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(72) Inventor: Gunter Seegers

(54) TRAILER BRAKE SYSTEM

(71) We, WABCO FAHRZEUGBREWSEN GMBH, formerly WABCO WESTINGHOUSE G.m.b.H., a Company orgnaised according to the laws of the Federal Republic of Germany, of 3000 Hannover 91, Postfach 91 12 80, Federal Republic of 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:-

The invention relates to a two-line, two-circuit brake system controlled automatically in dependence on the load in motor vehicles having a trailer control valve arranged in the line leading to the trailer coupling of the trailer brake line.

Guidelines 75/524/EEC dated 25th July 1975 have been published as a supplement to guidelines 71/320/EEC dated 26th July 1971 drawn up by a commission of the European Comminity for adapting the legal regulations of the member states with regard to brake systems of motor vehicles and their trailers to technical progress. In these supplementary guidelines, publications that are available for public inspections show the legal requirements as regards distribution of the brake forces over the vehicle axles of a vehicle, and the regulations about coordination of the braking effect of the towing vehicle and the trailer relative to the brake pressure in the brake line leading to the trailer, measured at the coupling head. The publications available for public inspection relating to the co-ordination of the braking effect of towing vehicle and trailer are intended to form the basis for simplifying the changeability of towing vehicles and trailers. The requirement that during deceleration of a truck-trailer combination, in which the towing vehicle is not loaded, the brake pressure at the coupling head of the trailer brake line must be higher than the pressure in the service brake system of the towing vehicle, is of particular importance; since if there were a lower brake pressure at the coupling head the trailer would tend to push the towing vehicle when the truck-trailer combination decelerates which could lead to a dangerous situation. Moreover, the differing wear on the brake linings which would arise would be an economic problem for the vehicle owner.

To fulfil both requirements, at the present time an automatic, load-dependent control of the rear axle and in some cases also of the front axle is used. The requirement as regards the distribution of the brake forces over the vehilce axles, that is, of the front axle starting to lock before the rear axle in a certain deceleration range, can be very satisfactorily fulfilled by means of a load-dependent brake force control. The simultaneous fulfilment of the second requirement, the matching of towing vehicle and trailer, frequently necessitates a correction of the control setting which as a general rule leads to a deterioration in the distribution of the brake force over the axles.

It is an object of the invention to provide a control for increasing the brake pressure at the coupling pressure at the coupling head of the trailer brake line with respect to the brake pressure in the service brake system of the unladen towing vehicle and for correspondingly reducing the higher pressure at the coupling head as the towing vehicle is progressively more loaded, until with a fully laden towing vehicle, a ratio of the two brake pressures of, for example, 1 : 1 is reached.

According to the invention a braking system for a motor vehicle includes.

(a) a service brake circuit,

(b) a load-dependent brake force regulator connected in the service brake circuit, the inlet port of the brake force regulator being connected to the supply side of the service brake circuit,

(c) a trailer brake circuit,

(d) a trailer control valve connected in the

trailer brake circuit, the inlet port of the trailer control valve being connected to the supply side of the trailer brake circuit, and the trailer control valve having first and second control input ports connected respectively to the inlet and outlet ports of the load-dependent brake force regulator,

the trailer control valve being arranged to control the delivery of pressure medium to the outlet side of the trailer brake circuit in dependence on the load by means of a single piston, included in the control valve, which piston is adapted to receive on one side the pressure from the first input port and on the other side, over separate areas, the pressure from the second inlet port and the pressure from the outlet side of the trailer brake circuit, respectively, The rear wheels only of the motor vehcile may be subject to load-controlled braking.

In order that the invention may be fully understood and readily carried into effect it will be explained in greater detail below with reference to the accompanying drawings, wherein a detailed explanation of the invention follows the description of the function of a trailer control valve. In the drawings:-

Figure 1 shows the lay-out of a two-line, two-circuit brake system; and

Figure 2 shows the cross-section of a trailer control valve.

The diagram shown in Figure 1 of a brake system includes brake cylinders 4 on the rear axle of a vehicle of a first brake circuit I to which a brake pressure medium is supplied from a supply container 1 and through a motor vehicle brake valve 2 by way of an automatic, load-dependent brake force regulator 3 responsive to the loading on the rear axle. The brake system also includes brake cylinders 6 on the front axle of a second brake circuit II, to which a brake pressure medium is supplied from a supply container 5 through the motor vehicle brake valve 2.

