



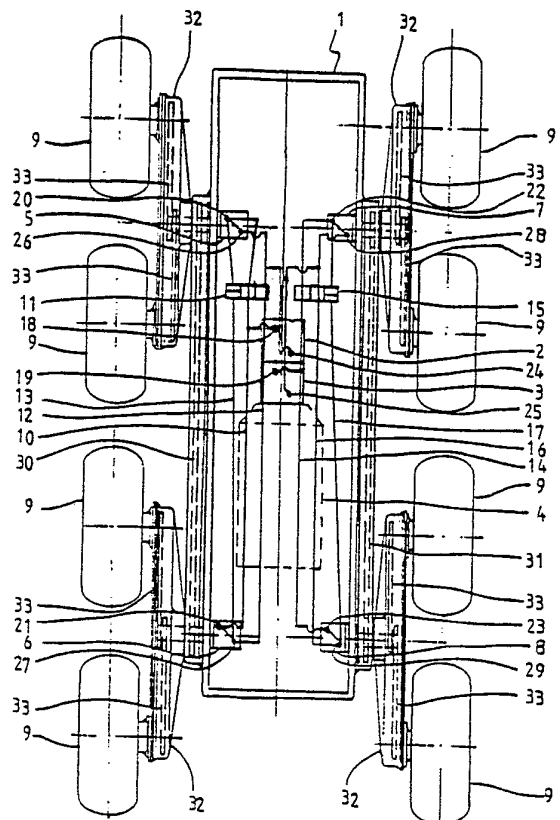
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(54) Title: HYDROSTATIC DRIVE SYSTEM

(57) Abstract

Hydrostatic drive system for a slip-steered vehicle (1), comprising two controllable hydraulic pumps (2, 3), which are preferably mounted on one and the same driven shaft, a pair of hydraulic motors (5, 6; 7, 8) at each side of the vehicle, each of the said pairs (5, 6; 7, 8) being connected with a hydraulic pump (2, 3) of its own, whereby each hydraulic motor (5, 6, 7, 8) is arranged so as to drive at least one wheel (9). The invention is characterized in that the two hydraulic pumps (2, 3) are connected to the corresponding pairs of hydraulic motors (5, 6; 7, 8) via a closed system of pipes and valves (10, 11, 12, 13; 14, 15, 16, 17), which permits switching over from hydraulic motors (5, 6; 7, 8) connected in parallel to hydraulic motors (5, 6; 7, 8) connected in series.



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Hydrostatic drive system

The present invention is concerned with a hydrostatic drive system for a slip-steered vehicle, comprising two controllable hydraulic pumps, which are preferably mounted on one and the same driven shaft, a pair of hydraulic motors at each side of the vehicle, each of the said pairs being connected with a hydraulic pump of its own, whereby each hydraulic motor is arranged so as to drive at least one wheel.

Prior-art drive systems for slip-steered vehicles having more than one hydraulic motor per side are either provided with hydraulic motors connected in series or in parallel, or they may be provided with a number of hydraulic pumps equalling the number of motors. All of these systems are confined to one speed range only, which restricts their scope of application considerably. Vehicles with hydraulic motors connected in parallel obtain a high tractive power on each wheel, but their running speed is relatively low. Owing to these circumstances, such a vehicle is well suitable, e.g., for heavy transportations in difficult terrain, whereas they are, on the whole, not at all suitable for running on the highway, owing to the low running speed. In stead, vehicles provided with hydraulic motors connected in series can be driven at a twice as high running speed compared to a vehicle provided with similar hydraulic motors connected in parallel, but, on the contrary, the tractive effort of vehicles with hydraulic motors connected in series goes down to about half the tractive effort of a vehicle with hydraulic motors connected in parallel. Therefore, vehicles provided with hydraulic motors connected in series are well suitable for running on highway, but the tractive effort of the vehicle is not quite enough for heavy transportations in difficult terrain.

The object of the present invention is to provide a drive system for a slip-steered vehicle which is suitable equally well for running in difficult terrain and on highway. This has been achieved by means of a drive system which is characterized in that the two hydraulic pumps are connected to the corresponding pairs of hydraulic motors via a closed system of pipes and valves, which permits switching over from hydraulic motors connected in parallel to hydraulic motors connected in series. The further characteristics of the invention come out from the accompanying claims 1 to 6.

