



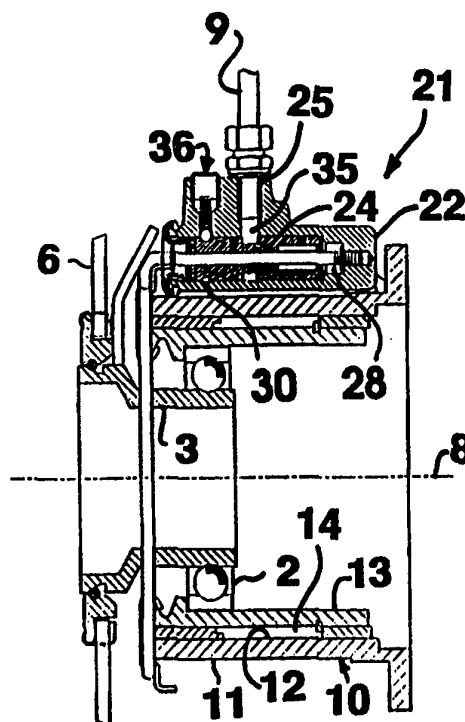
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(54) Title: WEAR WARNING ARRANGEMENT ON A SLAVE CYLINDER OPERATED DISC CLUTCH

(57) Abstract

On a slave cylinder operated clutch the slave cylinder (10) is provided with an arrangement for warning when clutch linings are worn. The arrangement incorporates a valve (21) on the inlet line (9) to the slave cylinder. The valve has a free-flowing position and a constricting position. When linings are worn, the valve (21) is caused to assume its constricting position under the influence of a sensor detecting the position of the working piston (13) of the slave cylinder. Application of the constriction makes the clutch pedal become harder to operate, which gives the driver an indication and warning that linings are worn and need changing.



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Wear warning arrangement on a slave cylinder operated disc clutch

The present invention relates to a wear warning arrangement
5 on a slave cylinder operated disc clutch in accordance with
what is indicated in the preamble to the attached patent
claim 1.

State of the art

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Disc clutches are subject to continual wear and in order to
make it easier to replace the discs at the correct time it is
generally desirable to be able to monitor the wear without
having to dismantle the whole clutch. In clutches which are
15 operated via a lever, the latter is mechanically connected to
the clutch disc plate in a manner which makes direct measure-
ment of wear relatively easy by measuring the position of
rest of the lever. In a clutch which is operated by means of
a slave cylinder, the whole transfer of movement between the
20 operating device (usually a pedal) and the clutch takes place
hydraulically, so there is no lever or other mechanical
feedback which would be readily accessible and usable for
detecting and indicating disc wear.

25 Instead, it becomes necessary to arrange a sensor directly on
the slave cylinder. One way of doing this is described in
patent application DE 41 20 643 and its counterpart
GB 2 256 907. These describe an embodiment in which wear
indication is provided by electrical contacts arranged on the
30 slave cylinder which close when the slave cylinder piston
moves beyond a certain limit corresponding to wear, thereby
creating the possibility of wear being indicated electri-
cally, e.g. via a warning lamp. In alternative embodiments
the piston movement may be detected continuously by means of
35 resistances or capacitances whose values are altered by
movement of the slave cylinder piston and are hence also
altered by disc wear. These latter variants may also be used
for controlling automated clutch systems in which it is for
example necessary to be able to control with a certain

accuracy the engagement process during clutch operation. A disadvantage of this solution, however, is that it imposes relatively demanding requirements on the components involved. The components of the slave cylinder are subject to both
5 mechanical and thermal stresses. Further components are also required for converting signals from sensors into a form perceptible to the driver. All this leads to solutions which are relatively expensive, at least if their sole object is to indicate lining wear. The aforesaid patent applications also
10 give no indication as to how different slave cylinders may be individually adapted to different clutch discs. This solution therefore supposes that all the components have nominal dimensions, something which rarely happens in practice. This means that it is instead necessary to design the solution
15 taking into account the tolerances which may normally occur and that indications become correspondingly unreliable.

Another way of indicating disc wear is described in patent application SE 92033 15-8. In this case the indication that
20 disc wear has exceeded a certain limit is that the driver finds that substantially more effort is required to operate the clutch pedal. This indication is created by change-over of a valve incorporated in a pipe for supplying pressure medium to a servo cylinder under the influence of a piston in
25 the servo cylinder. This solution is intended, however, for the more conventional type of clutch which is operated under the action of a lever and which also incorporates a servo cylinder in which the position of the piston depends on the wear of the discs. This solution is therefore not applicable
30 to a slave cylinder operated clutch.