A relay valve 7 acting as trailer control valve is connected by way of connections 8 and 9 and lines 10 and 11 respectively to the brake circuits I and II, by way of a connection 12 and line 13 to the trailer supply line 14, by way of connection 15 and line 16 to a coupling head 17 of the trailer brake line and by way of connection 18 and line 19 to a hand brake valve 20. For the purposes of the invention the valve 7 also has a connection 21 which produces by way of a line 22 a connection to a line 23 joining the automatic, load-dependent brake force regulator 3 and the rear axle brake cylinders 4.

Further details of the spring-loaded brake system controlled by the hand brake valve 20 will not be given here, since the function of this system is not of relevance to the invention.

The relay valve 7 which serves as a trailer control valve is shown in more detail in Figure 2 and consists of a valve housing 24 in which two coaxially arranged relay pistons 25 and 26 are sealed and are axially displaceable, the relay piston 26 being firmly connected by way of a guide sleeve 28 guided in a bore 27 of the valve housing 24 to a diaphragm piston 29. The relay piston 25 operates as a graduating piston which in the example shown is constructed as a stepped piston, the upper side of which has a face 30, and on the underside of which there is an inner face 31 and an outer annular face 32. At the lower end of the piston 25 there is located a valve seat 33. A double valve member 34, arranged so that it is sealed to and can be axially displaced in the guide sleeve 28, forms, together with a valve seat 35 located on the relay piston 26 an inlet valve 34/35, and together with the valve seat 33 of the relay piston 25 and outlet valve 33/34. The double valve member 34 is loaded by a spring 36 such that it is pressed towards the valve seat 35.

The connection 8 of the brake circuit I is connected by way of a bore 37 to a chamber 38 above the relay piston 25, and the connection 9 of the brake circuit II is connected by way of a bore 39 to a chamber 40 beneath the diaphragm piston 29. The connection 12 (not shown in Figure 2) is intended for receiving the supply of pressure medium and is connected to a chamber 41 beneath the relay piston 26. A chamber 42 above the relay piston 26 is connected to the connection 15, and this chamber 42 may also be connected by way of the inlet valve 34/35 to the chamber 41, and to the atmosphere by way of the outlet valve 33/34, a bore 43 in the double valve member 34, a bore 44 in the guide sleeve 28 and an air relief valve 50.

A stop 45 for the relay piston 25 is provided in the valve housing 24. The connection 18 is connected by way of a bore 46 to a chamber 47 above the diaphragm piston 29. Normally, this chamber 47 is subjected to the pressure of the spring-loaded brake circuit when the hand brake valve 20 is off. A chamber 48 beneath the outer annular face 32 of the relay piston 25 is connected by way of a bore 49 to the connection 21.

The manner in which the relay valve 7 functions in the brake system shown in Figure 1 as a trailer control valve is as follows:

Chamber 41 is constantly supplied with air from a supply of compressed air (the pressure medium) by way of the connection 12. The supply pressure also acts upon chamber 47 in the runing position (i.e. the hand brake is off) by way of connection 18 from the hand brake valve 20, so that the diaphragm piston 29 is in its lower-most position. The trailer brake line leading away from connection 15 does not contain compressed air because it is openito the atmoshpere by way of outlet valve 33/34 and air-relief valve 50, when the relay valve is in the position just described.

When the motor vehicle brake valve 2 is actuated, compressed air flows from circuit I by way of connection 8 into the chamber 38 above the piston 25, and moves it downwards. As a result of the valve seat 33 of the piston 25 being positioned on the valve member 34, the outlet valve 33/34 is closed, and upon further downward movement, the inlet 34/35 is opened. Compressed air passes from connection 12 to connection 15 and supplies the trailer brake line via coupling head 17 in accordance with the brake pressure of the motor vehicle. As soon as the pressure building up in chamber 42 (and connection 15 and the trailer brake line) has produced the necessary counter-pressure, assisted by the compressed air pressure building up in the chamber 48 which is derived from the line 23 and consequently from the regulator 3, is dependent on the loaded state of the vehicle, the piston 25 is lifted up against the brake pressure in chamber 38, tending to close the inlet valve 34/35.

