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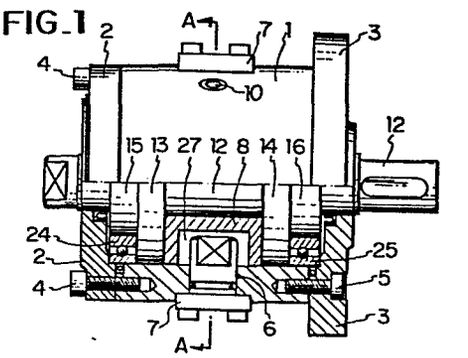
(54) Rotary actuator and making method thereof.

(57) A novel rotary actuator utilizes viscosity of the oil and prevents the oil leakage, without using the sealing member to the vane. The instant device installs the flanges (13, 14) in parallel and fixes the vane therebetween, and sets within the cylinder (1) the rotor keeping the stopper (8) therebetween, not fixing it, and the radial bearings (24, 25) at the both sides of the cylinder (1) to support the stopper (8), whereby a fine clearance is maintained between the flange (13, 14) and the inner wall of the cylinder (1). The rotor is formed in order of machining into flanges, small diameter portions and a rotary shaft. The vane is formed by cutting the material of doughnut shape into a sector.

FIG_1



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ROTARY ACTUATOR AND MAKING METHOD THEREOF

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

The present invention relates to a rotary actuator serving reciprocating rotation and a making method thereof.

DESCRIPTION OF THE PRIOR ART

There have been found openings and closings of doors of heavy weight, hatch covers of ships, large scaled butterfly vanes, or other various mechanisms, the moving angle of which is less than one rotation. Such mechanisms will also develop the utilizing fields thereof in the future. Thus, the rotary actuator is employed for providing the reciprocating rotation (oscillation) within limited angle. The conventional rotary actuator substantially comprises a casing securing a stopper to an inner wall thereof, a stator and vanes, and the reciprocating rotation (oscillation) has been accomplished by alternately supplying oil under pressure into an inlet and an outlet ports. In case, the pressure oil leaked from a clearance defined between the casing and its inner wall, proper driving force would

not be provided, and therefore, sealing material such as rubber, synthetic resin or the like is attached to the vanes. However, the sealing material is extreme in abrasion, or creats friction in relation with an inner side of a cylinder, resulting in hindering efficiency of generating rotation torque. Being in these circumstances, requisions have arisen to appearence of such rotary actuator which prevents the oil leakage without using the sealing material.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a rotary actuator which prevents the oil leakage without securing the sealing material to the vane but utilizing viscosity of the oil, and provide a making method thereof.

It is another object of the invention to provide a rotary actuator which may satisfactorily absorb sizing error or setting-up error, and provide a making method thereof.

It is a further object of the invention to provide a rotary actuator which, at setting up, keeps a fine clearance between the cylinder inner wall and a flange rotor to the extent that the oil does not penetrate therein, but securely supports the rotor, and provide a making method thereof.

It is a still further object of the invention to provide a method of making a rotary actuator which may exactly accord a diameter of the flange to a diameter of the vane to be kept between the flanges.

Other and further objects, features and advantages will appear more fully from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows partially a cross sectional front view of an embodiment of the invention,

Fig. 2 is a cross sectional view seen from A - A line in Fig. 1,

Fig. 3 is a front view showing a making process of a rotor,

Fig. 4 is a side view showing a making process of a vane,

Fig. 5 shows partially a cross sectional front view of the other embodiment of the invention, and,

Fig. 6 is a cross sectional view seen from B - B line in Fig. 5.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

An explanation will be made to preferred embodiments of the invention with reference to the attached drawings.

Fig. 1 is a partial cross sectional front view of an embodiment according to the invention, in which vanes are two installed. A cylinder 1 is mounted with a rotor thereon, and is closed at its both sides by securing end covers 2 and 3 with bolts 4, 5. The cylinder 1 is defined with holes on an upper and a lower faces into which core metals will be inserted. The core metal 7 is secured to the cylinder 1 by tightening bolts, and this metal serves to restrain action of stoppers 8, 9 as later mentioned. The cylinder 1 is further formed with oil ports 10, 11 around the core metal 7 for charging and discharging the oil under pressure.

