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**Datasheet for the decision
of 16 April 2021**

Case Number: T 0364/18 - 3.2.04

Application Number: 12705171.2

Publication Number: 2635812

IPC: F04B7/00, F04B49/22, F04B49/24,
F04B53/10, F04B49/06, F04B17/02

Language of the proceedings: EN

Title of invention:

METHOD OF CONTROLLING A HYDRAULIC MACHINE TO REDUCE TORQUE
RIPPLE AND/OR BEARING SIDE LOAD

Patent Proprietor:

MITSUBISHI HEAVY INDUSTRIES, LTD.

Opponent:

POCLAIN HYDRAULICS INDUSTRIE

Headword:

Relevant legal provisions:

EPC Art. 54
EPC R. 76(2) (c), 99(2)

Keyword:

Novelty - main request (no)
Extent of opposition

Decisions cited:

G 0009/91

Catchword:

Reasons 4 : Extent of scrutiny limited by principle of ne
ultra petita



Beschwerdekammern

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Case Number: T 0364/18 - 3.2.04

D E C I S I O N
of Technical Board of Appeal 3.2.04
of 16 April 2021

Appellant: POCLAIN HYDRAULICS INDUSTRIE
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Decision under appeal: **Interlocutory decision of the Opposition
Division of the European Patent Office posted on
23 November 2017 concerning maintenance of the
European Patent No. 2635812 in amended form.**

Composition of the Board:

Chairman A. de Vries
Members: C. Kujat
T. Bokor

Summary of Facts and Submissions

- I. The appeal lies from the interlocutory decision of the opposition division of the European Patent Office, posted on 23 November 2017 concerning maintenance of the European Patent No. 2 635 812 in amended form pursuant to Articles 101(3) (a) and 106(2) EPC.
- II. The opposition division held that the patent as amended according to auxiliary request 2 and the invention to which it related met the requirements of the EPC, having regard *inter alia* to the following documents:
- E1: WO 2010/076543 A2
E1': US 2012/0031263 A1
E1 and E1' are family documents with the same priority.
- III. The appellant opponent lodged an appeal, received on 5 February 2018, against this decision and simultaneously paid the appeal fee. The statement setting out the grounds of appeal was received on 30 March 2018.
- IV. In preparation for oral proceedings the board issued a communication pursuant to Article 15(1) RPBA dated 29 June 2020 setting out its provisional opinion on the relevant issues. Oral proceedings were duly held on 16 April 2021.
- V. The appellant opponent requests that the decision under appeal be set aside, and that the Claims 1-5, 8, 9, 11, 15-17, 19 and 20 of European patent No. 2635812 be revoked.

VI. The proprietor as respondent requests that the appeal be dismissed, or alternatively that the decision under appeal be set aside and the patent be maintained in an amended form on the basis of the Auxiliary Request filed with the response to the grounds of appeal dated 20 August 2018.

VII. The relevant independent apparatus claims read as follows:

Main Request (Auxiliary Request 2 in the impugned decision)

1. "A hydraulic machine comprising a controller (16), a plurality of cylinders (2), a low pressure working fluid line (20), a high pressure working fluid line (30), and a plurality of valves (18, 28) regulating the flow of working fluid between each cylinder and the low and high pressure working fluid lines (20, 30), at least one valve associated with each cylinder being an electronically controlled valve, the controller (16) being operable to actively control the opening and/or closing of the electronically controlled valves to select whether a cylinder undergoes an active cycle during which there is a net displacement of working fluid or an inactive cycle during which there is no net displacement of working fluid, for each cylinder on each cycle of cylinder volume (4), wherein the controller (16) is configured to cause selected cylinders to undergo active cycles and the remainder of said plurality of cylinders to undergo inactive cycles, wherein the selected cylinders form one or more groups of cylinders, so that there is a correlation between cylinders in each group undergoing active cycles, the hydraulic machine further comprises

a database (44) for storing cylinder group data (46) which defines a plurality of cylinder groups each including correlated cylinders, and wherein the controller (16) is configured to select (104) one or more groups of cylinders to undergo the active cycles from the plurality of cylinder groups defined by the stored cylinder group data (46), characterized in that the controller (16) is configured to monitor a shaft position of the hydraulic machine continuously and to determine whether an individual cylinder is selected using selected cylinder data which defines said one or more selected groups of cylinders whenever a decision point for said individual cylinder is reached at which it is determined whether said individual cylinder undergoes an active or idle cycle."

