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(19)

(54) PRESSURE-CONTROL VALVE ASSEMBLY

(71) We, ALFRED TEVES GMBH, a joint stock Company organised under the Laws of Germany, of 6000 Frankfurt Am Main, Guerickestrasse 7, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a pressure-control valve assembly for hydraulic brake systems.

There are already known pressure control arrangements which comprise a plunger piston which is sealingly slidable in a bore and defines a chamber connected with at least one brake cylinder, the chamber being connected with a brake fluid pressurizing source through a valve which is kept in the open position by mechanical means in that end position of the plunger piston in which the chamber volume is smallest, the plunger piston being displaceable into this end position by pressure supplied by an auxiliary pressure source, the auxiliary pressure from this source being controllable for effecting an anti-skid control, for which purpose the auxiliary pressure source is connected with a control chamber lying opposite the chamber through at least one auxiliary valve.

In the known pressure-control arrangement, a valve closure member of the valve is urged in the closing direction by a spring and is kept open by the plunger piston when in its end position by means of a tappet fitted thereto. When the plunger piston leaves its end position, the tappet and the valve closure member become separated, thereby enabling the spring to close the valve. In the event of a pressure decrease in the chamber, the differential pressure thereby occurring exerts additional pressure on the valve closure member in the closing direction. The valve can be re-opened only after the plunger piston has again reached its end position, thereby disregarding the fact that the valve performs at the same time the function of a check valve inhibiting the passage of fluid towards the chamber. On account of this purely mechanical valve control care must be taken, in the event of failure of the auxiliary pressure controlling the plunger piston, that the plunger piston maintains in any case its end position keeping the valve open, since otherwise the plunger piston would be moved away from its end position immediately upon the application of a slight pressure supplied to the brake cylinders. The valve would be closed thereby and no further brake pressure could build up. Therefore, the known pressure-control arrangement has another auxiliary power source in the form of an emergency spring which is kept in a stressed position as long as auxiliary pressure is available. If the auxiliary pressure fails, the spring will relax, keeping the plunger piston in its end position. In this process, the emergency spring must still have a biassing force sufficiently high to enable the plunger piston to maintain its end position in opposition to the maximum possible brake pressure.

It is a disadvantage of the above-mentioned pressure-control arrangement that generally a second outside power source has to be provided to ensure normal braking without anti-skid control in cases where the auxiliary pressure has failed. This results in substantially larger size, more weight and increased costs of the pressure-control arrangement. In addition, the fitting of such a strongly pre-stressed emergency spring causes considerable difficulties. This disadvantage has particular weight because the emergency spring is required for a very rarely occurring case only as a safety measure, just to keep the valve open. The fact that it prevents at the same time an increase of the chamber volume in the event of failure of the auxiliary pressure, that means no pressure fluid is drawn from the brake system, is rather irrelevant for a large number of brake systems, since a limited increase of the chamber volume can be handled without difficulty.

An example of such a system is the brake system known from German patent specification 909 657. In this specification, the plunger piston is completely mechanically separated from the valve. The plunger piston is controlled by the auxiliary pressure purely by hydraulic means, without the provision of additional means for keeping it in the end position upon failure of the auxiliary pressure.

If the auxiliary pressure fails, it will thus be displaced into a position enlarging the chamber volume. The valve will be switched magnetically, independent of the position of the plunger piston. In order to avoid the expenditure becoming too high, the valve, together with an auxiliary valve controlling the auxiliary pressure for anti-skid control, are switched by means of a solenoid. The auxiliary valve has the same function as the auxiliary valve provided in the above-described pressure-control arrangement, which is to disconnect a control chamber from the outside pressure source and connect it with the return line in order to achieve a decrease in brake pressure. To increase the brake pressure again, the control chamber is re-connected with the outside pressure source so that the pressure therein increases and the plunger piston is urged back into its end position.