The rotor to be disposed within the cylinder 1 comprises a rotor shaft 12, flanges 13, 14 parallel thereto, small dia-

meter portions 15, 16 as outer sides of the flanges 13, 14, and the vanes 17, 18 fixed between the flanges 13, 14. The rotor shaft 12 is formed with a narrow path 21 communicating oil chambers 19 and 20 as seen in Fig. 2, and a narrow path 22 communicating oil chambers which will be gradually defined between the stopper 8 and the vane 17 and between the stopper 9 and the vane 18 by rotation of the rotor. The paths 21, 22 may be omitted if the vane and the stopper make a one pair, and those may be also omitted if the cylinder 1 is formed on its lower face with oil ports as the oil ports 10, 11.

Preferably, the rotor is made in a following manner. That is a circular material is ready for which is in diameter the same as or a bit larger than the flange, and it is machined on respective parts. At the outset, it is processed up to size of the diameter of the small diameter portions 15, 16, leaving parts which will be the flanges 13, 14 at left and right sides, subsequently the processing is continued up to size of the diameter of the rotor shaft 12, leaving parts which will be the small diameter portions 15, 16. Thus, portions of the flanges 13, 14, the small diameter portions 15, 16 and the rotor shaft 12 are formed integrally and sequentially.

Depending upon this manner, connections at respective parts are not necessary any longer, and accordingly no attention should be paid to discrepancy or error with respect to right angle, etc. In the instant actuator, the viscosity of the oil is utilized for preventing the oil leakage without using the sealing material to the vanes 17, 18. For this purpose, there is kept a clearance of microns to the extent that the oil leakage does not occur, between the inner wall of the cylinder 1 and the circumferential

faces of the flanges 13, 14. Therefore, it is preferable to manufacture the rotor as mentioned above, since such precision as microns is required to sizing and settin-up of each of the parts. For the vanes 17, 18, such cylindrical body like a doughnut is ready for which has an inner diameter equal to the diameter of the rotor shaft 12 and has an outer diameter being equal to or a bit larger than the outer diameter of the flanges 13, 14, and it is cut out at one part into a sector of small width and is kept by a bolt between the flanges 13, 14. In this case, if the outer diameters of the vanes 17, 18 are prepared as slightly larger than a determined outer diameter of the flange, it is possible to accord to the outer diameter of the flanges 13, 14 by grinding the vanes 17, 18 on protruding parts thereof from the flanges 13, 14 after having fixed the vanes 17, 18 between the flanges 13, 14. The vanes 17, 18 are secured to the flanges 13, 14 by the bolts. If the vanes 17, 18 are formed with cutouts 23, the oil smoothly penetrates between the contacting vane and stopper.

A next reference will be made to fitting of the rotor into the cylinder 1. The rotor 6 is urged into the cylinder 1 under condition that the stoppers 8, 9 are kept between the flanges 13, 14 on the upper and lower parts thereof. The stoppers 8, 9 are positioned within spaces defined between the rotor shaft 12, the flanges 13, 14 and the inner wall of the cylinder 1, but are not fixed to either of them. Thereby, thrust loading acting on the rotor shaft 12 may be absorbed and at the same time the sizing error or setting-up error at each of the parts may be corrected. After the rotor has been urged into the cylinder 1, radial bearings 24, 25 are forcibly set at the both sides, outer wheel of

which bearings 24, 25 are a bit larger in the diameter than the inner diameter of the cylinder. The inner wheels of the radial bearings 24, 25 are mounted on the small diameter portions 15, 16 of the rotor. The rotor is securely supported in that the radial bearings 24, 25 are used, the outer wheel of which has the diameter larger than the inner diameter of the cylinder, so that the clearance is maintained between the circumferential faces of the flanges 13, 14 and the inner wall of the cylinder. The core metals 7 are inserted into the holes 6 and are fixed at end portions seated within bores 26, 27 of the stoppers 8, 9.

