked at the fluid level. As larger amounts of air are taken into the cylinder 55 with the applications of the compressor, the amount of non-compressible liquid will be lessened and a slack developed in the brakes which ultimately will let the brake pedal come down to the floor board without fully applying the brakes. As this slack continues to develop the driver cannot help but notice it and have more reserve liquid put into the housing 50.

This slack in the application of the brakes due to exhaustion of the reserve liquid, of course, does not develop suddenly but over a considerable period of time so that the brakes are still usable and the driver is given ample time in which to attend to replenishing the liquid.

As to the relation between the capacity of the pump and that of the compressor, the pump should be of sufficient capacity to compensate for minor fluid losses from the system, but still it should not be of such capacity that it will cause all of the slack to be taken up by pumping an excess of fluid into the system should the driver successively apply full and then relaxed pressures by the compressor without letting the compressor piston come back to normal where the cylinder will be drained of excess fluid by the port 83. Thus, as here shown, the pump could be actuated two or three times or more without an intervening relief, without pumping so much liquid into the system as to take up the slack on the brakes and cause them to lock.

It will be observed that if the piston 67 were an ordinary piston—that is did not have the pump formed by the bore 70—its effective area in moving inwardly would be slightly more than in moving outwardly because of negligible slippage past the cup washer 68. However this is only incidental as compared with the differential between the effective areas of the piston when moving forwardly and moving backwardly, when my central pump is incorporated in it.

In the modified form of compressor unit shown in Figures 10, 11, and 12 the cylinder 55*a* forms a part of a more or less circular end plate 53*a* rather than a part of the bottom plate, so that the cylinder is inserted from the end of the main housing 50.

Instead of using the retractile spring 21' for the brake pedal positively to withdraw the piston through the coupling afforded by the pin 76, I use a retractile spring 95 interposed between the piston and the cylinder. This permits the brake pedal to return to normal independently of the piston and tends at all times to keep the piston cup 68*a* against the piston.

I provide a stop for limiting the outward movement of the piston, in the form of a spring wire 96. The wire is bent into a C-shape of somewhat more than 180 degrees so that it will securely grasp the cylindrical periphery of the end of the cylinder. It has hair pin rebent ends 97, with the terminals offset inwardly as at 98 on a diameter. The offset ends extend through holes 99 in the wall of the cylinder 55*a* and project a short distance inwardly therebeyond as a stop for the piston 67*a*. The purpose of the relatively great developed length is to minimize the danger of the spring wire being bent beyond its elastic limit in removing it.

A discharge passage 100 leads from the inner end of the bore of the cylinder 55*a* down past the normally inoperative check valve 89*a* and to the line 22*a* leading to the wheel brakes.

I claim:

1. In a hydraulic brake system of the class described having brake mechanisms operated in one direction by fluid pressure and springs for operating said mechanisms in the opposite direction, the combination of a liquid compressor hydraulically connected with said brake mechanisms, a liquid reservoir for supplying said compressor, a pump in said compressor and drawing liquid from said reservoir to supplement the compressor in supplying liquid under pressure to the system, said pump having a capacity less than half of that required to take up the normal slack in the brake mechanisms, common actuating means for causing simultaneous discharge of said pump and said compressor, and valve means for draining the system of excess liquid when the compressor is in its position of rest.

2. In a fluid pressure system of the class described including a fluid motor and means operated thereby, the combination of a compressor in fluid communication with said motor, said compressor having a reciprocating piston, said piston having one area effective on the discharge stroke and a second area effective on the return stroke, said first-mentioned area being greater than said last-mentioned area whereby said piston on its forward stroke discharges from said compressor a larger quantity of fluid than can be accommodated in said compressor by the return stroke of said piston, and means for conducting said difference in quantity of said fluid to a fluid reservoir.

3. In a hydraulic brake system having brakes hydraulically actuated in one direction and spring means for returning said brakes to inoperative condition, the combination of a compressor comprising a cylinder element and a piston element, a liquid connection between the compressor and the hydraulically actuated brakes, a pump coaxially arranged with the compressor and comprising a cylinder element and a piston element, one of said pump elements being carried by one of said compressor elements, and a common actuating member for the compressor and the pump for simultaneously compressing the liquid in the compressor cylinder and for pumping the surcharge of liquid from the pump cylinder into the compressor cylinder, a fluid reservoir, and means for conducting to said reservoir the excess of the surcharge returned through the operation of said springs.

