CONVENTION OR NON-CONVENTION APPLICATION FOR A
PATENT OR PATENT OF ADDITION

We (a) LUCAS..INDUSTRIES..LIMITED,
A British Company of Great King Street,
Birmingham 19, England

of (b)

hereby apply for the grant of a (c) patent, patent of addition for an invention entitled
(d) IMPROVEMENTS IN VEHICLE HYDRAULIC BRAKING SYSTEMS

which is described in the accompanying (c) provisional/complete specification.

1/ We request that the term of the patent of addition be the same as that of the patent for the
main invention or so much of the term of the patent for the main invention as is unexpired.

This application is a Convention application and is based on the following application or
applications for a patent or patents or similar protection made in the following country or
countries on the following date or dates:

No. (g) 36758/78 in (h) Great Britain... on (i).......
No. (g) ............... in (h) ............... on (i) ............... 
No. (g) ............... in (h) ............... on (i) ............... 

Our address for service is care of CLEMENT HACK & CO., Patent Attorneys, 140
William Street, Melbourne, Victoria, 3000, Australia.

(j) Dated this 10TH day of SEPTEMBER, 1979.

(k) LUCAS INDUSTRIES LIMITED

..............................
CLEMENT HACK & CO.

..............................
DECLARATION IN SUPPORT OF A CONVENTION OR NON-CONVENTION APPLICATION FOR A PATENT OR PATENT OF ADDITION

In support of the application made by Lucas Industries Limited for a patent for an invention entitled Improvements in Vehicle Hydraulic Braking Systems

Name(s) and address(es) of person(s) making declaration

Country/filing date and name of applicant(s) for the or each basic application

Name(s) and address(es) of the or each actual inventor

See reverse side of this form for guidance in completing this part

1. I am/we are the applicant(s) for the patent, or am/are authorised by the abovementioned applicant to make this declaration on its behalf.

2. The basic application(s) as defined by Section 141 of the Act was/were made in the following country or countries on the following date(s) by the following applicant(s) namely:

   in Great Britain on 14th September 1978
   by Lucas Industries Limited

3. The said basic application(s) was/were the first application(s) made in a Convention country in respect of the invention the subject of the application.

4. The actual inventor(s) of the said invention is/are Alfred Yardley, a British Subject of
   12 Mill Close, Blakewell, Kidderminster, Worcestershire, England

5. The facts upon which the applicant(s) is/are entitled to make this application are as follows:
   The Applicant is the Assignee of the said actual inventor.

DECLARED at Birmingham, this 20th day of August 1979

Authorised Signatory - Lucas Industries Limited

This form may be completed and filed after the filing of a patent application but the form must not be signed until after it has been completed and filed.
This invention relates to vehicle hydraulic braking systems of the kind incorporating a tandem master cylinder comprising a pedal-operated primary piston and a floating secondary piston working in a bore in a housing, a primary pressure space defined in the bore between the two pistons, and a secondary pressure space defined in the bore between the secondary piston and a closed end of the housing, a first compression spring acting between the pistons, and a second compression return spring acting between the secondary piston and the closed end of the housing, a first connection between one of the pressure spaces and brakes on the front wheels of the vehicle and a second connection between the other pressure space and brakes on the rear wheels of the vehicle. The invention also relates to an improved tandem master cylinder for use in a system of the kind set forth.

Claim

1. An hydraulic braking system of the kind set forth in which the primary pressure space is connected to the rear wheel brakes, the secondary pressure space is
connected to the front wheel brakes, and the relative strengths of the return springs are chosen such that fluid in the secondary pressure space cannot be pressurised until a predetermined pressure has first been generated in the primary pressure space.
The following statement is a full description of this invention, including the best method of performing it known to me/us.
IMPROVEMENTS IN VEHICLE HYDRAULIC BRAKING SYSTEMS

This invention relates to vehicle hydraulic braking systems of the kind incorporating a tandem master cylinder comprising a pedal-operated primary piston and a floating secondary piston working in a bore in a housing, a primary pressure space defined in the bore between the two pistons, and a secondary pressure space defined in the bore between the secondary piston and a closed end of the housing, a first compression spring acting between the pistons, and a second compression return spring acting between the secondary piston and the closed end of the housing, a first connection between one of the pressure spaces and brakes on the front wheels of the vehicle and a second connection between the other pressure space and brakes on the rear wheels of the vehicle. The invention also relates to an improved tandem master cylinder for use in a system of the kind set forth.