Figs.5 and 6 illustrate the other embodiment, in which cushion mechanism is disposed. Herein, oil ports 28, 29 are prepared with a main path 30 and a subpath 31, and the main path 30 is directed to an oil chamber. The subpath 31 is communicated with the oil chamber via a path 34 which is normally closed by a ball valve 33 acted by a spring 32, and a bypath 35. The bypath 35 is controlled in its width by a control screw 36 in the cylinder 1. The other mechanisms are the same as mentioned above.

The action of the inventive rotary actuator will be referred to. If the pressure oil is supplied from the oil port 10, the oil goes between the upper stopper 8 and the vane 17, i.e., into the cutout 23, the vane 17 contacting the stopper 8 slowly separates therefrom and rotates in the counterclockwise direction in Fig. 2 until it contacts the lower stopper 9. Then, part of the oil is led via the narrow path 21 into between the vane 18 and the stopper 9 and separates the both. On the other hand, the oil charged in the oil chamber 19 passes through the narrow path 21 by the vane 17 into the oil chamber 20, and is discharged from the oil port 11 by the vane 18 together with the oil charged in

the chamber 20, and the rotation of the rotor is stopped in that the vane 17 contacts the stopper 9 and the vane 18 contacts the stopper 8. When the relation of the inlet and the outlet of the oil is exchanged with respect to the respective oil ports 10, 11 the same operation as mentioned is then performed to the reverse, that is, the vanes 17, 18 rotates in the opposite direction and returns to the state shown in Fig. 2. The said normal and reverse rotations are repeated and the rotary shaft is effected with reciprocating rotation.

Herein, a reference will be made to receiving manner of the thrust load in the rotary actuator. While the rotor serves the normal and reverse rotations, the rotor is always given the thrust load which is a component force other than the radial load. As far as the component force is light, it may be sufficiently received by only supporting the rotor on the radial bearing. However, if a large thrust load were acted on while the thrust load is acted on the rotary shaft from the outside, the inner wheels of the radial bearings 24, 25 would slightly biased toward the thrust in response to the extent of such thrust load and the rotor also moves accordingly, though the outer wheels of the radial bearings are so close to the inner face of the cylinder 1 and do not move. If, at this time, the stoppers 8, 9 were fixed to the inner wall of the cylinder 1, one of the flanges would be strongly urged against the stopper at its side by the thrust load, so that not only reduction of the output torque is invited but burning is caused to obstucle the rotation of the rotor.

In view of such circumstances, in the present rotary actuator, the stoppers 8, 9 are not fixed to the cylinder 1 at its inner wall, whereby the stoppers 8, 9 may be moved while the rotor moves

with fitting to neighbourhood to avoid occurrence of said disadvantages. Being supported under non-fixing condition, the stoppers 8, 9 move freely and fit to the adjacient members. Therefore, it is possible to adjust the sizing errors or the setting-up errors when the members are set up.

An explanation will be referred to the embodiment preparing the cushion mechanisms shown in Figs.5 and 6. In Fig. 5, the oil from the port 28 is checked by the ball valve 33 pressed by the spring 32, and it flows bit by bit only from the bypath 35. The bypath 35 is adjusted in its width by operating an adjusting screw 36. When the vane 18 comes to the stopper 8, the oil is reduced in the discharging amount and controls the rotation of the vane 18 to make shock moderate, generated when the vane 18 contacts the stopper 8. For providing the reverse rotation of the rotor, it is sufficient to make reverse the relation of the inlet and the outlet of the oil with respect to the oil ports 28, 29.

As many apparently widely different embodiments of this invention may be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific embodiments thereof except as defined in the appended claims.

WHAT IS CLAIMED IS:

1. Rotary actuator, comprising

a cylinder having a pair of oil ports,

a rotary installing flanges on a rotor shaft in opposition and keeping flanges between vanes, diameter of the flange being smaller than an inner diameter of the cylinder,

a couple of radial bearings supporting the rotor within the cylinder, and

stoppers which are kept at upper and lower parts thereof between the inner face of the cylinder and the rotor shaft and are kept at both sides thereof between the flanges, and which are restrained in rotation by means of core metals projecting from the inner side of the cylinder.