Since, in the brake system according to German patent specification 909 657, the valve opens completely independently of the position of the plunger piston and the brake-fluid pressure prevailing in the chamber, there will be no approximation between the effective brake pressure and the pressure of the brake pressure source. On the contrary, the valve will re-open just when the brake pressure in the chamber is at its lowest value within the respective control cycle, because it is at this moment that the auxiliary valve has to change its position to urge the plunger piston back into its end position. Because of the valve opening at that moment, fluid under pressure from the brake pressure source will all of a sudden flow into the chamber which leads to a sudden yielding of the brake pedal. Also, the brake pressure will be increased to the pressure level of the brake pressure source before the plunger piston reaches its end position. If the wheel concerned does not become locked again thereby, the plunger piston will continue moving into its end position and urge the pressure fluid supplied out of the chamber again, thereby causing the brake pedal to be raised again, in opposition to the force exerted by the driver. In most cases, however, the wheel will lock again because of the sudden increase in pressure so that another control cycle will follow in which the plunger piston starts to leave its middle position. The distance within which the plunger piston is allowed to move must be closely restricted in order to avoid the chamber drawing too much pressure fluid in the case of failure of the auxiliary pressure which would entail the risk of exhaustion of the brake-pressure source. As a consequence, a movement of the plunger piston away from its middle position to avoid wheel lock is not sufficient. It will be apparent from the above that the mechanical control of the valve in dependence on the plunger piston is necessary in a pressure-control arrangement of the type initially referred to in order to ensure a satisfactory anti-skid control.

From German patent specification No. 2 130 100 a pressure-control arrangement has already become known comprising substantially a floating piston inserted in the brake line. In this arrangement, one piston end is exposed to pressure from the brake-pressure source which causes displacement of the piston and generation of the brake pressure acting on the wheel brake cylinders on the other piston end. To achieve an anti-skid control, the auxiliary pressure, controlled by auxiliary valves, is applied to an additional annular surface of the piston, acting against the pressure from the brake-pressure source and causing the piston to move. While it is true that this pressure-control arrangement has the advantage that failure of the auxiliary pressure merely causes the anti-skid control to become ineffective and does not affect the brake system, it is, however, a disadvantage that any control cycle, no matter how small the decrease in brake pressure it causes is, results in pressure fluid being urged back to the brake-pressure source which will make itself felt immediately at the brake pedal in the case of static brake-pressure sources being used. In contrast thereto, it should be the aim of all anti-skid control systems to achieve that in a normal control cycle, during which only a minor pressure decrease is necessary, no pressure fluid can be urged back. In a strong control cycle effecting substantial pressure changes which usually occurs only during variations of the coefficient of friction, a small amount of pressure fluid which is urged back to the brake-pressure source could be put up with without difficulty. In this case, when using a static brake-pressure source, a normal control cycle would make itself felt not at all, and a strong control cycle only slightly. Such operating characteristics would no doubt constitute an advantageous side effect in a pressure-control arrangement. However, of primary importance are the disadvantages inherent in the known pressure-control arrangements.

According to the present invention there is provided a pressure-control valve assembly for a hydraulic brake system comprising a plunger piston which is in a bore and which forms a bound of a main chamber for connecting with at least one brake cylinder, said main chamber being connectible with a brake-pressure source through a principal valve which is kept in the open position by mechanical means when said plunger piston is in its end position in which the main chamber volume is smallest, the plunger piston being displaceable into said end position by pressure supplied by an auxiliary pressure source, said auxiliary pressure being controllable for effecting an anti-skid control, for which purpose a control chamber lying opposite said main chamber is connectible with the auxiliary pressure source through at least one auxiliary valve, wherein a second piston is provided which is connected with a valve closure member of the principal valve and has a first end face to which is applied the pressure from the brake-pressure source in the direction to open the principal valve, and a second end face to which is applied the auxiliary pressure in the direction to close the principal valve, said end faces being so dimensioned that in use said valve closure member will always be urged in the closing direction by the auxiliary pressure when normally available.