Auxiliary Request

Independent claims 1 to 7 are combinations of granted claim 1 and respective ones of unopposed granted claims 6, 7, 10, 12 to 14 or 18.

- VIII. The appellant opponent argued as follows:
The subject matter of independent claim 1 of the Main Request lacks novelty over document E1/E1'.
- IX. The respondent proprietor argued as follows:
The subject matter of independent claim 1 of the Main Request is novel over document E1/E1'.

Reasons for the Decision

1. The appeal is admissible.
2. *Background*

The invention concerns a hydraulic machine such as a pump or a motor. The machine comprises a controller, a plurality of cylinders, a low pressure working fluid line, a high pressure working fluid line, and a plurality of valves regulating the flow of working fluid between each cylinder and the low and high pressure working fluid lines. At least one valve associated with each cylinder is electronically controlled by the controller to actively control the opening and/or closing of the electronically controlled valves. The controller selects whether a cylinder undergoes an active cycle during which there is a net displacement of working fluid or an inactive cycle during which there is no net displacement of working fluid, for each cylinder on each cycle of cylinder volume. Selected cylinders form one or more groups of cylinders, so that there is a correlation between cylinders in each group undergoing active cycles. To this end the hydraulic machine comprises a database for storing cylinder group data which defines a plurality of cylinder groups each including correlated cylinders, with the controller configured to select one or more groups of cylinders to undergo the active cycles from the plurality of cylinder groups defined by the stored cylinder group data. The controller is further configured to monitor a shaft position of the hydraulic machine continuously and to determine whether an individual cylinder is selected using selected cylinder

data which defines said one or more selected groups of cylinders whenever a decision point for said individual cylinder is reached at which it is determined whether said individual cylinder undergoes an active or idle cycle.

The concept of cylinder groups including correlated cylinders improves the lifetime of the machine , e.g. by reducing torque ripple or bearing side load (patent, paragraph 0012).

3. *Main Request - Novelty*

Claim 1 of the present Main Request is identical with claim 1 of Auxiliary Request 2 underlying the impugned decision, which the decision held to be novel over family documents E1 and E1'. The opponent as appellant disputes this finding. In the following reference is only made to the English language document E1'.

- 3.1 It is common ground that E1' discloses a hydraulic machine comprising a controller 34, a plurality of cylinders 14A to 14I, a low pressure working fluid line 26, a high pressure working fluid line 28, and a plurality of distribution valves 32 regulating the flow of working fluid between each cylinder and the low and high pressure working fluid lines, as well as an angle sensor 35 for detecting relative positions of cam 20, as shown generally in figure 1, see also paragraphs 0113 to 0126. E1' considers different distributions of elementary motors, "by lobe" or "by cylinder", paragraph 0131. The distribution of the hydraulic motor with "by-cylinder elementary motors" 70, 72 and 74 is shown in figure 3, see also paragraphs 0133 to 0136. In that arrangement of elementary motors 70, 72 and 74, the distribution valves 32 associated with each

cylinder 14A to 14I are electronically controlled valves, and a controller 34 implemented as an electronic computer is operable to actively control the opening and/or closing of the valves to select whether a cylinder undergoes an active cycle during which there is a net displacement of working fluid or an inactive cycle during which there is no net displacement of working fluid, see paragraphs 0125 and 0135. The controller 34 is configured to cause all cylinders of a given elementary motor, i.e. three selected cylinders in the embodiment shown in figure 3 of E1', to undergo active cycles and the remainder of the cylinders to undergo inactive cycles, see paragraphs 0127 and 0135 and the activation table in paragraphs 0055 and 0056. Thus, the three selected cylinders of an elementary motor form a group of cylinders, so that there is a correlation between cylinders in each group undergoing active cycles in E1'.

