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(54) **Method of controlling a pellet mill**

(57) It is the object of the present invention to provide a method of controlling a pellet mill, said pellet mill comprising

- a number of rollers (2,3,4),
- a cylindrical die (1) provided with perforations, said rollers (2,3,4) being mounted inside said cylindrical die (1) for pressing material to be pelletized through said perforations,
- an adjustment mechanism (5,6,7) for adjusting the distance between the rollers (2,3,4) and the die, (1)
- a drive mechanism (M_4) for rotationally driving said die (1) and said rollers (2,3,4), said method of controlling comprising the steps of
- providing a measurement (8,9,10,11,12,13,14) of a parameter ($x, y, z, W_1, W_2, W_3, W_4$), said parameter indicating if an overload of the pellet mill is arising, and
- in case of such indication being detected, reducing the load on the pellet mill by suitable countermeasures.

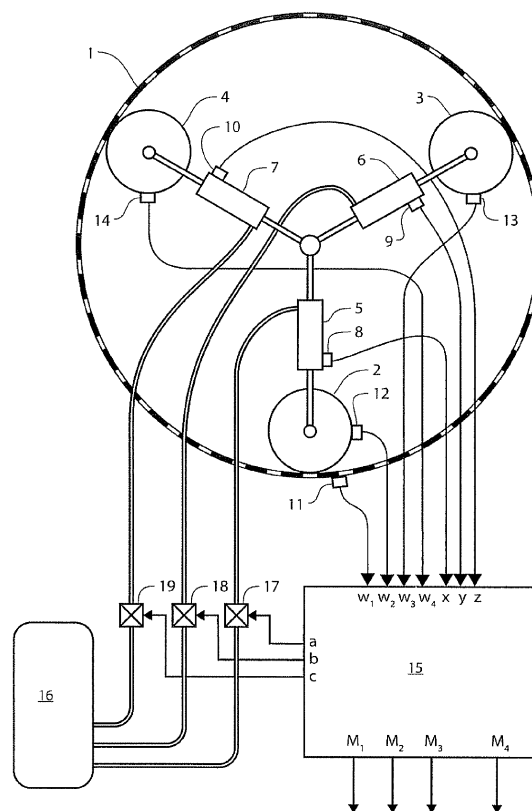


FIG. 1

Description

TECHNICAL FIELD

[0001] The present invention pertains to a method of controlling a pellet mill, said pellet mill comprising a number of rollers mounted inside a cylindrical die for pressing material to be pelletized through perforations provided in said cylindrical die. The pellet mill further comprises one or more adjustment mechanisms for adjusting the distance between the rollers and the die, and a drive mechanism for rotationally driving the die and rollers. Typically, the rollers are driven by the friction between the die, the material to be pelletized and the rollers and the drive mechanism thus merely drives the die.

BACKGROUND OF THE INTENTION

[0002] In order to maximize the output of such a pellet mill, it is normally driven close to maximum load and thus just minor fluctuations may lead to overload of the pellet mill. Typically, such overload is not detected until the safety mechanism, e.g. in the form of a shear pin break, which leads to disengagement of the roller support, whereby the rollers and roller support may rotate with the die, when blocking of the pellet mill has been encountered. Subsequently, it will be necessary to disassemble the pellet mill in order to empty the space between the rollers and the die and insert a new shear pin for the safety mechanism before restarting the pellet mill. Another problem encountered in connection with pellet mills is non-rotating or slow rotating rollers due to possible reduced friction between die, material to be pelletized and roller. Such reduced friction may be due to increased content of water, oil or other variations in the material to be pelletized and result in slip between roller and die, which results in less or no material being pelletized. Naturally, further material feed to the process will result in an overfilled pellet mill and activation of the above-mentioned safety mechanism or similar stopping of the process.

SUMMARY OF THE INVENTION

[0003] It is the object of the present invention to provide an improved method of controlling a pellet mill of the above kind, whereby there can be provided an early warning of an overload of the pellet mill and initiation of suitable corresponding countermeasures for avoiding total stop of the pellet mill in such situations.

[0004] According to the present invention, the above-mentioned and further objects are obtained by the controlling method comprising the steps of providing a measurement of a parameter, said parameter indicating if an overload of the pellet mill is arising and in case of such indication being detected, reducing the load on the pellet mill by suitable countermeasures.