Embodiments of the invention are described below with reference to the accompanying drawings, of which:

figure 1 shows an embodiment providing an auxiliary pressure source having a pressure level lying below the maximum brake pressure; and

figure 2 shows an embodiment including a reaction piston for a brake system in which the auxiliary pressure is controlled proportional to the braking pressure.

Terms such as "left", "right", "upper", "lower" used in the specification refer to the apparatus as depicted in the drawings and are not to be taken as referring to the described equipment when actually fitted to a vehicle.

In figure 1, a housing 1 includes a bore 2 subdivided by steps into sections A, B and C. Bore 2 receives, sealingly and slidably, a plunger piston 3 also stepped which is sealed relative to each of the sections A, B and C. Section A includes two seals, one either side of an annular groove 4 of plunger piston 3. Annular groove 4 is in communication with a brake-pressure source (not shown) through a port 5. The brake-pressure source may be, for instance, a conventional master cylinder. The left-hand end of plunger piston 3 forms one bound, in section A, of a chamber 6 which connects with brake cylinders (not shown) through a port 7. Between a step of sections A and B, a compensating chamber 8 is formed which is always unpressuriezed and communicates with atmosphere. An annular chamber 9 which is provided at a step between sections B and C and is contained between the seals of plunger piston 3 in sections B and C, is in permanent communication with an auxiliary pressure source (not shown) through a port 10. The right-hand end of plunger piston 3 forms one bound in section C of a control chamber 11 which is connected with the auxiliary pressure source or an unpressurized reservoir through a port 12 via an auxiliary valve (not shown). In an intermediate position of the auxiliary valve, control chamber 11 may also be fluid-tight.

Thus, the plunger piston has on its left an end 13 supplied with the braking pressure which is also supplied to the brake cylinders, and which causes the piston to be urged to the right. Further, it has an annular surface 14 forming one bound of annular chamber 9, which is at all times exposed to the auxiliary pressure fully available and likewise causes plunger piston 3 to be urged to the right. It has another end 15 forming one bound of control chamber 11, upon which the auxiliary pressure acts to the left to a degree determined by the auxiliary valve. So long as no control cycle takes place, the pressure in control chamber 11 is the full auxiliary pressure available. Surfaces 13, 14 and 15 are so dimensioned that, so long as the full auxiliary pressure prevails in control chamber 11, plunger piston 3 is always held in its left end position in which chamber 6 has its smallest volume. With the auxiliary pressure diminishing in control chamber 11, plunger piston 3 will be displaced to the right, thereby increasing the volume of chamber 6. The travel of displacement is dependent on the degree of reduction of auxiliary pressure in the control chamber and on the reaching of a correspondingly reduced brake pressure in chamber 6.

Plunger piston 3 has a coaxial bore 16 connecting at the left end with chamber 6 through a passageway 17. A valve seat 18 is formed between bore 16 and valve passageway 17. The left-hand end of bore 16 connects with annular groove 4. The right-hand end of bore 16, which is stepped, has a diameter larger than that of the left-hand portion arranged in section A, with the right-hand portion connecting with annular chamber 9. The two ends of bore 16 are separated from one another by a piston 20 provided with a seal in each of the left-hand and right-hand portions. A space between the seals is connected to compensating chamber 8.

Piston 20 has a first applied end 21 facing valve passageway 17, said end being exposed to the pressure from the brake-pressure source, and a second applied end 22 facing the right-hand end of bore 16, said end 22 forming one bound of a chamber 24 and being always exposed to the full auxiliary pressure. The applied piston ends are so dimensioned that piston 20 is always urged to the left when auxiliary pressure is available.

Piston 20 has a projection 23 extending from the first applied end 21 and forming a valve closure member 23 cooperating with valve seat 18. When piston 20 is displaced to the left, valve closure member 23 will move into engagement with valve seat 18, thereby closing passageway 17, whereas passageway 17 will be open during displacement of piston 20 to the right.

