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(54) A CONTROL DEVICE FOR A MOTOR VEHICLE PNEUMATIC BRAKING SYSTEM

(71) We, FIAT SOCIETA PER AZIONI, a Joint Stock Company of Italian Nationality, of Corso Marconi 10/20, Torino, Italy, 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:—

The present invention relates generally to pneumatic braking systems for motor vehicles, and particularly to devices for modifying the braking pressure generated in the braking circuit upon depression of the brake pedal, in dependence on the load exerted on the axles of the vehicle.

One of the major problems of this type of control device is that of adequately controlling the pressure of air fed to the brakes of the vehicle so as to obtain a balanced braking action on the wheels of the front and rear axles of the vehicle in all the different operating conditions encountered in use of the vehicle.

The object of the present invention is to provide a control device of the above-mentioned type, for a motor vehicle pneumatic braking system, which is of simple and economic construction and which is capable of varying in a particularly advantageous manner the pressure of the air fed to the brakes of at least one axle of a vehicle to which it is fitted, in dependence on the braking pressure applied to the brake pedal and the load on this or both axles of the vehicle.

According to the present invention there is provided a control device for a pneumatic braking system of a motor vehicle, comprising a cylindrical housing closed at each end by respective end walls, a piston sliding in the housing and comprising a first cylindrical part and a second cylindrical part, the said first cylindrical part of the piston forming with the facing end wall of the housing a first chamber communicating, through an input duct provided in the housing, with an input port of the housing connectable to a feed duct of the pneumatic braking installation and the said second cylindrical part of the piston forming with the facing end wall of the housing a second chamber, said chambers communicating with one another through an axial duct, the said first cylindrical part of the piston being of smaller diameter than the said second cylindrical part of this piston, so that for an equal pressure in the two chambers, the piston is subject to a resultant force urging it towards the first chamber, means applying a load on the piston in the axial direction from the first to the second chamber proportional to the load on the axle of the vehicle on which means controlled by the aforementioned displacement of the piston and capable of producing a corresponding and proportional opening of a control valve in the axial duct, and means for limiting the stroke of the piston under the action of the said load sensitive means, characterised by the fact that the said second chamber communicates, through an output duct provided in the housing, with a delivery duct intended to control the compressed air supply to the brakes of the motor vehicle, or with the outside of the housing depending upon the condition of the said control valve.

Various embodiments of the invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a diagram of a pneumatic braking system provided with a control device according to the invention;

Figure 2 is a sectional view in greater detail of a device of the invention; and

Figure 3 is a diagram illustrating in schematic form a number of curves representing the variation of output pressure in the control device with varying input

pressure under different operating conditions.

Referring now to the drawings, and particularly to Figure 1, there is shown schematically a braking circuit for the front axle 1 and the rear axle 2 of an industrial truck or motor vehicle. The braking circuit includes two reservoirs 3, 4, for compressed air which is fed in a controlled manner to the brake of the front axle or axles 1 and the rear axle or axles 2 when the brake pedal (not shown) is depressed. The reservoir 3 is connected to the front brakes of the motor vehicle by a line 5 which feeds through a servo-valve 7 which controls the pressure and the flow of air from the reservoir 3 to the brakes of the front axle 1. The servo-valve 7 is connected by a pneumatic control line 8 to the reservoir 3 via a distributor valve 9 whose operational position is controlled by the force exerted by the operator on the brake pedal (not shown).

The brakes of the rear axle 2 are fed from the reservoir 4 along a line 6 and through a servo-valve 10. The servo-valve 10 is controlled by the pressure in a control line 11 which is fed to a control device 12 having two fluid pressure control inlets one of which is fed with pressure along a line 11*b* which is fed with compressed air from the reservoir 4 by the distributor valve 9 and the other of which is fed by a line 13 which is fed with the pressure in the line 8 tapped off at a junction 13*a*. The control device 12 also has a mechanical connection between the rear axle 2 and a fixed part of the body or chassis of the vehicle so as to modify the pressure on the line 11*c* in dependence on the axle loading as will be described in detail below.

The control device 12 is shown in greater detail in Figure 2 and comprises an outer body 14 having a shaped, generally cylindrical housing 14*a* closed at each end by respective transverse end walls 14*b*, 14*c*. Although the device 12 may be mounted in any orientation it will be described herein in the orientation in which it is shown in the drawings as in an "upright" orientation and references to upper and lower parts should be construed accordingly as references only to the drawings.