3.2 The points of contention in respect of novelty are whether E1' also discloses the following features (using the parties' notation):

g) the controller 34 is operable to actively control the opening and/or closing of the electronically controlled valves 32 to select whether a cylinder undergoes an active cycle during which there is a net displacement of working fluid or an inactive cycle during which there is no net displacement of working fluid, for each cylinder on each cycle of cylinder volume, that

j) the hydraulic machine comprises a database for storing cylinder group data which defines a plurality of cylinder groups each including correlated cylinders,
k) the controller 34 being configured to select one or

more groups of cylinders to undergo the active cycles from the plurality of cylinder groups defined by the stored cylinder group data

n) the controller 34 is configured to monitor a shaft position of the hydraulic machine continuously and to determine whether an individual cylinder is selected using selected cylinder data which defines said one or more selected groups of cylinders whenever a decision point for said individual cylinder is reached at which it is determined whether said individual cylinder undergoes an active or idle cycle.

3.3 *Features j), k)*

3.3.1 The impugned decision, as also maintained by the appellant-opponent, considered the activation table according to paragraphs 0055 and 0056 a database which enabled the controller to control the opening and/or closing of the distribution valves for each cylinder on each cycle of cylinder volume. The respondent proprietor disputes that there is a direct and unambiguous disclosure of a database in E1', essentially arguing that the various cylinders could be connected to the controller with fixed wiring, and that the activation table does not define groups of cylinders.

3.3.2 The board concurs with the respondent proprietor that the activation table according to paragraphs 0055 and 0056 of E1' is drawn up on the level of "sub-motors", i.e. elementary motors. However, that disclosure must be seen in the context of the activation scheme of a single elementary motor in E1'. According to that document, each elementary motor is capable, when fed on its own, to supply drive torque (paragraph 0020). As

can be gleaned from figure 3, the hydraulic machine has nine cylinders 14A to 14I grouped into three elementary motors 70, 72 and 74, as well as a central shaft 24 with a cam surface 20 having six lobes and corresponding rising and falling ramps, see paragraphs 0117 and 0135. In order to drive shaft 24 in a clockwise manner e.g. by elementary motor 70 alone, it does not suffice to connect all its three cylinders 14A, 14E and 14F to the high pressure circuit simultaneously, since that would cancel out their forces. The reason is that the respective rollers of these cylinders act on differently shaped areas of the cam. Thus, as explained in paragraph 0023, a piston that comes out of its cylinder acts on a rising ramp, and a retracting cylinder does so for a falling ramp. Applied to the situation shown in figure 3 with clockwise rotation and considering, by way of example, elementary motor 60 which comprises cylinders 14A, 14E and 14F in the position shown, cylinder 14A is at bottom dead centre, cylinder 14E is on a falling ramp and cylinder 14F on a rising ramp. For elementary motor 60 to be in drive mode according to paragraph 0028 - in which all its pistons undergo active cycles - cylinder 14A must be switching from pump high pressure (i.e. the high pressure working fluid line in the wording of claim 1) to pump low pressure (i.e. the low pressure working fluid line), cylinder 14E is connected to pump low pressure, and cylinder 14F is connected to pump high pressure, with each switching of the respective distribution valve for establishing connections to different pump pressures / working fluid lines taking place at respective cam angles as the cam rotates. Clearly each cylinder of elementary motor 60 must be driven separately and individually in dependence of its position with respect to the cam 20 and in accordance with its grouping.

3.3.3 Therefore, the controller 34 must control the opening or closing of the distribution valve 32 of *each* cylinder of a *given* elementary motor *individually* by sending signals as a function of the position of cam 20 / shaft 24, see paragraph 0126. For that purpose, the controller, which is an electronic computer, paragraph 00125, must be able to identify which cylinder belongs to which elementary motor and when it should be activated/deactivated. This is only possible if it has a corresponding database with data for each cylinder of all elementary motors, which is considered cylinder group data.