Objects of the invention

The present invention has the object of providing an arrange-
35 ment for indicating clutch disc wear which may be used on a slave cylinder operated clutch. The invention therefore has the object of giving the driver an indication that the discs have worn so much as to require their replacement as soon as possible. This indication is to be primarily given by the

driver finding that significantly more effort than normal is required to operate the clutch pedal.

Further objects of the invention are that it be easy and inexpensive to manufacture and have no appreciable influence on the design in other respects of the slave cylinder. The invention is moreover intended to have no appreciable influence on the normal functioning of the slave cylinder when no indication is being given, and it also has to be possible for the slave cylinder to be dimensioned for optimum normal functioning.

Brief description of the invention

According to the invention, the objects aimed at are achieved by the arrangement being designed in accordance with what is indicated in the characterising part of patent claim 1.

Arranging a valve on the inlet line to the slave cylinder enables the inflow of hydraulic oil to take place entirely unhindered during normal operation and to take place via an apparent constriction when there is indication of worn linings. This means that the indication can be given both effectively and clearly. A further advantage of the invention is that even if the clutch pedal feels more resistant when linings are worn it nevertheless remains possible to operate the clutch and continue driving the vehicle normally in other respects. The invention means that in normal operation, before linings are so worn as to need changing, the slave cylinder may be optimised and dimensioned for a quick and easily operated clutch.

The attached subclaims indicate advantageous embodiments of the invention. The advantages of those embodiments are indicated in more detail by the description below which exemplifies an advantageous embodiment of the invention.

List of drawings

The description refers to the attached drawings of an arrangement for operating a clutch in a transmission. They
5 depict the following:

Fig.1 a clutch pedal forming part of the arrangement,

Fig.2 a slave cylinder forming part of the arrangement, and
a wear sensor arranged on the slave cylinder. The
clutch is depicted in a disengaged position and the
10 wear sensor in a position for new linings.

Fig.3 shows the same slave cylinder as Fig.2, but with the
clutch in an engaged position and the wear sensor in
a position for worn linings, and

Fig.4 shows a detail enlargement of the wear sensor
15 according to Fig.2.

Description of an embodiment

In this embodiment the invention is described as applied to a
20 vehicle. The invention may also be applied, however, to other
types of transmissions.

The vehicle driver's compartment is provided with a clutch
pedal 1 for the driver (the operator) to operate a disc-type
clutch which forms part of the vehicle drive unit and more
25 specifically of the transmission between a drive engine and a
gearbox. The clutch pedal 1 is bearingly fastened to a
bracket on a cowl panel 4 to which a master cylinder 5 is
also fastened. The vehicle clutch is only shown schematically
in the drawings in the form of a partly depicted conventional
30 diaphragm spring 6 which forms part of the clutch and which
is operated by a slave cylinder 10 arranged concentrically
about the clutch centreline 8. The slave cylinder 10 is
connected to the clutch pedal 1 via a hydraulic line 9 in
order to transmit pedal movements to the slave cylinder 10.

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The slave cylinder 10 incorporates a housing 11 with an inlet
connection (not depicted) for supplying hydraulic oil from
the master cylinder 5. The slave cylinder 10 incorporates
conventionally a cylinder 12 containing a working piston,

hereinafter called the operating piston 13, which together with the cylinder 12 delineates the working space 14 of the slave cylinder. Operating movements result in the working space 14 being pressurised by hydraulic oil which acts on the 5 piston with an inserting movement relative to the cylinder 12, which movement is imparted via a disengagement bearing 2 and a sleeve 3 to the fan 6 and thereby operates the clutch in a conventional manner. The clutch is thus of the so-called pulling type, meaning that the clutch during disengagement is 10 acted on by a pulling force. (In alternative embodiments of the invention the clutch may be of a pushing type). For drive power transfer between the engine and the gearbox, the clutch returns to an engaged position under the action of the spring force exerted on it by the fan 6. Since clutches of this type 15 of well-known per se and further information on them is not required for understanding the present invention, no more detailed description of them will be given here.

The slave cylinder 10 is provided with an arrangement according to the invention for detecting and giving the driver an 20 indication and warning that clutch disc linings are worn and need renewing. The invention incorporates a valve 21 arranged on the hydraulic line 9 between the master cylinder 5 and the slave cylinder 10. The design of this valve is depicted in 25 more detail in Figures 2-4. The valve 21 is depicted as a separate unit connected to the slave cylinder 10 but may in alternative embodiments be more or less integrated with the slave cylinder 10.