The generally cylindrical housing 14*a* has a cylindrical bore in two parts, one having a radius which is greater than the other. Within this two parts bore slides a shaped piston 15 having a first part 15*a* of smaller radius, and a second part 15*b* of larger radius. The first and second parts 15*a* and 15*b* of the piston are slidingly sealed in the smaller and larger parts of the bore respectively by respective sealing rings 16*a* and 16*b*. Between the end face of the first smaller part 15*a* of the piston and the facing transverse wall 14*b* of the housing there is defined a first chamber 17, and between the end face of the second larger part of the piston and the facing transverse wall 14*c* of the housing 14*a* there is defined a second chamber 18. A plunger 19, which is part of the piston 15 is located within said first chamber 17 and is projected out from the housing 14*a* and sealed slidingly in the bore by a sealing ring 19*a*.

In use of the device a force Q is applied to the plunger 19 tending to displace it along the first chamber 17 towards the second chamber 18 such as to reduce the volume of that second chamber. The force Q is proportional to the load on the axle of the vehicle on which the device operates. Such displacement of the piston 15 is limited, however, by the presence of a number of projections 20 provided on the internal surface of the transverse wall 14*c* of the housing 14.

The housing 14 has an inlet port 21 with a threaded section 21*a* for receiving a threaded connector on the pipe 11*b* (see Figure 1). The port 21 has a chamber from which leads an input duct 21*b* communicating with the first chamber 17 within the cylindrical bore of the housing 14*a*. The first chamber 17, therefore, directly receives through the inlet port 21, the braking control pressure in the pipe 11*b* upon depression of the brake pedal. Since the first chamber 17 communicates through an axial duct provided by a chamber 23 formed by a recess in the plunger 19 an axial passageway 37 and a radial passageway 37*a* formed in said plunger and an annular passageway 25 in the larger part 15*b* of the piston 15 with the second chamber 18 the braking control pressure in the pipe 11*b* is also passed into the second chamber 18. Since the area of the larger part 15*b* of the piston, which forms one wall of the second chamber 18, is greater than the area of the smaller part 15*a* of the piston, which forms one wall of the first chamber 17, then although the pressure of fluid in the two chambers is the same when the brake pedal is depressed, the piston 15 will nevertheless experience a resultant force urging it towards the first chamber 17.

Against the end of the hollow axial spigot 26, formed in the transverse wall 14*c* and standing out from the annular passageway 25, is pressed a sealing element 27 by one end of a compression spring 28, the other end of which presses against the end face of the chamber 23 in the plunger 19. The opening in the piston 15 which defines the outer face of the annular passage 25 has an axially projecting lip 29 around its rim, with which the sealing element 27, which is in the form of a plate, cooperates in such a way as to form a control valve

which controls the flow of compressed air between the two chambers 17 and 18. The hollow spigot 26 has an axial hole 26*a* one end of which communicates (except when the sealing element 27 is pressed against it) with the first chamber 17 and the opposite end of which communicates with the atmosphere.

The second chamber 18 communicates with an outlet port 30 to which the pipe 11*c* (see Figure 1) is connected when the system is assembled. The pressure in the outlet port 30 of the control device 12 controls, through the servo-valve 10, the supply of compressed air to the rear brakes of the motor vehicle.

The operation of the devices illustrated in Figure 2 is as follows. In normal operating conditions the piston 15 is acted on by a force Q which is proportional to the load on the axle of the vehicle on which the device 12 is mounted; before a braking operation, therefore, the piston 15 is urged to the position in which it is illustrated in Figure 2, but is pressed against the projections 20 on the lower transverse wall 14*c* with the passage between the rim 29 of the opening 25 and the plate-like sealing element 27 being completely open. In consequence, when the brake pedal is operated, compressed air entering through the inlet 21 passes readily from the first chamber 17 to the second chamber 18 without suffering any appreciable reduction in pressure, and then passes on from the second chamber 18 through the outlet 30 to the servo-valve 10.