When a vehicle travelling in a forward direction is braked there is a transfer of weight from the rear wheels to the front wheels and it is customary therefore for a greater proportion of the braking effort to be applied by the front wheel brakes than is applied by the rear wheel brakes. Since the greater proportion of the braking effort applied by the front wheel brakes is less likely to cause the front wheels to skid after weight has been transferred to them, it is sometimes desirable, particularly when a braking system of the kind set forth is installed in a commercial vehicle, for operation of the front wheel brakes to be delayed until after the rear wheel brakes have been applied with consequent weight transfer having taken place.

In tandem master cylinders for use in braking systems of the kind set forth it is usual for the spring
forces and the diameters of the pistons to be chosen such that both pressure spaces are pressurised substantially simultaneously and it is also known to incorporate in a braking system of the kind set forth a separate pressure proportioning valve which is operative to prevent fluid under pressure from one of the pressure spaces being supplied to the front wheel brakes until a predetermined pressure has been applied to the rear wheel brakes. This pressure proportioning valve has separate connections with both pressure spaces, and with the front and rear wheel brakes.

According to our invention in an hydraulic braking system of the kind set forth the primary pressure space is connected to the rear wheel brakes, the secondary pressure space is connected to the front wheel brakes, and the relative strengths of the return springs are chosen such that fluid in the secondary pressure space cannot be pressurised until a predetermined pressure has first been generated in the primary pressure space.

This enables us to delay operation of the front wheel brakes until after the rear wheel brakes have been applied, by a modification of the master cylinder. This avoids the necessity of having to provide a further, separate, valve with all the inherent additional complications.

Preferably the second spring is pre-compressed or pre-stressed to a predetermined value in an off position of the brakes, and the said predetermined value is sufficient to resist a force due to compression of the first spring plus the force due to the pressure in the primary pressure space acting over the area of the adjacent end of the secondary piston.
Normally the relative strengths are chosen to provide a threshold pressure difference of substantially 200 p.s.i.

Pre-compression or pre-stressing of the second spring can be achieved by trapping the spring between the closed end of the housing and the secondary piston by the use of a back stop against which the secondary piston abuts to define its retracted position in the off position of the brakes.

Alternatively the back stop can be omitted and the second spring can be trapped between the secondary piston and a retainer which is coupled to the secondary piston through a slidable connection.

Conveniently the bore is of constant diameter throughout its axial length.

Two embodiments of our invention are illustrated in the accompanying drawings in which:

Figure 1 is a longitudinal section through a tandem hydraulic master cylinder; and

Figure 2 is a longitudinal section through the forward end portion of the master cylinder of Figure 1 but showing a modification.

The tandem hydraulic master cylinder illustrated in Figure 1 comprises a housing 1 having a longitudinal blind bore 2 of constant diameter throughout its axial length.

A pedal-operated primary piston 3 works in the bore 2, and a secondary floating piston 4 works in a
portion of the bore 2 between the primary piston 3 and the closed end 5 of the bore 2.

A primary pressure space 6 connected through a first outlet port 7 and a brake line to rear wheel brakes of a vehicle is defined in the bore 2 between the pistons, and a secondary pressure space 8 connected through a second outlet port 9 and a brake line to the front wheel brakes is defined in the bore 2 between the piston 4 and the closed end 5.

The pistons 3 and 4 are held in the retracted position shown by means of a first compression return spring 10 which acts between adjacent ends of the pistons, and a second compression return spring 11 which acts between the piston 4 and the closed end 5.

In the retracted position shown with the brakes in an off position the pressure spaces 6 and 8 are connected to an hydrostatic reservoir for hydraulic fluid through radial recuperation ports 12 and 13, respectively, in the wall of the housing 1 so that the fluid in the pressure spaces 6 and 8 and in the lines to the brakes is at atmospheric pressure. The secondary piston 4 engages with a backstop comprising a peg 14 projecting radially into the bore 2, and the compression spring 11 is held in a predetermined pre-compressed or pre-stressed condition, whereas the spring 10 is unstressed.

When the master cylinder is operated by the pedal, the primary piston 3 is advanced in the bore 2, initially against the loading in the spring 10, through a first distance to close the recuperation port 12 and thereafter pressurise fluid in the pressure space 6 to operate the rear wheel brakes. Due to the load in the spring 11,
the secondary piston 4 remains stationary and the front wheel brakes cannot be applied until the force in the spring 11 is overcome by a force equal to the thrust due to compression of the spring 10 plus the force of the pressure in the primary pressure space 6 acting over the area of the adjacent end of the secondary piston 4. When this point is reached, the secondary piston 4 is advanced in the bore, accompanied by compression of both springs 10 and 11, initially to close the recuperation port 13 and, thereafter, to pressurise the fluid in the pressure space 8 to apply the front wheel brakes.