30 The valve 21 incorporates a valve housing 22 with a cylinder 23 and, contained in the latter, a piston 24. The valve 21 has an inlet 25 connected to the master cylinder 5 and an outlet connected to the inlet connection of the slave cylinder 10. The valve 21 thus forms a connecting link 35 between the master cylinder 5 and the slave cylinder 10. The cylinder 23 is provided in the vicinity of one of its ends (the righthand end in Figures 2-4) with a shoulder 26 which prevents the piston 24 from being inserted too far into the cylinder 23. The inner end of the cylinder 23 consists partly

of a cylindrical space 28 and partly of a blind inner end hole 29.

The shell surface of the valve piston 24 is provided with a number of annular grooves. Its lefthand end is provided with a first locking groove 30 and a second locking groove 31, both of which have the same cross-sectional shape. The piston 24 is also provided with two O-ring grooves accommodating seals in the form of O-rings 32, one of which is arranged in each groove. Between the two O-ring grooves the piston is provided with a first groove 33 and a second groove 34 which merge directly into one another. The first groove 33 is provided with a diameter which is substantially smaller than the largest diameter of the piston 24, while the second groove 34 has a diameter which is only insignificantly smaller than the largest diameter of the piston 24. In an alternative embodiment and with suitably dimensioned radial clearance between the piston 24 and the cylinder 23 the second groove 34 may be omitted and be represented instead by the shell surface of the piston 24 in this region. In Figures 2-4 as depicted the difference in diameter between the second groove 34 and the largest diameter of the piston 24 is so small as not to be visible in these drawings. In the region between the two O-rings 32, there debouch into the cylinder 23, substantially at the same axial position relative to the cylinder 23, not only a duct 35 connected to the inlet 25 of the valve 21 but also a duct (not depicted) connected to the outlet of the valve 21. In the position of rest in which the valve 21 is depicted in Figures 2 and 4, these two ducts 35 both debouch centrally relative to the first groove 33, which means that hydraulic oil from the inlet 25 of the valve can pass substantially unhindered to the outlet of the valve via the annular first groove 33. When the valve 21 and the piston 24 assume an activated position corresponding to the position shown in Figure 3 for the piston 24, however, the second groove 34 in the piston 24 will assume a position central to the respective orifices of the ducts 35. The second groove 34 will thus act as a constriction which substantially prevents the passage of hydraulic oil, although not more than an

certain amount of hydraulic oil can still pass between the master cylinder 5 and the slave cylinder 10.

In the valve housing 22 and debouching into the cylinder 23 is a transverse hole containing a closing device 36 with a spring-loaded closing ball 37. The spring 38 takes the form of a coil spring designed as a compression spring which has its outer end bearing on a plug 39 fixed in the hole and its inner end abutting against the closing ball 37. In the position of rest of the valve 21 the closing ball 37 fits into the first locking groove 33 on the piston 24 and holds the latter in that position. When the piston 24 moves, as described in more detail below, to its activated position, the closing ball 37 will instead fit into the second locking groove 34 and hold the piston 24 in the activated position.

The piston 24 is further provided with a central through hole consisting of two parts, both of which are cylindrical in shape and merge into one another via an annular shoulder 40. The hole has a larger diameter in the inner righthand end of the piston 24 than in its outer lefthand end. The hole accommodates a rod 41 which is partly arranged for movement as described in more detail below. One end of the rod 41 (in Figures 2-4 the lefthand end) extends beyond the cylinder 23 and is connected there to a cover 42 which is in its turn firmly connected to the operating piston 13 of the slave cylinder. This means that the rod 41 is at least indirectly connected to the operating piston 13 and has the latter's movements imparted to it when the clutch is operated. The rod 41 runs through a rubber seal 43 which is arranged at the lefthand end of the cylinder 23 and which seals the latter. The inner righthand end of the rod 41 extends partly into the inner end hole 29 of the cylinder. This righthand end of the rod 41 is provided with a number of annular shoulder-like furrows 44 to which a locking washer 45 is firmly clamped. The locking washer 45 is designed to be relatively easy to push onto the end of the rod 41 and also to be movable to the left along the furrows 44 of the rod. Movement of the locking washer in the opposite direction is barred. At the time of