If the braking action is only partial, the inlet valve 34/35 closes limiting the pressure applied to the trailer brake circuit accordingly. The trailer control valve 7 is now in its neutral position. If the braking action is a full one, however, piston 25 receiving the pressure from the braking valve 2 holds the inlet valve 34/35 open. Thus the piston 25 acts as a graduating piston.

At the same time as the above processes are taking place in the circuit I, chamber 40 beneath the diaphragm piston 29 is supplied with air from vehicle brake circuit II by way of connection 9.

The operation of the circuit II when the vehicle brake circuit I fails, and the operation of the brakes when control is carried out with the hand brake valve will not be described since these operations are not connected with the invention.

The construction of the graduating piston 25 as a stepped piston divides the lower piston face into two piston faces, that is, into the inner face 31 and the outer annular face 32, which form boundaries to the chambers 42 and 48 separated from each other by means of an O-ring 51 in a pressure-tight manner. The piston face 31 assigned to the chamber 42 is substantially smaller than that of the piston face 30 opposite which is acted upon by the pressure in the chamber 38, and this has the result that when the brakes are applied the pressure building up in the chamber 42 has to be substantially higher to form a counter-force than would be the case for the corresponding chamber with an undivided lower piston face, which means that the brake pressure at the coupling head 17 must also be correspondingly higher. It will be understood that the balance of forces on the piston 25 determines the closing of the inlet valve 34/35 and therefore the pressure in the chamber 42.

Under the pressure conditions so far described, the pressure on the annular face 32 has not been taken into account. During a braking action the annular face 32 of the piston 25 is acted upon by the brake pressure applied to the cylinders 4, which pressure is fed to the chamber 48 via the connection 21 and is controlled as function of the loaded state of the towing vehicle by the regulator 3. The brake pressure in the brake cylinders 4 of the towing vehicle is set by the automatic load-dependent brake force regulator 3 so that when the vehicle is not loaded or is only lightly loaded the brake pressure is limited to a lower level. Under such circumstances the pressure acting upon the piston face 32 only weakly assists the formation of a counter-force, which means that the pressure in the chamber 42 builds up to a higher value because this counter-force has to be applied predominantly by way of the face 31 by the pressure in chamber 42 to a greater extent than would be the case with a loaded vehicle having a pressure in the brakes 4 and the chamber 48 set to a higher level. Only when the vehicle is fully laden is a pressure ratio of the pressures acting upon the two lower piston faces 31 and 32 to the pressure acting upon the upper piston face 30 of 1 : 1 reached.

Although the invention has been described with reference to a specific example it will be appreciated that modifications may be made to the example described without departing from the invention. For example, the diaphragm piston 29 could be omitted and connections 9 and 18. Moreover, the invention could be used with a hydraulic braking system instead of a pneumatic one.

Certain aspects of the valve described above are the subject of copending application No 53175/77 (Serial No 1579286).

WHAT WE CLAIM IS:

1. A braking system for a motor vehicle, including

(a) a service brake circuit,

(b) a load-dependent brake force regulator connected in the service brake circuit, the inlet port of the brake force regulator being connected to the supply side of the service brake circuit,

(c) a trailer brake circuit,

(d) a trailer control valve connected in the trailer brake circuit, the inlet port of the trailer control valve being connected to the supply side of the trailer brake circuit, and the trailer control valve having first and second control inputs ports connected respectively to the inlet and outlet ports of the load-dependent brake force regulator,

the trailer control valve being arranged to control the delivery of pressure medium to the outlet side of the trailer brake circuit in dependence on the load by means of a single

piston, included in the control valve, which piston is adapted to receive on one side the pressure from the first input port and on the other side, over separate areas, the pressure from the second inlet port and the pressure from the outlet side of the trailer brake circuit respectively,

2. A braking system for a motor vehicle as claimed in claim 1, wherein the load-dependent brake force regulator is included in the rear service brake circuit of the vehicle.

3. A braking system as claimed in claim 1 or claim 2, wherein the piston has a stepped profile on one side provided by a central cylindrical projection surrounded by an adjacent annular part, and the spaces adjacent to the projection and the annular part, respectively, are separated by a cylindrical shell into which the cylindrical projection extends.

4. A braking system substantially as herein described with reference to and as illustrated by Figures 1 and 2 of the accompanying drawings.