2. Rotary actuator as claimed in Claim 1, characerized in that the oil port is provided with subpath, and the subpath communicates with oil chamber via bypath and path which is normally closed by ball valve pressed by spring.

3. Rotary actuator as claimed in Claim 2, wherein the cylinder is screwed with screw for adjusting the bypath in width thereof.

4. Method of making rotary actuator, characterized by mounting a rotor on a cylinder, setting radial bearings on the cylinder at its both sides, outer diameter of the bearing being larger than an inner diameter of the cylinder, and mounting small diameter portion as the outer side of the flange on inner wheel of the bearing.

5. Method of processing rotor for the rotary actuator, characterized by machining a circular member with leaving of flanges at

its left and right sides, of equal or nearly equal diameter to the diameter of the flange, further machining to form a rotor shaft with leaving of small diameter portion being smaller than the flange at the outside of the flange, cutting out part of a cylindrical member having an inner diameter equal to the diameter of the rotor shaft for forming vane, and fixing the vane between the flanges.

6. Method as claimed in Claim 5, characterized by preparing the vane such that its outer diameter is larger than the flange, fixing the vane between the flanges and carrying out grinding thereon to make the vane equal to the diameter of the flange

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FIG_1

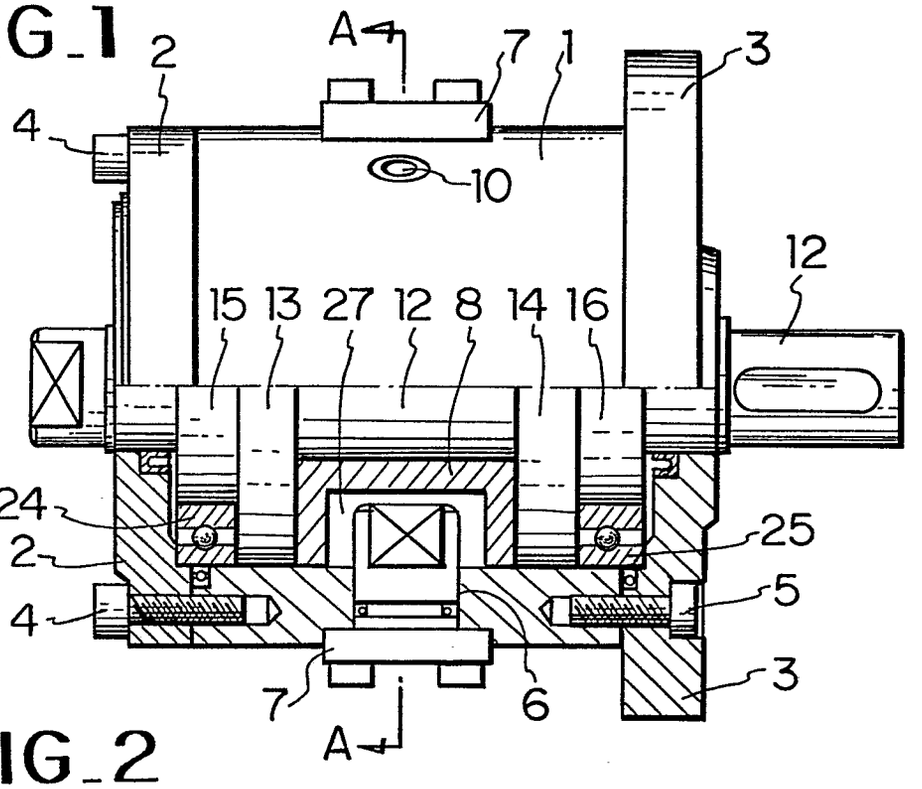

FIG_2

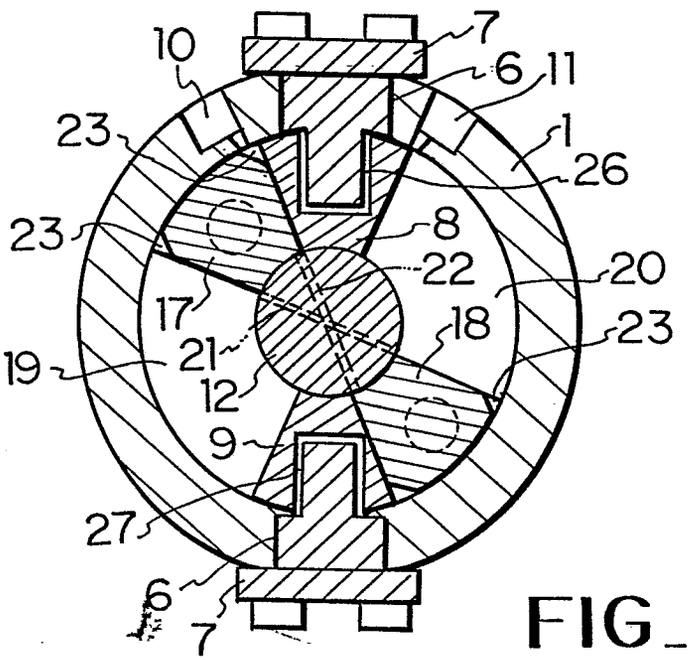

FIG_4

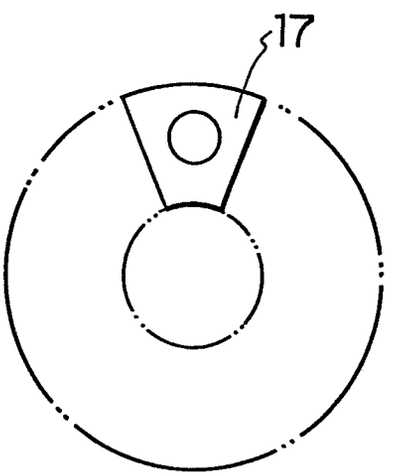

FIG_3

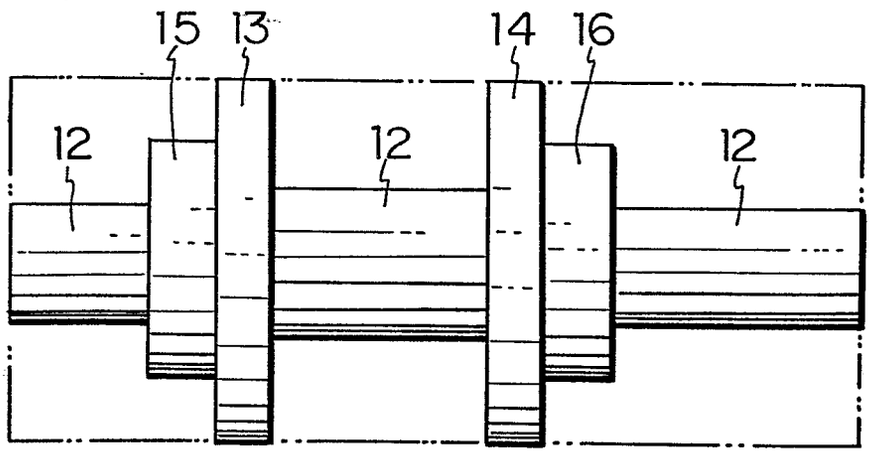

FIG_5

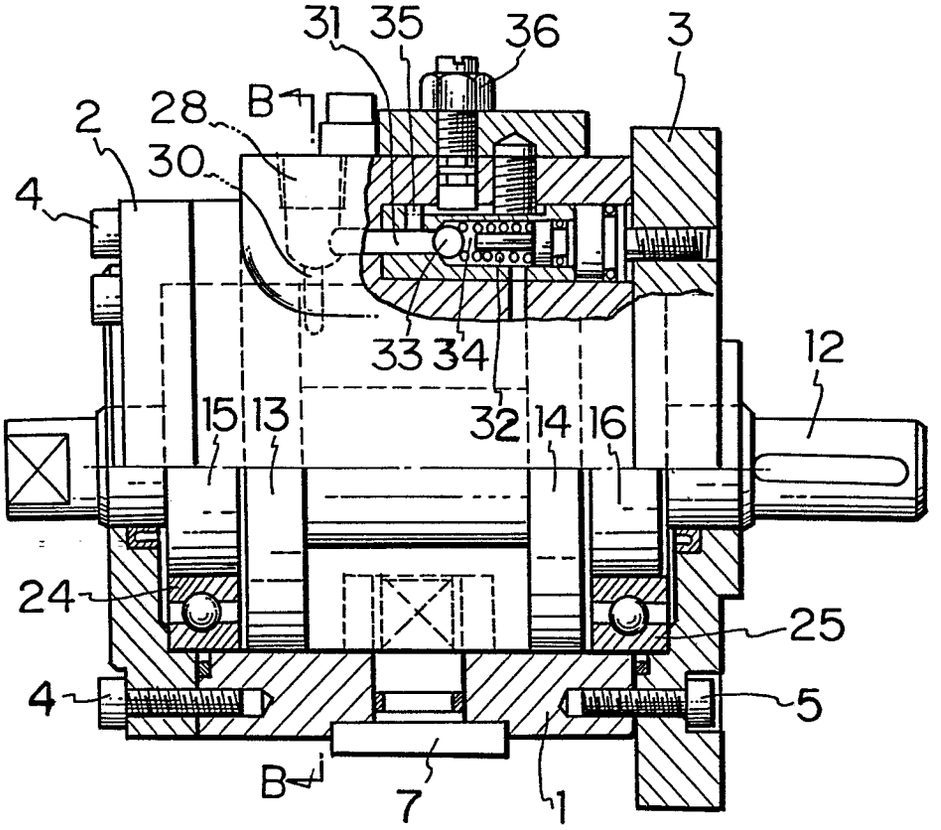
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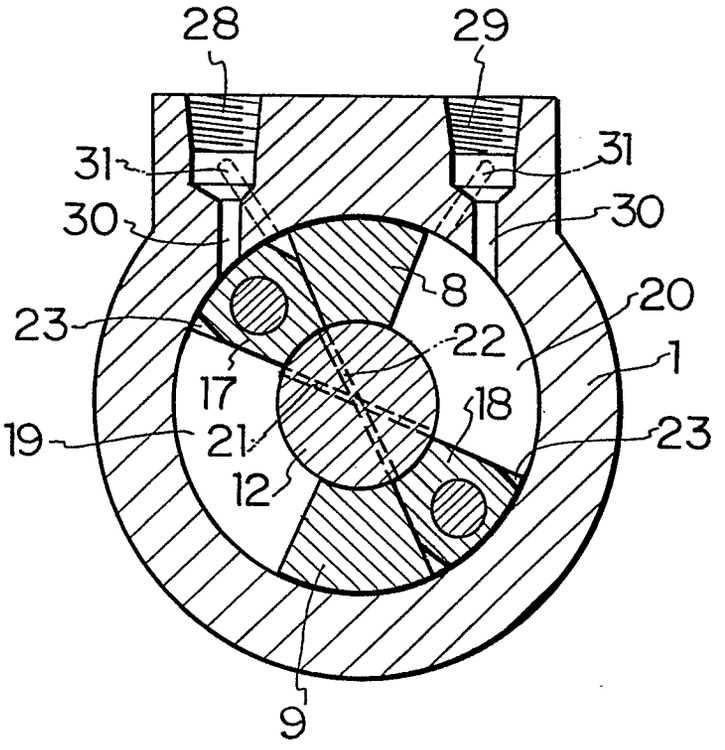
FIG_6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EUROPEAN SEARCH REPORT

Application number EP 81 10 4040

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
X	DE - A - 2 321 043 (BARNSTEINER) * the whole document * --	1,2
	DE - A - 1 750 352 (STEINBACH) * the whole document * --	1
	DE - C - 1 028 903 (SCHIFFS-KONSTRUKTION) * the whole document * --	1
	US - A - 2 798 462 (LUDWIG) * column 3, lines 24-43 * --	2,3
A	GB - A - 885 185 (AUTOMOTIVE)	
A	DE - A - 2 161 831 (FERAG) -----	

CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)

F 15 B 15/12

TECHNICAL FIELDS SEARCHED (Int.Cl. 3)

F 15 B

CATEGORY OF CITED DOCUMENTS

X: particularly relevant if taken alone
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A: technological background
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D: document cited in the application
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X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	25-01-1982	KNOPS