Since the area of the second part 15*b* of the piston 15 on which the compressed air acts in the second chamber 18, is greater than that of the corresponding surface of the first part 15*a* of the piston 15 in the first chamber, there is, as mentioned above, a resultant force on the piston 15 in the direction opposite the force Q and proportional to the difference between the exposed areas of the two parts 15*a*, 15*b*, of the piston 15. This resultant force is, of course, also proportional to the pressure of the compressed air and thus is related to the force exerted on the brake pedal (not shown). As long as this resultant force does not exceed the force Q, the piston 15 remains in the position illustrated in Figure 2 and the air pressure at the outlet 30 remains substantially the same as the air pressure in the inlet 21. If, however, this resultant force exceeds the force Q the piston 15 is displaced towards the first chamber 17 thereby tending to close the annular passage between the plate-like sealing element 27 and the annular rim 29. The result of restricting this passage is that the air pressure in the second chamber 18 and therefore in the outlet 30 is reduced to that at which the forces acting on the piston 15 are balanced. This two stage operation is illustrated in Figure 3 in which along the ordinate are indicated the variations in pressure at the outlet 30 and along the abscissa are indicated the variations in pressure in the inlet 21. In the first stage, during which the outlet pressure Pu is equal to the inlet pressure Pe, the diagram is constituted by a straight line at 45°; in the second stage, in which the outlet pressure Pu is reduced with respect to the inlet pressure Pe, the diagram is constituted by a second straight line inclined at a smaller angle than in the first stage. The point of transition from the first to the second stage depends on the value of the force Q acting on the piston 15, which in turn depends on the axle loading, whilst the inclination of the second segment depends on the ratio between the area of the two opposite faces of the piston 15 in the first and second chamber respectively. In other words if the vehicle is lightly laden, so that the force Q is small, the braking pressure applied to the brakes for a given pedal pressure is reduced with respect to what it would be if the vehicle were heavily laden so that the force Q were large. When the vehicle is heavily laden, however, the braking pressure is directly proportional to the pedal pressure only up to a certain value and pedal pressures in excess of this value result in relatively less braking pressure being applied at the brakes.

When at the end of the braking operation, the air pressure in the inlet 21 is reduced to amtospheric pressure the piston 15 is thrust by the pressure remaining in the second chamber 18 in such a manner as to lift the sealing element 27 allowing the compressed air to discharge to the atmosphere through the passageway 26*a*.

Between the outer surface of the annular skirt 151*a* and the facing surface of the cylindrical bore in the housing 14 a side clearance is provided forming an annular duct 40. This annular duct 40 opens into an annular chamber 41 facing the larger part 15*b* of the piston 15 opposite the face thereof which forms part of the second chamber 18. The sealing ring 38 between the plunger 19 and the inner surface of the annular skirt 151*a* prevents, in normal operating conditions of the device, the passage of compressed air from the annular chamber 39 to the annular chamber 41 through the annular duct 40.

The reference numeral 42 indicates a connector union provided with a central hole 43. The union 42 screws into a threaded socket 42*a* in the housing 14 from which leads a passageway 46, aligned with the central hole 43 in the union 42, and opening into the first chamber 17. Within

the socket 42*a*, and covering the passageway 46 there is a valve element 44 of elastomeric material which is pressed against the mouth of the passageway 46 by a compression spring 45 compressed between the sealing element itself and the union 42.

A duct 47 leading from the annular chamber 41 opens into a small chamber 42*b* at the base of the socket 42*a*, which is closed by the rim of the sealing element 44. The manner of operation of the device differs if the force Q acting on the plunger 19 is absent. In such conditions, in fact, the action of the compressed air in the central chamber 23 and in the annular chamber 39 is such as to cause the displacement of the plunger 19 separating it from the piston 15 and, therefore, separation of the piston 15 from the plunger. This displacement carries the sealing ring 38 past the rim of the skirt 151*a* allowing communication between the annular chamber 39 and the annular duct 40. The compressed air which is thus introduced into the chamber 41 balances the forces exerted on the two opposed faces of larger part 15*b* of the piston 15 so that this remains in the position illustrated in Figure 2, that is to say, in contact with the projections 20 of the transverse wall 14*c*. The valve plate 27 is thus held away from the rim 29 of the central opening 25 in the piston so that the compressed air can pass from the first chamber 17 to the second chamber 18, through the annular passageway defined by the opening 25, without any substantial reduction in pressure. Thus when the force Q is absent this embodiment always operates with the output pressure Pu substantially equal to the input pressure Pe; this corresponds to the first stage of operation in accordance with the line at 45° of Figure 3, and not in accordance with the shallower inclined line of this Figure, corresponding to the second stage of operation. The valve element 44 which covers the hole 46 is held shut by the spring 45 and by the pressure difference across the valve element 44 itself (the pressure in the pipe 13 from the junction 13*a* with the front brake control circuit would usually be higher than the pressure in the chamber 17). However, if, for any reason, such as a failure in the front brake circuit the pressure normally present in the control circuit 8 is reduced or absent altogether, the valve element 44 is displaced by the air pressure in the first chamber 17 overcoming the force of the spring 45 to permit communication, through the passages 46 and 47, between the first chamber 17 and the annular chamber 41. Thus, even though there may be a force Q exerted on the plunger 19 the larger part 15*b* of the piston is held, for all brake pedal pressures, against the stops 20 so that the braking pressure at the outlet 30 is always substantially the same as the pressure at the inlet 21. Clearly, if for any reason the braking of the front brakes is reduced the rear brakes must be operated at full pressure, without any reduction in order to compensate for the loss of braking effect on the front wheels.