3.3.4 Indeed, the table of paragraph 0032, which gives as a function of angular position of the cylinder block relative to the cam over 360° the state desired for the distribution valves of an elementary motor, is part of such a database. The skilled person will thus understand the statements "has a table" and "includes an activation table" in paragraphs 0032 and 0056 in the sense that the angle dependent table and also the activation table are stored in the memory of the electronic computer, effectively forming that database.

The activation table is also considered a database for storing cylinder group data, since it contains data for each sub-motor or elementary motor, see paragraph 0056. As the activation table contains data for all elementary motors, e.g. the exemplary two sub-motors Cyl 1 and Cyl 2 in paragraph 0056, or the three elementary motors 70, 72 and 74 when applied to the embodiment of figure 3, the entries in that database define a plurality of cylinder groups. Each of these cylinder groups implicitly includes correlated cylinders, since the angle dependent table according to

paragraph 0032 must be applied by the controller to each elementary motor in order to control its distribution valves individually for generating drive torque (see paragraph 3.3.2 above).

3.3.5 Summarizing the above, the activation table in E1' qualifies as a database for storing cylinder group data within the meaning of feature j) of claim 1. As a logical consequence, the selection of elementary motors based on that activation table according to paragraphs 0055 and 0056 of E1' discloses feature k). Whether or not the control signals are then sent to the distribution valves by means of fixed wiring, as argued by the respondent proprietor, is immaterial. The transmission of control signals only concerns a second step subsequent to the first step of the controller selecting one or more groups of cylinders from that database. Furthermore, even if the control signals were transmitted by fixed wiring, there would not be a simultaneous transmission to all distribution valves of a given elementary motor as explained in paragraph 3.3.2 above.

3.4 *Feature g)*

3.4.1 With regard to feature g), the respondent proprietor essentially argued in their reply to the appeal that this feature would limit the patent to the category of machines where decisions are made as to whether a cylinder undergoes an active or inactive cycle for each cylinder on each cycle of cylinder volume (paragraphs 7 and 8 of the reply, emphasis added by the board). In particular, in E1' such decisions would not be taken for each cylinder on each cycle of cylinder volume, but only at setpoint of each elementary motor, paragraph 0031.

3.4.2 The board disagrees. Firstly feature g) does not refer to decisions but selections. Even so, in the board's view, the controller of E1' takes decisions for each cylinder on each cycle of cylinder volume. The reason is that the controller, an electronic computer, that by its nature carries out sequences of logical operations, must necessarily also take logical decisions as to which cylinder is active or not active and when, as it carries out the control of the individual cylinders and associated distribution valves during each cycle and in dependence of a respective elementary motor's operation mode.

At the level of control logic cam angle is monitored in E1', and when a given cam angle for connecting given cylinders to pump high pressure or low pressure is ascertained the controller selects those cylinders for the corresponding control of their distribution valves. In the wording of claim 1 it so selects which cylinder undergoes an active cycle. For example, the controller can run the hydraulic motor at maximum output by operating all elementary motors simultaneously in "drive mode", see paragraph 0035 of E1', which corresponds to operating the hydraulic machine according to claim 1 at 100% output, see paragraph 0071 of the patent. In order to put all elementary motors in in E1' in drive mode, i.e. by selecting all cylinders 14A to 14I to undergo an active cycle during which there is a net displacement of working fluid, the controller must control the opening and/or closing of the corresponding distribution valves 32 for each cylinder 14A to 14I on each cycle of cylinder volume at the correct cam angle for a given cylinder in the manner indicated in paragraph 3.3.2 above; that is, the

controller in E1' must takes decisions for each cylinder on each cycle of cylinder volume.

3.5 *Feature n)*

- 3.5.1 Turning to the first part of feature n) the respondent proprietor disputes that controller 34 is configured to monitor a shaft position (of central shaft 24; see paragraph 0117) continuously, essentially arguing that an occasional detection of marks on the shaft suffices for knowing top and bottom dead centre of the cam in E1'.