fitting the valve 21, the locking washer 45 is placed in the outermost of the furrows 44 on the rod 41, after which the rod 41 is inserted to a predetermined position relative to the operating piston 13 of the slave cylinder so that the righthand end of the rod 41 is inserted to a greater or lesser extent into the inner end hole 29 of the cylinder, with simultaneous movement of the locking washer 45 along the furrows 44 of the rod. When the rod 41 thus reaches a defined position, the locking washer 45 will also have assumed, by abutting against the inner end of the cylinder, a predetermined position relative to the rod 41 and the cylinder 23. This predetermined position corresponds to the position which the operating piston 13 of the slave cylinder assumes in its position of rest when the disc linings are new. At the time of fitting, it is supposed that the piston 24 is fitted in its position of rest in which the closing ball 37 defines, by fitting into the first locking groove 33, the predetermined position of rest of the piston 24. The position of the locking washer 45 on the rod 41 will thus be individually adapted to the particular slave cylinder and the current thickness of the disc linings.

The functioning of the arrangement described is as follows. During normal operation, when the disc linings are not worn beyond a certain limit, the slave cylinder 10 will conventionally, when the clutch is operated, effect clutch movements in response to the driver's operation of the clutch pedal 1. At the time of a clutch disengaging movement, the working space 14 of the slave cylinder 10 is filled with oil from the master cylinder 5 and pushes the operating piston 13 into the cylinder 12, i.e. to the right in the drawings. The movements of the slave cylinder piston 13 will be imparted to the rod 41 through its connection via the cover 42. The return movement after a clutch disengaging movement will by similar means be imparted to the rod 41 to make it move outwards to the left relative to the cylinder 23. Figures 2 and 4 show the clutch in a disengaged position in which the rod 41 is inserted in the piston 24 and in the cylinder 23. Figure 3 shows the clutch in an engaged position

corresponding to the position of the clutch when it transfers drive power between the engine and the gearbox, and how the rod 41 is thus pushed outwards relative to the valve 21. This movement pushing the rod 41 outwards when the clutch returns to the engaged position is not sufficiently powerful, however, to bring the locking washer 45 arranged on the end of the rod 41 into contact with the shoulder 40 of the piston 24. The rod 41 will thus run freely through the central hole in the valve piston 24, and the latter will remain in its position of rest. The hydraulic oil which passes to the slave cylinder 10 can pass substantially unhindered via the valve 21 and the annular first groove 33 of the piston 24, thereby causing the driver to find that the pedal 1 can be operated with normal resistance. As disc linings become worn, the position of rest of the operating piston 13 of the slave cylinder, and hence also the rod 41, will move ever further outwards relative to the cylinder 23 (to the left). When the degree of lining wear exceeds a predetermined limit value, the outward movement when the clutch returns to the engaged position will be so great that the locking washer 45, by abutting against the shoulder 40 of the piston, will cause the piston 24 to assume the activated position by moving to the left. In this activated position the valve 21 acts as a constricting valve. Hydraulic oil which has to pass through the valve 21 will now be forced to pass the constriction formed by the second annular groove 34 of the piston. This results in the driver, when operating the clutch, finding that movement of the clutch pedal 1 requires substantially more effort than previously, and this increased resistance to clutch operation is a direct indication to him that linings are now so worn as to need renewing. Even if the driver finds that movement of the pedal 1 requires greater effort, the clutch still remains fully operable and the vehicle can continue to be driven normally in other respects.

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The invention may, within the framework of the patent claims set out below, be modified and implemented in ways other than described above. Making the clutch pedal 1 act directly, as previously described, on a master cylinder 5 so as to direct

hydraulic oil to the slave cylinder 10 is a solution suited to passenger car use. In the case of heavier vehicles such as a truck or a bus, it may instead be more advantageous to use some form of servo device or booster for facilitating clutch operation. In such cases conventional servo devices based on pneumatics and/or hydraulics may be used for providing the servo effect. For operating the slave cylinder 10 and for possibilities of being able to use the invention, how the hydraulic oil pressure imparted to the slave cylinder 10 is generated is unimportant, what is important is that the driver's operating movement is somehow converted to a hydraulic oil pressure which can be imparted to the slave cylinder 10. The presence of servo devices does of course mean that the forces with which the clutch is operated are of a different magnitude than when servo devices are not used, but the relative difference in pedal force which the driver detects between new and worn linings remains palpable, given suitable dimensioning, even when servo devices are present.