WHAT WE CLAIM IS:—

1. A control device for pneumatic braking systems for motor vehicles comprising: a cylindrical housing closed at each end by respective end walls, a piston sliding in the housing and comprising a first cylindrical part and a second cylindrical part, the said first cylindrical part of the piston forming with the facing end wall of the housing a first chamber communicating, through an input duct provided in the housing, with an input port of the housing connectable to a feed duct of the pneumatic braking installation and the said second cylindrical part of the piston forming with the facing end wall of the housing a second chamber, said chambers communicating with one another through an axial duct, the said first cylindrical part of the piston being of smaller diameter than the said second cylindrical part of this piston, so that for an equal pressure in the two chambers, the piston is subject to a resultant force urging it towards the first chamber, means applying a load on the piston in the axial direction from the first to the second chamber proportional to the load on the axle of the vehicle on which the device operates, means controlled by the aforementioned displacement of the piston and capable of producing a corresponding and proportional opening of a control valve in the axial duct, and means for limiting the stroke of the piston under the action of the said load sensitive means, characterised by the fact that the said second chamber communicates, through an output duct provided in the housing, with a delivery duct intended to control the compressed air supply to the brakes of the motor vehicle, or with the outside of the housing, depending upon the condition of the said control valve.

2. A device according to Claim 1, characterised by the fact that the axial duct connecting the two chambers facing the end walls of the housing comprises an enlarged chamber, provided in the piston and communicating with the first of the aforementioned two chambers, and a reduced end section connecting that enlarged chamber with the second of the two chambers, and that the end wall of the housing facing the second of the two aforementioned chambers is provided with a cylindrical appendix extending within the terminal section of the axial duct and whose free end debouches into the enlarged chamber of the

duct itself; the said free end being engageable by a transverse plate and forming the fixed seat of the control valve and the said transverse plate extending radially in such a manner that it faces onto the adjacent edge of the reduced end section of the aforementioned axial duct, this edge forming the mobile closure of the aforementioned control valve, the said cylindrical appendix presenting a coaxial through-hole debouching at its free end to the outside of the housing.

3. A device according to Claim 1, characterised by the fact that the piston is subdivided into two adjacent cylindrical bodies and between whose facing surfaces there is enclosed an annular chamber communicating with the enlarged chamber of the axial duct; the first of these bodies being comprised between the first chamber and the annular chamber and the second of these bodies being comprised between the annular chamber and the second chamber; the conformation and dimensions of the annular chamber being such that the compressed air it contains causes, on the first cylindrical body, a thrust greater than that produced by the compressed air contained in the first chamber, this thrust causing, in the absence of counter action produced by the load sensitive means, a displacement of the first cylindrical body with respect to the second cylindrical body; the said displacement being such that it puts into communication the annular chamber with an auxiliary duct debouching into the internal surface of the housing facing the second cylindrical part of the piston in a position opposite to the second chamber.

4. A device according to any one of the preceding claims characterised by the fact that the first chamber communicates with a passageway closed by an interception valve which is held against a fixed seat by the combined effect of a spring element and of the air pressure from the control circuit of the front brakes of the motor vehicle failure of the pressure normally present in said front brake control circuit resulting in displacement of the interception valve by the air pressure in the first chamber to permit pressure air from the first chamber to flow through said passage and a duct in the housing to act on the larger diameter part of the piston to hold the same against the stroke limiting means.

5. A control device for a motor vehicle pneumatic braking system, substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

6. A pneumatic braking system for a motor vehicle, substantially as hereinbefore described with reference to the accompanying drawings.

For the Applicants:
F. J. CLEVELAND & COMPANY,
Chartered Patent Agents,
40-43 Chancery Lane,
London, WC2A 1JQ.