A rod 19 rigid with the housing extends into passageway 17 and projects, in the left-hand end position of plunger piston 3, into bore 16 past valve seat 18, thereby mechanically keeping valve closure member 23 off valve seat 18. Thus, valve closure member 23 can reach its closing position only if plunger piston 3 has left its left-hand end position.

Between chamber 6 and annular chamber

4, a check valve 25 is provided stopping flow towards chamber 6, said valve being indicated in the drawing only schematically. It prevents that the pressure in chamber 6 ever becomes higher than in annular chamber 4.

The mode of operation of the embodiment of figure 1 is as follows:

Already before any braking, the full auxiliary pressure is effective in control chamber 11, annular chamber 9 and chamber 24, Plunger piston 3 is thereby urged to and actually occupies its left-hand end position. Piston 20 is likewise urged towards the left, to bear upon rod 19 and thus upon housing 1.

Passageway 17 remains therefore open, in spite of the piston 20 being urged so as to close it.

During normal braking, there is thus free passage of pressure fluid between ports 5 and 7 so that the pressure from the brake-pressure source is directly fed to the brake cylinders. In this process, the pressure acting on the first applied end 21 of piston 20 is not in a position to overcome the biassing force, i.e. the force resulting from the auxiliary pressure acting on the second applied end 22, and to displace piston 20 to the right. Neither is the pressure acting on end 13 of plunger piston 3 in a position to shift plunger piston 3 to the right, in opposition to the full auxiliary pressure acting on end 15. Consequently, all parts remain in their illustrated positions.

However, upon the occurrence of a locked-wheel condition, when the auxiliary pressure in control chamber 11 is reduced by the auxiliary valve, plunger piston 3 starts moving to the right. This will cause rod 19 in passageway 17 to be withdrawn behind valve seat 18, so that valve closure member 23 closes passageway 17 at valve seat 18 as the piston 20 moves to the left relative to plunger piston 3. As soon as valve closure member 23 has moved into engagement with valve seat 18, the biassing force of piston 20 will be exerted upon plunger piston 3 to the left through valve seat 18.

Thereupon, plunger piston 3 will first remain in this position until further suitable pressure decrease has taken place in control chamber 11 so that plunger piston 3 is again put in a position to move further to the right. However, since chamber 6 is then disconnected from the brake-pressure source and increases its volume as piston 3 moves to the right, there will result a corresponding decrease in the effective brake pressure. Plunger piston 3 will move to the right until a state of equilibrium is achieved between the pressure in chamber 6 and the other forces acting upon plunger piston 3. Decrease of the effective brake pressure is therefore always in a preset relationship to the reduction of the auxiliary pressure in control chamber 11. It should be noted in this connection that, because of the second applied end 22 of piston 20 and the supporting of piston 20 through valve seat 18, a certain pressure decrease is present in control chamber 11 during which plunger piston 3 does not move, with passageway 17 being, however, closed. It will be understood that this intermediate position of plunger piston 3 is not conditioned upon a certain point within the pressure course of the auxiliary pressure prevailing in control chamber 11. The intermediate position can therefore be reached in a particularly simple manner by reducing the auxiliary pressure in chamber 11 to any arbitrary value within this range.

However, if the auxiliary pressure fails, the pressure from the brake-pressure source will act to the right only on end 13 of the plunger piston and on the first end 21 of piston 20. Any counterforces, leaving frictional forces aside, are not present. Therefore, both plunger piston 3 and piston 20 are shifted to their extreme right-hand positions. Valve closure member 23 is thereby moved from engagement with valve seat 18 so that pressure-fluid communication between ports 5 and 7 is not interrupted. This ensures, even when the auxiliary pressure has failed, that normal braking can still be effected, though without any anti-lock.

The embodiment of figure 2 corresponds, as far as plunger piston 3 is concerned to the embodiment of figure 1 so that repeated explanation of these parts may be dispensed with. Where necessary, the same reference numerals will be used as in figure 1.