4. In a hydraulic braking system of the class described having hydraulically actuated wheel brakes and springs for releasing said brakes and for returning fluid supplied thereto, the combination of a compressor in liquid communication with said wheel brakes, said compressor comprising a cylinder, a compressor piston reciprocable therein, said piston having a bore, a pump piston acting in said bore and including a check valve permitting the liquid to pass from the bore forwardly into the cylinder, a liquid reservoir for supplying fluid to said compressor and bore, a check valve carried by the compressor piston permitting the

passage of liquid from the reservoir to the bore of the compressor piston outwardly from the pump piston, means for reciprocating the compressor piston for actuating the brakes and for simultaneously actuating the pump comprised by said piston bore and said pump piston for supplying an excess of liquid towards said brakes, and means for conducting to the reservoir the excess of liquid returned by said springs.

5. In a hydraulic pressure system of the class described having means operated in one direction by hydraulic pressure and returned by spring means, the combination of a compressor in liquid communication with said hydraulically operated means, said compressor comprising a liquid reservoir, a master cylinder submerged therein, a compressor piston reciprocable in said cylinder, said piston having a bore constituting the cylinder bore of a pump, a pump piston working in the pump bore and including a cup packing having a check valve action permitting the flow of liquid from the pump bore to the cylinder, a check valve between the pump bore and the reservoir located outwardly from said pump piston, means for actuating the compressor piston to operate the compressor and the pump, means for returning the compressor piston independently of any back pressure created by said springs, and passage means between the compressor cylinder and reservoir for relieving excess liquid returned to said cylinder under the influence of said spring means.

6. A master cylinder unit for a hydraulic brake system having brake mechanism operated in one direction by hydraulic pressure and in the opposite direction by spring means comprising a compressor cylinder, a piston therein, a reservoir communicating with the outer end of the piston, means for reciprocating the piston for compressing the liquid in the cylinder, and a reciprocating pump formed within the piston and actuated by the reciprocation of the piston for pumping a surcharge of liquid from the reservoir into the cylinder, and means for returning to the reservoir excess liquid returned under the influence of said spring means.

7. In a hydraulic brake system comprising motor means for actuating brake mechanism and spring means for returning said brake mechanism to inoperative position, the combination of compression means in fluid communication with said brake mechanism, a fluid reservoir forming a source of supply for said compression means, pump mechanism also supplied from said reservoir, a single rectilinearly reciprocable means forming a part of both said compression means and said pump means, said reciprocable means forcing a larger quantity of fluid toward said motor means than can be accommodated in said compressor means by the return stroke of said reciprocable means, and means for permitting return to said reservoir of excess fluid returned under the influence of said spring means.

8. In a hydraulic braking system having liquid operated wheel brakes, the combination of an actuating compressor in liquid communication with said brakes, and normally inoperative means manually manipulable to operable condition as a discharge check valve for the compressor to prevent recession of liquid from the brakes to the compressor whereby the compressor may be actuated as a pump to fill the liquid system therebeyond.

9. In a hydraulic braking system including liquid operated wheel brakes, the combination of an actuating compressor having liquid inlet means from a source of liquid supply, there being operating liquid connections between said compressor and said wheel brakes and normally inoperative means manually rendered operable as a discharge check valve for the compressor to prevent recession of liquid from the brakes to the compressor whereby the compressor may be actuated as a pump to fill the liquid system.

10. In a hydraulic braking system having liquid operated wheel brakes, the combination of an actuating compressor having liquid inlet means from a source of liquid supply, there being operating liquid connections between the compressor and the wheel brakes, and a discharge check valve for the compressor preventing recession of liquid from the brakes to the compressor whereby the compressor may be actuated as a pump to fill the liquid system, and means operable at will to render the check valve inoperative.

11. In a hydraulic braking system having liquid operated wheel brakes, the combination of an actuating compressor having a passage in liquid communication with said brakes, and a check valve manually shiftable into and out of said passage whereby in the latter position the check valve becomes inoperative and in the former position operates to prevent recession of liquid from the brakes to the compressor when the compressor is actuated as a pump.

12. In a hydraulic system of the class described having elements actuated by hydraulic pressure, the combination of a compressor having an operating liquid connection with said elements, check valve means in the connections through which liquid passes to and from the compressor, and manually operable means to adjust the check valve means to permit liquid flow in either one direction only or in both directions.

13. In a hydraulic pressure system of the class described, including hydraulically actuated mechanism, the combination of a compressor, liquid lines leading from the compressor to said means, a liquid passage between the compressor and the lines comprising intersecting bores, a check valve in one of said bores comprising a stem, a perforate head making a substantially fluid-tight fit with the check valve bore, a check valve element cooperating with the perforate head, and manual means for reciprocating the check valve in its bore across the intersection of said bores whereby in one position the check valve is operably inserted in the passage and in the other position it is rendered inoperative.

WALLACE F. OLIVER.