The board disagrees in view of paragraph 0063 of the patent, which states that a microprocessor or microcontroller 38 executes a program on the basis of which it generates signals for the distribution valves. A microcontroller is of course a digital device, and therefore operates only in a pseudo-continuous manner, due to the clock frequency of its central processing unit and the bus frequency of its input and output channels. The same is implicitly disclosed in E1', since the electronic computer controller 34 will be construed by a skilled person as a digital microcomputer with the same characteristics. In that computer controller a table gives the desired state of the distribution valves 32 as a function of angular position over 360° as sensed by angle sensor 35 detecting the position of the cam 20, see paragraphs 0032 and 0126. In combination that implies a continuous monitoring of a shaft position by means of the angle sensor 35. The computer thus operates at high frequency to achieve precise control, paragraph 0033.

- 3.5.2 With regard to the remaining part of feature n) relating to the use of "decision points" for each

cylinder to determine whether it undergoes an active or idle cycle, the respondent proprietor argues that such "decision points", as shown in the flow diagram of figure 4, would not be made for each cylinder and each cycle in E1'.

The board disagrees. Such individual "decision points" are seen to be inherent in the control logic used by the controller of E1' to control each and every cylinder in each and every cycle in dependence on cam angle as discussed above in the context of running the hydraulic motor at maximum output by operating all elementary motors simultaneously. In that example, the point at which the inherent control logic of the controller ascertains cam angle for connecting a given cylinder to pump high pressure can be considered a "decision point", in the sense of the patent, namely where it is determined which cylinder undergoes an active or idle cycle, cf. paragraph 0065 of the patent.

As a result of its control logic controller 34 in document E1' transmits elementary commands to the distribution valves 32 to set the respective drive modes of the elementary motors, see paragraph 0031. Where all elementary motors are operated in drive mode, see paragraph 0035 of E1', there will necessarily be a "decision point" for each cylinder. This setting of drive modes implies individual commands for each distribution valve 32 for each cylinder of each elementary motor on each cycle of cylinder volume as described above in paragraph 3.3.2. These elementary commands are a result of the logic control scheme of the electronic computer controller 34, which therefore must be considered decisions within the meaning of feature "n".

3.6 Hence, the board considers the subject-matter of claim 1 of the Main Request to lack novelty over the disclosure of document E1', Article 54 EPC.

4. *Auxiliary Request*

4.1 The notice of opposition, first paragraph, expressly requested revocation of claims 1-5, 8, 9, 11, 15-17, 19 and 20. This request was repeated at the start of oral proceedings before the opposition division (minutes, point 2, second paragraph) and again upon appeal (statement of grounds, 1st page). The board sees herein an *express* statement that the patent is opposed and the decision is appealed only in as far as the claims mentioned are concerned, thus defining the extent of opposition according to Rule 76(2)(c), respectively the extent to which decision is to be amended according to Rule 99(2) EPC. Consequently, and in accordance with the principle of *ne ultra petita* the board sees itself limited to examining the patent only for the claims opposed.

4.2 The Auxiliary Request is directed at the subject-matter of unopposed granted claims 6, 7, 10, 12 to 14 and 18, in the form of independent claims 1 to 7 combining the features of respective ones of these claims with granted claim 1. As it is thus directed at the subject-matters not opposed, and the board has no power to examine such subject-matter, the patent must be maintained in this limited form.

5. In conclusion, the board holds that the subject-matter of claim 1 of the Main Request lacks novelty over the disclosure of document E1', Article 54 EPC. Further, the board does not have the power to examine patentability of the Auxiliary Request. Therefore, the patent can be maintained in an amended form on the basis of the Auxiliary Request pursuant to Article 101(3)(a) EPC, provided that the description is adapted to the amended claims.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the opposition division with the order to maintain the patent with the following claims and a description to be adapted thereto :

Claims: No. 1-7 of the Auxiliary Request filed with letter dated 20 August 2018.

The Registrar:

The Chairman:



G. Magouliotis

A. de Vries

Decision electronically authenticated