20 Instead of using a slave cylinder operated by means of hydraulic oil, it is of course possible to use a slave cylinder for other pressure media.

The embodiment described refers to a vehicle in which the clutch is operated by means of a clutch pedal. When the invention is used in other (non-vehicle) transmissions, the clutch may instead be operable via other operating devices instead of a pedal.

Patent claims

1. Wear warning arrangement on a slave cylinder operated clutch, preferably forming part of a vehicle drive unit, incorporating a slave cylinder (10) which is arranged concentrically with the clutch and has a pressure medium operated working piston (13) arranged in a working space (14) in the slave cylinder which, when the clutch is operated by an operator, is supplied with pressure medium via an inlet line (9) on which a sensor is arranged to give, by detecting the position of the working piston (13), an indication when clutch linings are worn, characterised in that a valve (21) is arranged on the inlet line (9) to the working space (14) of the slave cylinder, that the valve (21) in a first position substantially without hindrance can conduct pressure medium to the working space (14), that the valve (21) in a second position is arranged to apply a constriction (34) in the inlet line (9), and that the valve (21) is controlled under the influence of the sensor so that the valve (21) switches from the first position to its second position when the sensor indicates that the degree of lining wear exceeds a predetermined value, in order thereby to apply the constriction (34) and delay the pressure medium supply during clutch operation, thereby giving the operator a wear indication by increased resistance to clutch operation.

2. Arrangement according to patent claim 1, characterised in that the valve (21) incorporates a valve housing (22) provided with a cylinder (23) containing a valve piston (24), that the valve piston (24) in cooperation with the cylinder (23) delineates a sealed space, and that the sealed space forms part of the inlet line (9) to the working space (14) of the slave cylinder.

3. Arrangement according to patent claim 2,
c h a r a c t e r i s e d in that the valve piston (24) is
provided with an axial through hole which accommodates a rod
(41) running through it which on one side of the valve piston
5 (24) is at least indirectly connected to the slave cylinder
working piston (13) and which on the other side of the valve
piston (24) is provided with a device (45) by means of which,
when clutch linings are worn, clutch movements may result in
axial movement being imparted to the valve piston (24) so
10 that it assumes its second position at which the constriction
(34) is applied so as to delay pressure medium supply to the
working space (14) of the slave cylinder.

4. Arrangement according to patent claim 3,
15 c h a r a c t e r i s e d in that when linings are worn the
valve piston (24) is arranged to be acted upon via the rod
(41), at least indirectly, by the slave cylinder working
piston (13) during the latter's return movement after clutch
operation, until it assumes the second position.

20

5. Arrangement according to patent claim 3,
c h a r a c t e r i s e d in that the valve piston (24) is
provided with a first locking groove (30) and a second
locking groove (31) which cooperate with a closing device
25 (36), preferably in the form of a spring-loaded closing ball
(37) fitting into either of the two grooves (30,31) so as to
define the respective first and second positions of the valve
piston (24).

30 6. Arrangement according to patent claim 5,
c h a r a c t e r i s e d in that the valve piston (24) is
further provided with a first groove (33) and a second groove
(34) which respectively define a passage and substantially
hinder a passage with a constriction through the valve (21).

7. Arrangement according to patent claim 4,
c h a r a c t e r i s e d in that the device by means of
which, when clutch linings are worn, clutch movements may
impart axial movement to the valve piston so that the latter
5 assumes its second position, consists of a locking washer
(45) mounted firmly on the end of the rod (41).

8. Arrangement according to patent claim 7,
c h a r a c t e r i s e d in that the locking washer (45)
10 may only move along the rod (41) in one direction and that
movement in an opposition direction is barred, and that the
position of the locking washer (45) relative to the rod (41)
at the time of fitting has to be adapted individually to a
particular slave cylinder (10).