In addition to what was shown in figure 1, a cylinder bore 30 is provided which is coaxial with bore 2 and receives, sealingly and slidably, a reaction piston 31. Its right-hand reaction face 32, forms one bound of a reaction chamber 33. Reaction chamber 33 is in communication with the brake-pressure source or port 5 through a port 34. Thus, during any braking operation, reaction chamber 33 is always of the same pressure exerted by the operator's pedal force as is supplied to annular chamber 4. By virtue of this pressure, reaction piston 31 is urged to the left, to bear upon a stop 35 rigid with the housing. A projection 36 extends from end 15 of plunger piston 3 to the right into a reaction chamber 37 on the left-hand side of reaction piston 31, passing through an opening between control chamber 11 and reaction chamber 37, wherein it is sealingly slidable. If all parts are in their inactive positions, i.e. if plunger piston 3 and reaction piston 31 are in their left-hand end positions, the end of projection 36 is at a predetermined distance from reaction piston 31. The distance is so adjusted that plunger piston 3 is allowed to move to the right as far as is necessary for a normal control cycle. Any further movement of plunger piston 3 to the right brings projection 36 into abutment with reaction piston 31 so that further movement of plunger piston 3 to the right can only be achieved in conjunction with reaction piston 31.

The features so far described with reference to figure 2 permit two variants of embodiment. In a first variant, a pressure-fluid connection 38, represented in figure 2, is disposed in projection 36 and provides for communication between chamber 24 and reaction chamber 37. Reaction chamber 37 is otherwise closed, as shown. A second variant would not provide for pressure-fluid connection 38 so that chamber 24 and reaction chamber 37 are separated from one another. In this case, reaction chamber 37 connects with atmosphere so that there can be no build up of pressure in it.

In the following, there is described first the way in which the second variant functions, which has no pressure-fluid connection 38 and in which reaction chamber 37 communicates with atmosphere. In normal control cycles during which projection 36 does not move into abutment with reaction piston 31, the mode of operation of this variant is identical to that of the embodiment of figure 1. However, if a strong control cycle occurs, in which movement of projection 36 into abutment with reaction piston 31 is not sufficient, plunger piston 3 will in a first stage be kept in this position via reaction piston 31 by the pressure from the brake-pressure source prevailing in reaction chamber 33. After overcoming a range of pressure decrease similar to that occurring at the end 22 of piston 20, the force in annular chamber 9 and on end 13 of plunger piston 3 will be sufficient to displace plunger piston 3, together with reaction piston 31, further to the right, in opposition to the effect of the pressure from the pressure-fluid source, thereby further reducing the pressure in chamber 6. Pressure fluid is urged out of reaction chamber 33 back to the brake-pressure source. Because a certain pressure range has to be passed through in the pressure course of control chamber 11 between the abutment of projection 36 against reaction piston 31 and the further displacement of plunger piston 3 to the right, this method affords a particularly simple possibility of approaching this position of plunger piston 3, while it will suffice to select any arbitrary pressure within the pressure range in control chamber 11.

If in this variant the auxiliary pressure fails, plunger piston 3 and piston 20 will first be shifted as described with reference to figure 1, however, only until projection 36 comes into abutment with reaction piston 31. In no case will passageway 17 be closed thereby. As soon as projection 36 is in abutment with reaction piston 31, plunger piston 3 and reaction piston 31 will take support upon each other and will be pressure-balanced since chamber 6 and reaction chamber 33 will be pressurized to the same value as determined by the brake-pressure source. The entire arrangement will draw no further pressure fluid from the brake-pressure source, irrespective of whether it remains in this position or is displaced further by any impacts whatsoever.