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Sheet 1

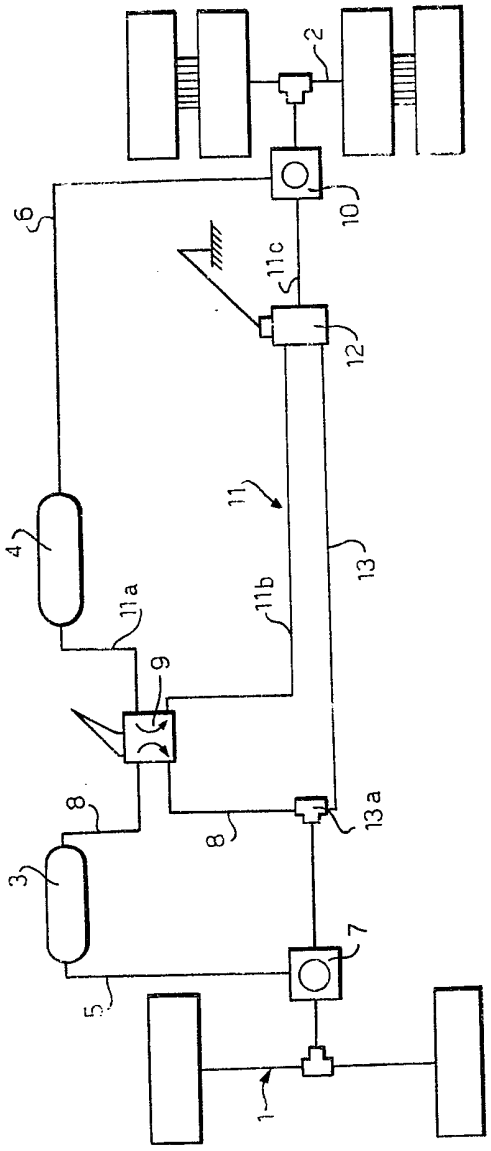
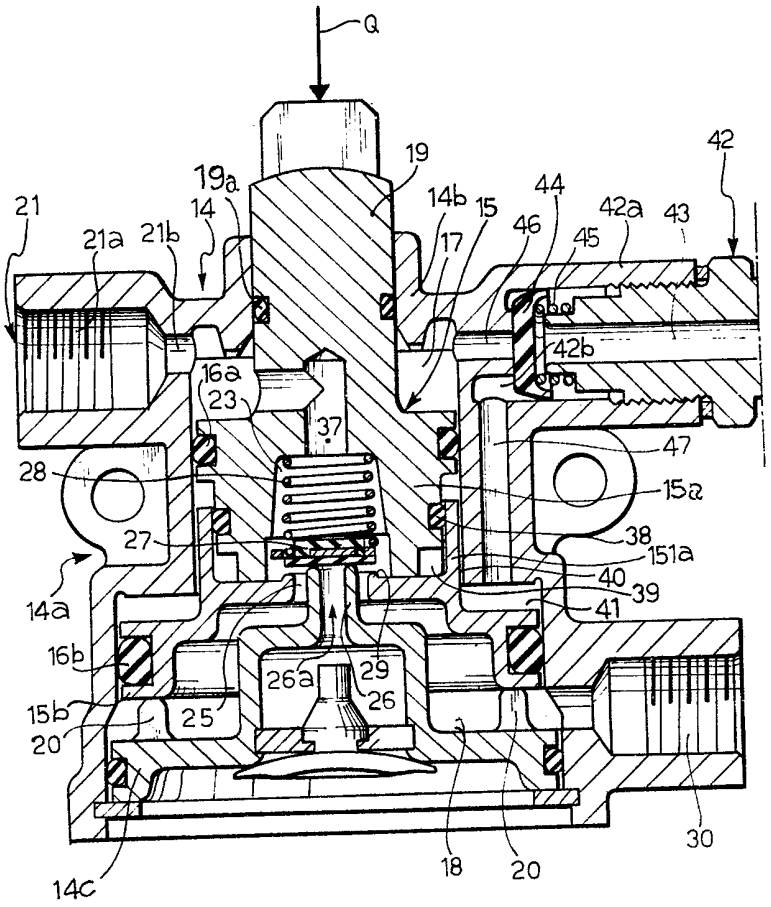


Fig.1

Fig.2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1561588 COMPLETE SPECIFICATION
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Sheet 3

FIG. 3