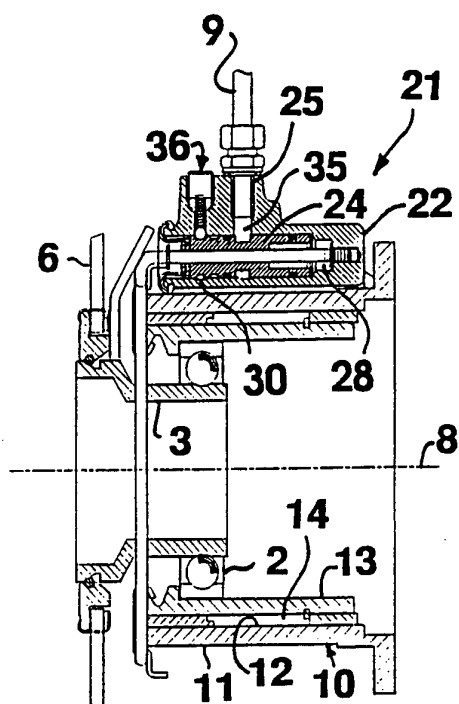


FIG 2

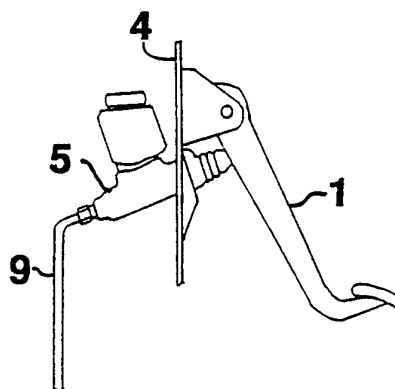


FIG 1

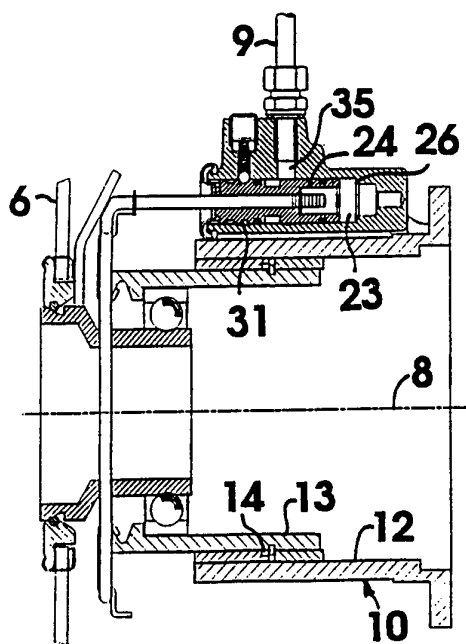


FIG 3

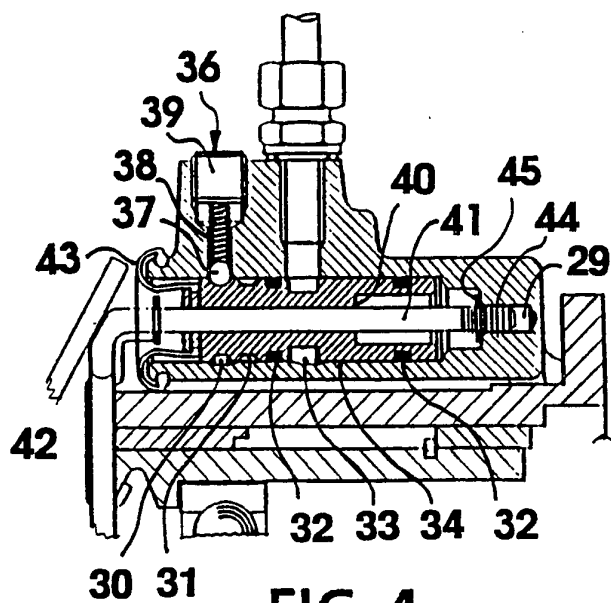


FIG 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 94/01231

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: F16D 25/12, B60K 23/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: F16D, B60K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, A1, 0076351 (BENDITALIA S.P.A.), 13 April 1983 (13.04.83), page 3, line 36 - page 4, line 30 --	1
A	GB, A, 2256907 (FICHTEL & SACHS AG), 23 December 1992 (23.12.92), figures 6-9 --	1
A	US, A, 4084671 (TERNEHALL), 18 April 1978 (18.04.78), figure 1, abstract --	1
A	GB, A, 2076101 (FABBRICA ITALIANA MAGNETI MARELLI S.P.A.), 25 November 1981 (25.11.81), figure 3, abstract --	1-2

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

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13 -04- 1995

Name and mailing address of the ISA/
Swedish Patent Office
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Facsimile No. +46 8 666 02 86

Authorized officer

Marianne Dickman
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A,P	WO, A1, 9411647 (SAAB-SCANIA AKTIEBOLAG), 26 May 1994 (26.05.94), figure 1, claim 1 -- -----	1-8

INTERNATIONAL SEARCH REPORT
Information on patent family members

25/02/95

International application No.
PCT/SE 94/01231

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WO-A1- 9411647	26/05/94	NONE	