In the following, the invention will be examined in more detail with reference to the drawing, wherein

Figure 1 is a schematical illustration of an example of a drive system in accordance with the invention, whereat, for the sake of clarity of illustration, the hydraulic motors at the left side are connected in parallel and the hydraulic motors at the right side are connected in series,

Figure 2 shows an example of the way in which the drive system is arranged in a vehicle seen from the bottom side.

The drive system in accordance with the invention comprises two controllable hydraulic pumps 2,3 driven, e.g., by a diesel engine 4. The hydraulic pumps 2,3 are preferably mounted on one and the same driven shaft. The vehicle 1 is provided with a pair of hydraulic motors 5,6; 7,8 at each side, each of which pairs 5,6 and 7,8 is connected with a hydraulic pump 2,3 of its own. Each of the said hydraulic motors 5,6; 7,8 is arranged so as to drive at least one wheel 9. The maneuvering of the two hydraulic pumps takes place appropriately by means of a common control lever, e.g., in accordance with the US Patent No. 4,470,475, according to which the ends of a cross-piece attached to the control lever of the vehicle 1 are, by means of rods or

wires, connected to the control member of the corresponding hydraulic pump 2 or 3, respectively. Each of the hydraulic pumps 2 and 3 is included in its own closed pipe and valve system 10,11,12,13; 14,15,16,17, which
5 permit switching over between hydraulic motors 5,6; 7,8 connected in parallel and hydraulic motors 5,6; 7,8 connected in series. The switching-over takes place so that the valves 11,15 in the pipes 10,12,13; 14,16,17 are closed or opened, which must take place at the same
10 time in both of the systems 10,11,12,13; 14,15,16,17, so that either all of the hydraulic motors 5,6,7,8 are connected in parallel or all of the hydraulic motors 5,6,7,8 are connected in series. In the contrary case the vehicle becomes entirely uncontrollable. True enough,
15 in the general view in Fig. 1, the hydraulic motors 5,6 at the left side are connected in parallel, whereas the hydraulic motors 7,8 at the right side are connected in series, but this has been done only in order to illustrate both of the alternatives in the same figure.

20 One of the connection openings 18,19 on each of the hydraulic pumps 2,3 is connected to a pipe 10,14 provided with a valve, which said pipe communicates with the corresponding connection openings 20,21;22,23 on the hydraulic motors 5,6;7,8 at the respective side. The
25 other two connection openings 24,25 on the hydraulic pumps 2,3 are connected to their respective pipes 12,16 provided with valves, which said pipes communicate with the other two connection openings 26,27;28,29 on the hydraulic motors 5,6;7,8 at the respective side. The
30 system further includes one pipe 13,16 provided with a valve at each side, which said pipe connects the outlet opening 20;22 of one hydraulic motor 5;7 with the inlet opening 27;29 of the other hydraulic motor 6;8. In order that the system should work, the two connection openings
35 18,24; 19,25 of the respective hydraulic pumps 2,3 must be connected to the pipes 10,12 or 14,16, respectively, at opposite sides of the valve members 11 or 15, res-

pectively, in the respective closed pipe and valve systems.

When the hydraulic motors are connected in parallel, the valves 11 and 15 are set so that the pipes 10 and 12 as well as 14 and 16 are open, whereas the pipes 13 and 17 are closed. If the hydraulic pumps 2 and 3 are, e.g., set so that they pass hydraulic fluid from the connection opening 18 or 19, respectively, to the pipe 10 or 14, respectively, the flow of hydraulic fluid is distributed in each pipe system so that about half the fluid flows to the connection opening 20 or 22, respectively, of the hydraulic motor 5 or 7, respectively, whereas the other half flows to the connection opening 21 or 23, respectively, of the hydraulic motor 6 or 8, respectively, and drives the respective hydraulic motors 5,6,7 and 8 so that all the wheels 9 of the vehicle are made to revolve at an equally high speed in the same direction. From the connection openings 26 and 27 or 28 and 29, respectively, the hydraulic fluid flows are passed along the pipe 12 or 16, respectively, to the connection opening 24 or 25, respectively, of the hydraulic pump.

When the hydraulic motors are to be connected in series, the valves 11 and 15 are set so that they close the pipes 10 and 12 as well as 14 and 16, respectively, and open the pipe 13 and 17, respectively. If the hydraulic pumps 2 and 3 are set so that they pass hydraulic fluid from the connection opening 18 or 19, respectively, to the pipe 10 or 14, respectively, the entire fluid flow is passed through the said pipe to the connection opening 21 or 23, respectively, of the hydraulic motor 6 or 8, respectively, forcing the respective hydraulic motor to revolve. From the hydraulic motor 6 or 8, respectively, the flow of hydraulic fluid is passed further through the pipe 13 or 17, respectively, to the connection opening 20 or 22, respectively, of the hydraulic motor 5 or 7, respectively,

forcing the respective hydraulic motor 5 or 7, respectively, and, consequently, the corresponding wheel 9 to revolve. From the hydraulic motor 5 or 7, respectively, the hydraulic fluid flow is then passed back to the
5 respective hydraulic pump 2 or 3, respectively, via the pipe 12 or 16, respectively.