In a typical system, the pressure in the first pressure space will reach substantially 200 p.s.i. before the load in the spring 11 is overcome.

This ensures that the front wheel brakes cannot be applied until after any weight transfer from the rear wheels to the front wheels has taken place, consequent upon application of the rear wheel brakes.

In the modified construction illustrated in Figure 2, instead of trapping the spring 11 between the piston 4 and the closed end 5 of the housing 1 in the off position of the brakes by the use of the backstop 14, the backstop 14 is omitted and the spring 11 is trapped between the piston 4 and a retainer comprising an abutment member 16 in the form of a thimble and of which the separation relative to the piston 4 is limited by a headed stud 17 carried by, and extending axially from, the piston 4. Thus the piston 4 has a limited free movement relative to the abutment member 16. The abutment member 16 can slide on the stud 17 as the piston 4 is moved towards the closed end 5 of the housing 1.
The construction and operation of the embodiment of Figure 2 is otherwise the same as that of Figure 1 and corresponding reference numerals have been applied to corresponding parts.
CLAIMS

THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. An hydraulic braking system of the kind set forth in which the primary pressure space is connected to the rear wheel brakes, the secondary pressure space is connected to the front wheel brakes, and the relative strengths of the return springs are chosen such that fluid in the secondary pressure space cannot be pressurised until a predetermined pressure has first been generated in the primary pressure space.

2. An hydraulic braking system as claimed in Claim 1, in which the second spring is pre-compressed or pre-stressed to a predetermined value in an off position of the brakes, and the said predetermined value is sufficient to resist a force due to compression of the first spring plus the force due to the pressure in the primary pressure space acting over the area of the adjacent end of the secondary piston.

3. An hydraulic braking system as claimed in Claim 1 or Claim 2, in which the relative strengths are chosen to provide a threshold pressure difference of substantially 200 p.s.i.

4. An hydraulic braking system as claimed in Claim 2 or Claim 3, in which the second spring is trapped between the closed end of the housing and the secondary piston, and a back stop is incorporated against which the secondary piston abuts in the off position of the brakes to define its retracted position in which the second spring is pre-compressed or pre-stressed to the said predetermined value.

5. An hydraulic braking system as claimed in Claim 2 or Claim 3, in which the second spring is trapped between
the secondary piston and a retainer which is coupled to the secondary piston through a slidable connection.

6. An hydraulic braking system as claimed in any preceding claim in which the bore is of constant diameter throughout its axial length.

7. A tandem master cylinder for an hydraulic braking system comprising a pedal-operated primary piston and a floating secondary piston working in a bore in a housing, a primary pressure space defined in the bore between the pistons, and a secondary pressure space defined in the bore between the secondary piston and a closed end of the housing, a first compression spring acting between the pistons, a second compression spring acting between the secondary piston and the closed end of the housing, a first outlet port from the primary pressure space for connection to brakes on rear wheels of a vehicle, and a second outlet port from the secondary pressure space for connection to brakes on front wheels of the vehicle, in which the second spring is pre-compressed or pre-stressed to a predetermined value sufficient to resist a force due to compression of the first spring plus the force due to the pressure in the primary pressure space acting over the area of the adjacent end of the secondary piston.

8. A tandem master cylinder as claimed in Claim 7, in which the second spring is trapped between the closed end of the housing and the secondary piston, and a back stop is incorporated against which the secondary piston abuts to define a retracted position for the secondary piston in which the second spring is pre-compressed or pre-stressed to the said predetermined value.
9. A tandem master cylinder as claimed in Claim 7, in which the second spring is trapped between the secondary piston and a retainer which is coupled to the secondary piston through a slidable connection.

10. A tandem master cylinder for vehicle hydraulic braking system substantially as described herein with reference to and as illustrated in Figure 1 of the accompanying drawings.

11. A tandem master cylinder for a vehicle hydraulic braking system substantially as described herein with reference to and as illustrated in Figure 2 of the accompanying drawings.

DATED THIS 10TH DAY OF SEPTEMBER, 1979.

LUCAS INDUSTRIES LIMITED
By its Patent Attorneys

CLEMENT HACK & CO.,