In the first variant providing for the pressure-fluid connection 38 and also for fluid-tight closing of reaction chamber 37, there results the following function; it is to be understood, however, that this variant is only suitable for use in a brake system having a brake-pressure source in which an auxiliary pressure is supplied proportional to an actuating force, with the auxiliary pressure being adapted to actuate a static master cylinder. In this variant, the auxiliary pressure controlled by the brake-pressure source is also used for controlling plunger piston 3 and reaction 31, i.e. only during a braking operation will auxiliary pressure be available in control chamber 11, annular chamber 9, chamber 24 and reaction chamber 37, the auxiliary pressure being proportional to the pressure made available by the brake-pressure source for the braking operation. For an anti-skid control, the auxiliary pressure in control chamber 11 is modulated by an auxiliary valve in the same manner as was the case in the embodiment of figure 1 and the second variant of the embodiment of figure 2. Because the pressure effective in reaction chamber 37 is always the full auxiliary pressure provided by the brake-pressure source, reaction piston 31 is pressure-balanced since its reaction face 32 is exposed to the brake pressure made available by the brake-pressure source and acting in opposition thereto, this pressure being proportional to the auxiliary pressure. To achieve this, reaction piston 31 is designed as a stepped piston as shown in figure 2, the areas of the two ends of the piston depending on the relationship between auxiliary pressure and available brake pressure.

In this variant, reaction piston 31 offers no resistance to plunger piston 3 when auxiliary pressure is available, so that it is permitted to move freely even when projection 36 is in abutment with reaction piston 31. The auxiliary pressure to which plunger piston 3 is exposed is such that the plunger piston remains in its left-hand end position against the force resulting from the pressure in chamber 6 as long as no control cycle takes place. When a control cycle commences, plunger piston 3 will start moving to the right already when only a slight pressure decrease occurs in control chamber 11, even though the brake pressure level is still very low since in this case also the level of the auxiliary pressure is correspondingly low. Thus, with a control cycle commencing and the brake pressure level being low, it is not necessary to achieve first a substantial pressure decrease in control chamber 11 to displace plunger piston 3.

It is to be understood that the function is otherwise identical with the second variant of the embodiment of figure 2, this being also true in the event of failure of auxiliary pressure. In such a case, such brake systems provide for generation of brake pressure by the brake-pressure source without the assistance of auxiliary pressure by means of an emergency actuation.

WHAT WE CLAIM IS:—

1. A pressure-control valve assembly for an hydraulic brake system, comprising a plunger piston which is in a bore and which forms a bound of a main chamber for connecting with at least one brake cylinder, said main chamber being connectible with a brake-pressure source through a principal valve which is kept in the open position by mechanical means when said plunger piston is in its end position in which the main chamber volume is smallest, the plunger piston being displaceable into said end position by pressure supplied by an auxiliary pressure source, said auxiliary pressure being controllable for effecting an anti-skid control, for which purpose a control chamber lying opposite said main chamber is connectible with the auxiliary pressure source through at least one auxiliary valve, wherein a second piston is provided which is connected with a valve closure member of the principal valve and has a first end face to which is applied the pressure from the brake-pressure source in the direction to open the principal valve, and a second end face to which is applied the auxiliary pressure in the direction to close the principal valve said end faces being so dimensioned that in use said valve closure member will always be urged in the closing direction by the auxiliary pressure when normally available.

2. A pressure-control valve assembly as claimed in claim 1, wherein the valve closure member is formed by a coaxial projection of the second piston, said second piston being disposed in an axial bore of the plunger piston, said bore forming in the direction towards the main chamber as a passageway adapted to be closed by the valve closure member, with a rod fixed to the end wall of chamber projecting into said passageway; wherein the pressure from the brake-pressure source is fed between passageway and first end face of the second piston into the bore; and wherein a further chamber bounded by the second end face of the second piston and the end wall of the bore is directly connected with the auxiliary pressure source.

3. A pressure-control valve assembly as claimed in claim 2, wherein a check valve inhibiting flow in the direction towards main chamber is disposed between the main chamber and the brake-pressure source.

4. A pressure-control valve assembly as claimed in claim 2, wherein the plunger piston is a stepped piston, its cross section facing the control chamber being greater than its cross section facing the main chamber by an amount corresponding at least to the size of the second end face of the second piston.