It is a problem with hydraulic motors connected in parallel that substantially the whole drive power is passed to the hydraulic motor that, for the time being,
10 offers the least resistance, e.g. a hydraulic motor that drives a wheel which has lost its contact with the ground. This results in the circumstance that the other one of the hydraulic motors connected in parallel ceases to revolve. In order to eliminate this problem, as a rule,
15 some sort of a differential lock must be used. We have solved this problem by providing the outer mantle of the revolving part of each hydraulic motor with a tooth rim or equivalent, whereat, at both sides of the vehicle 1,
20 an endless chain 30,31 runs over the said tooth rims, which results in the circumstance that all the wheels 8 at the respective side of the vehicle are made to revolve with a mutually equal speed, irrespective of the mode of coupling of the motors and irrespective of any external factors, such as load and equivalent. To avoid
25 contamination of the chains and to reduce the risk of accidents, the said tooth rims and chains 30,31 are preferably encapsulated.

In order to facilitate the control of the valves of the drive system, all the valves 11,15 are
30 preferably arranged in a single unit so that the valves at each side can be controlled by means of one and the same control member. The switching-over can take place completely mechanically or possibly in the hydraulic or electromagnetic way. The valves are, e.g., ball
35 valves, but other types of valves may also be used.

Two hydraulic motors or possibly all of the four hydraulic motors 5,6,7 and 8 may appropriately be

arranged so as to drive the wheels 9 in a bogie unit 32.
In such a case, the respective hydraulic motor 5,6,7,8
is preferably arranged concentrically with the pivot
shaft of the bogie unit 32, whereby the hydraulic motor
5 concerned is arranged so as to transfer the drive power
by means of two endless chains 33 to the two wheels 9
of the respective bogie unit 32.

WHAT IS CLAIMED IS:

1. Hydrostatic drive system for a slip-steered vehicle (1), comprising two controllable hydraulic pumps (2,3), which are preferably mounted on one and the same driven shaft, a pair of hydraulic motors (5,6; 7,8) at each side of the vehicle, each of the said pairs (5,6; 7,8) being connected with a hydraulic pump (2,3) of its own, whereby each hydraulic motor (5,6,7,8) is arranged so as to drive at least one wheel (9), characterized in that the two hydraulic pumps (2,3) are connected to the corresponding pairs of hydraulic motors (5,6;7,8) via a closed system of pipes and valves (10,11,12,13; 14,15,16,17), which permits switching over from hydraulic motors (5,6; 7,8) connected in parallel to hydraulic motors (5,6; 7,8) connected in series.

2. Hydrostatic drive system as claimed in claim 1, characterized in that both connection openings (18,24; 19,25) of each hydraulic pump (2,3) are connected to their respective pipes (10,12; 14,16) provided with valves, which said pipes communicate with the corresponding connection openings (20,21; 26,27 or 22,23; 28,29, respectively) on the hydraulic motors (5,6; 7,8) at the respective side, in addition to which, in the system, at each side, there is a pipe (13,17) provided with a valve, which said pipe connects the outlet opening (20,22) of one hydraulic motor with the inlet opening (27,29) of the other hydraulic motor.

3. Hydrostatic drive system as claimed in claim 2, characterized in that the outer mantle of the revolving part of each hydraulic motor (5,6,7,8) is provided with a chain wheel, whereby the hydraulic motors (5,6; 7,8) at each side are interconnected by an endless chain (30,31) running over the said chain wheels.

4. Hydrostatic drive system as claimed in claim 3, characterized in that the valves (11,15) are arranged in one unit so that the hydraulic motors (5,6; 7,8) at each side can be switched over by means of one control from parallel connection to series connection.

5. Hydrostatic drive system as claimed in claim 4, characterized in that the valves (11,15) consist of ball valves.

10 6. Hydrostatic drive system as claimed in any of the preceding claims, characterized in that the switching-over from hydraulic motors (5,6; 7,8) connected in parallel to hydraulic motors (5,6; 7,8) connected in series takes place in the hydraulic way, preferably by means of one single little control lever.