ABEL & IMRAY,
Chartered Patent Agents,
Northumberland House
303-306 High Holborn,
London, WC1V 7LH.

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1579285 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

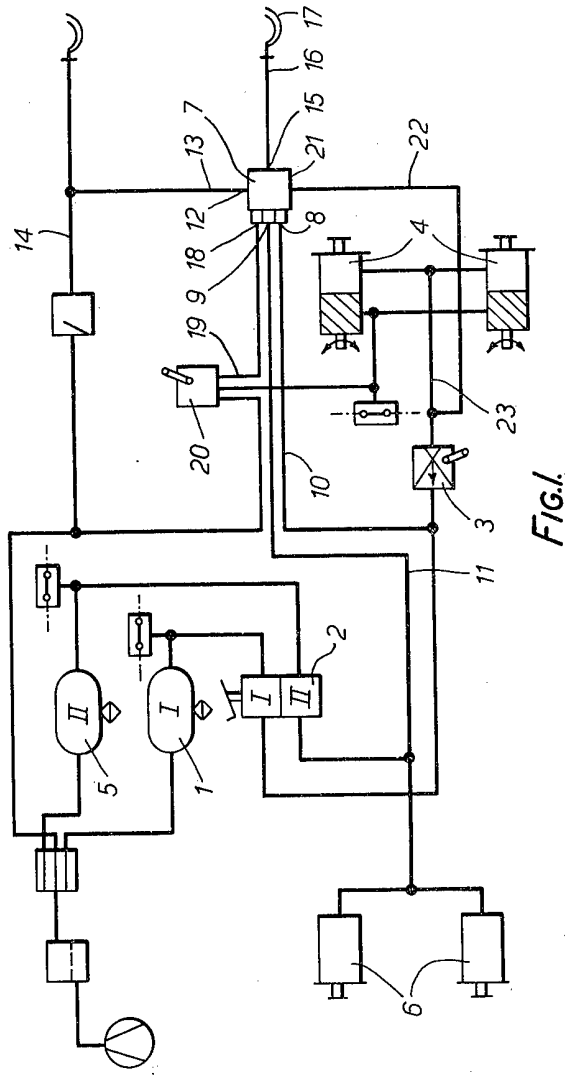

FIG.1.

1579285 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheet 2

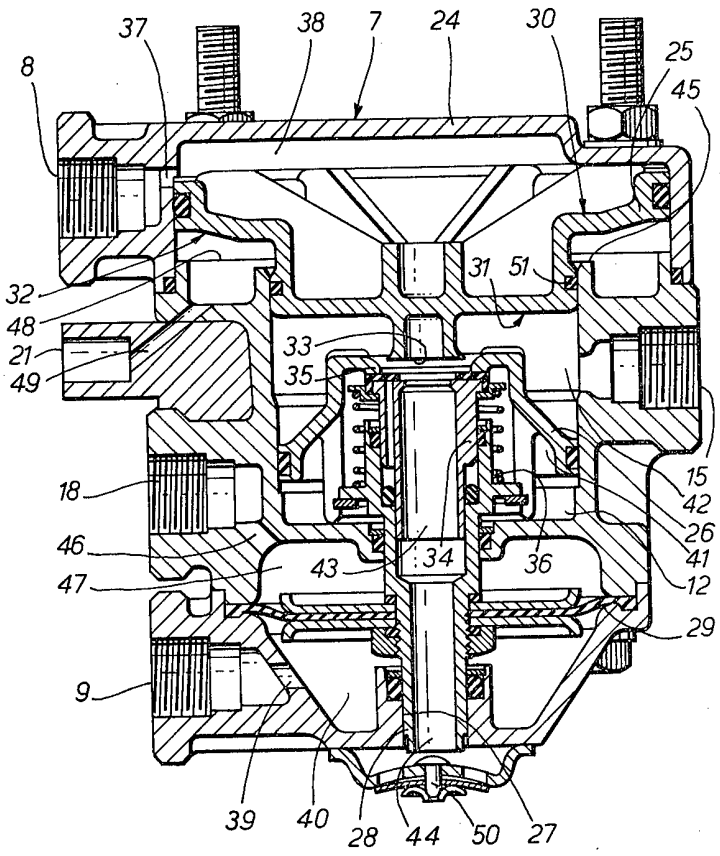

FIG.2.