5. A pressure-control valve assembly as claimed in claim 2, wherein the plunger piston and the second piston of the principal valve are stepped pistons, with the ratio between the second end face and the first end face of the second piston corresponding at least to the ratio between the maximum possible brake pressure and the auxiliary pressure; and wherein the ratio between the cross section of the plunger piston facing the control chamber diminished by the cross section in the further chamber (which corresponds to that of the second end face) and that cross section of the plunger piston facing the main chamber corresponds at least to the ratio between the second and first end faces of the second piston.

6. A pressure-control valve member as claimed in claim 2 or claim 5, wherein the plunger piston has a second step forming one bound of an annular chamber connecting with the further chamber, the annular surface of said second step thereof being exposed to the auxiliary pressure so that it is urged towards the control chamber.

7. A pressure-control valve assembly as claimed in claim 6, wherein the plunger piston has a coaxial projection extending away from the main chamber and being sealingly and axially slidable in a cylinder bore which receives sealingly and slidably a reaction piston, which piston is exposed to the pressure from the brake-pressure source urging it towards the main chamber and prevented, at a preset distance from said projection, from moving towards said projection by means of a stop rigid with the housing, said preset distance being chosen such as to enable the plunger piston to perform a movement corresponding to a normal control cycle before the projection comes into abutment with the reaction piston.

8. A pressure-control valve assembly as claimed in claim 7 wherein there is controlled delivery of the auxiliary pressure in proportion to an actuating force, wherein the auxiliary pressure is adapted to actuate a static master cylinder, and wherein a pressure-fluid connection or passage is provided between the further chamber and a reaction chamber which faces the projection and is bounded by the reaction piston.

9. A pressure-control valve assembly as claimed in claim 8, wherein the pressure-fluid connection extends through the coaxial projection.

10. A pressure-control valve assembly as claimed in claim 8 or claim 9, wherein the reaction piston is a stepped piston, the ratio between its end face facing the projection and the reaction face exposed to the brake pressure is equal to or cmaller than the ratio between brake pressure and auxiliary pressure.

11. A pressure-control valve assembly for hydraulic brake systems substantially as described with reference to figure 1 or figures 1 and 2 of the accompanying drawings.

12. An hydraulic anti-skid brake system being a pressure control valve assembly according to any preceding claim.

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1573805 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

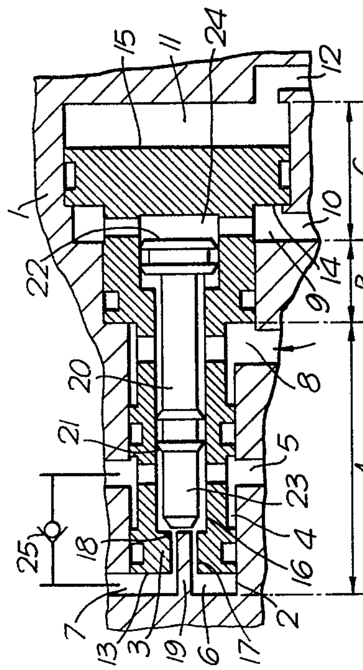

Fig. 1.

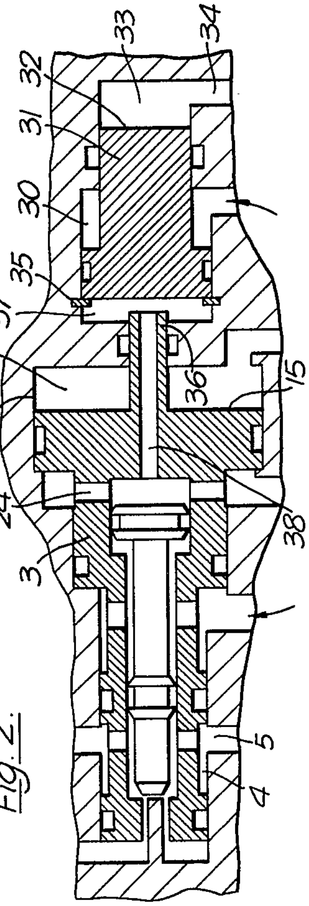

Fig. 2.