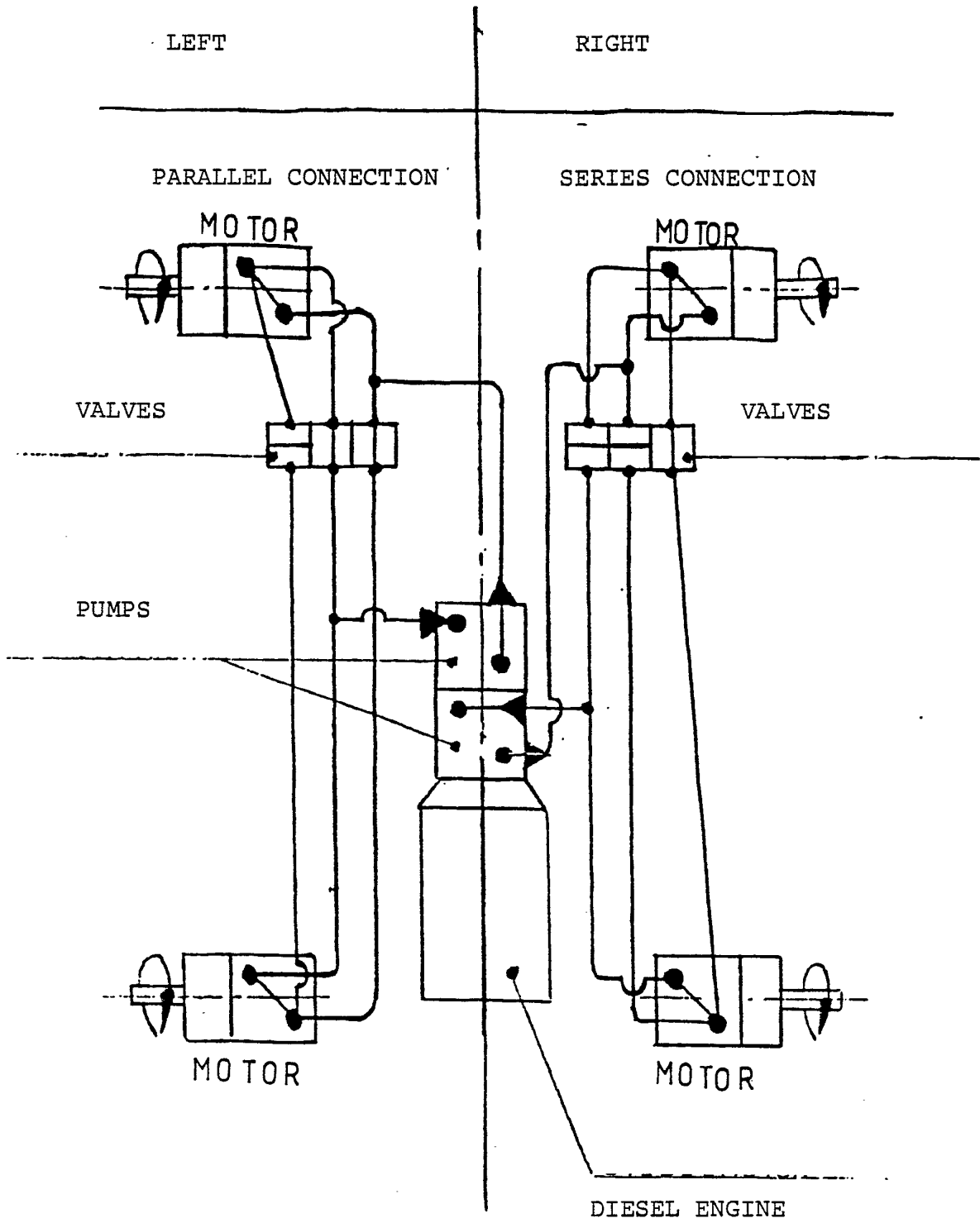


FIG. 1

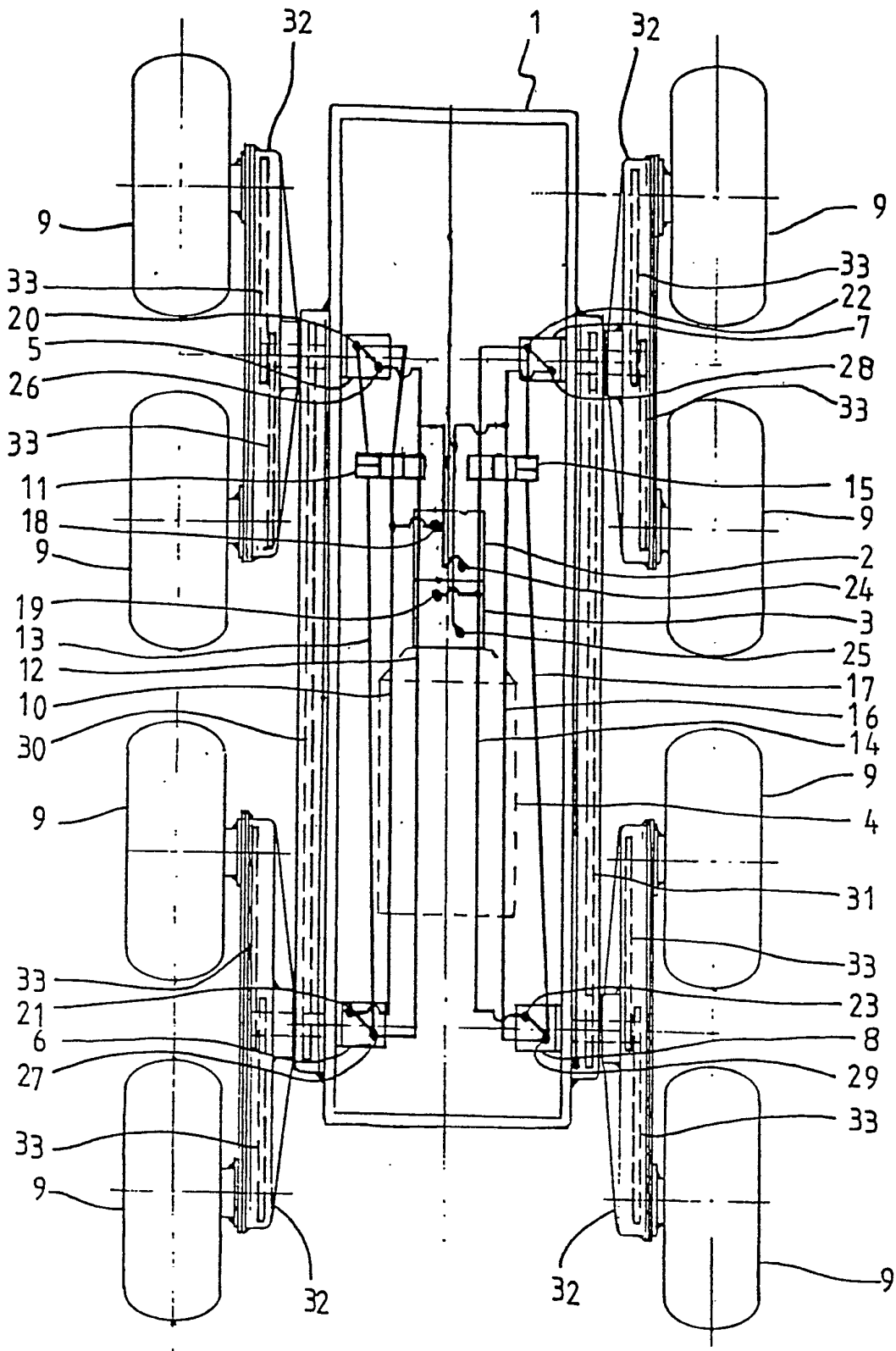


FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No

PCT/FI86/00009

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ⁶		
According to International Patent Classification (IPC) or to both National Classification and IPC 4		
B 60 K 17/10, 17/356		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁷		
Classification System	Classification Symbols	
IPC US CI	B 60 K 17/10, /34, /356 <u>180</u> :44, 51, 233, 242	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched ⁸		
SE, NO, DK, FI classes as above		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ⁹		
Category ¹⁰	Citation of Document, ¹¹ with indication, where appropriate, of the relevant passages ¹²	Relevant to Claim No. ¹³
Y	GB, A, 1 211 787 (DANFOSS AS) 11 November 1970 & CH, 483324 FR, 1594277 US, 3543645	1
Y	SE, B, 315 509 (ATLAS COPCO AB) 29 September 1969	1, 2, 6
Y	DE, A, 3 023 749 (HAINAUT-SAMBRE S A) 22 January 1981 & GB, 2058300	1
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IV. CERTIFICATION		
Date of the Actual Completion of the International Search		Date of Mailing of this International Search Report
1986-04-21		1986-04-25
International Searching Authority		Signature of Authorized Officer
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