[0005] The parameter measurement can be a meas-

urement of the rotational speed of the die and the rollers, respectively, and subsequent calculation of the slip between the rollers and the die, i.e. the difference between the peripheral speed of the rollers and the die, respectively. Whenever such calculated slip exceeds a predefined limit, this can be taken as an indication of an overload of the pellet mill. In a simplified version, the predefined limit could be such that measurement of the rotational speed of the rollers will be sufficient and non-rotation would be taken as the indication of overload.

[0006] The position of the rollers may be controlled by means of an adjustment mechanism, e.g. in the form of hydraulic piston cylinder units and the position is measured, typically by the physical position of said hydraulic piston cylinder unit. In a preferred method in accordance with the present invention, the position of the rollers is controlled to a predetermined distance between roller and die and the forces available for the adjustment mechanism is limited, in the case of a hydraulic system, by limiting the hydraulic pressure available, whereby the rollers will give way if larger forces are necessary for maintaining the position of the rollers and accordingly, such yield of a roller leading to non-maintenance of the predetermined distance between roller and die, can be taken as an indication of an overload of the pellet mill.

[0007] Furthermore, this yield of a roller will allow part of the material to be pelletized to be transported to the next following roller, where it may be pressed through the die. The limitation of the available forces for the adjustment mechanism also limits the possible unbalance between the rollers and thus the strain on the structural parts of the pellet mill.

[0008] In a preferred embodiment, the forces available for the adjustment are limited to a level equal to the level necessary for keeping the position under normal conditions plus a predefined value, preferably e.g. 10% thereof.

[0009] The suitable countermeasures for reducing the load on the pellet mill may comprise one or more of the following:

i) reducing the supply of material to the pellet mill and/or to a specific roller, for which an indication of overload has been registered.

ii) increasing the distance between the die and the rollers or, if overload is related to a specific roller, between the die and a specific roller, for which an overload has been indicated.

iii) allowing a short overload by short term increasing the hydraulic pressure for one or more rollers

iv) a combination of the above-mentioned

[0010] In a preferred embodiment, the measurements of the positions of the individual rollers are used in a closed loop control for the positions of the rollers. It is furthermore preferred that an individual position control

is performed and in connection with the slip measurement for the individual roller, individual initiation of countermeasures is performed for each of the rollers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] In the following detailed part of the present description, the invention will be explained in more detail with reference to the exemplary embodiments of methods of controlling a pellet mill according to the invention in connection with a pellet mill as shown in the drawings, in which

Fig. 1 schematically shows a pellet mill provided with means for performing measurements and for controlling the pellet mill in accordance with the method in accordance with the present invention, and

Fig. 2 schematically shows drive means for the pellet mill die and for supply of material to the pellet mill.

[0012] The pellet mill shown in Fig 1 is provided with suitable means for measuring relevant parameters for providing a control on the pellet mill. Thus, the figure shows means 8,9,10 for measurement of the individual positions x, y, z of the rollers of the pellet mill 11,12,13,14 and for measuring the rotational speed w_1, w_2, w_3, w_4 of the individual rollers and the die.

[0013] Various possibilities for performing the position measurements could be simple linear position detectors, rotational position detectors or, in case of hydraulic drive for controlling the position of the rollers, hydraulic fluid volume measurement, measuring the amount of hydraulic fluid delivered to the hydraulic cylinders for controlling the position of the rollers.

[0014] The measurement of the rotational speed of rollers and die, respectively, may be performed by means of optical sensors, inductive sensors, etc

[0015] The controller shown in Fig 1 is provided for converting the above-mentioned measurements to commands a, b, c for controlling the valves 17,18,19 controlling the positions x, y, z of the adjustment mechanisms for the roller position, e.g. in the form of double-acting hydraulic cylinder-piston units 5,6,7. Such adjustment mechanisms may furthermore comprise the provision of eccentrically supported axles for the rollers, said eccentrically supported axles being rotated by means of the adjustment mechanism connected thereto. Furthermore, the controller is able to control the drive motor M_4 for the die, the individual material supply motors M_1, M_2, M_3 supplying material for the individual rollers, if present, and possibly, again if present, drive motors for the individual rollers (not shown)

[0016] In Fig 1 it is schematically indicated that a hydraulic supply 16 is provided. The hydraulic supply 16 is preferably provided with a maximum pressure restriction, whereby the maximum force available for keeping the rollers in a desired position has been limited. Corre-

sponding limitation of the maximum force can naturally also be provided in connection with other types of adjustment drive mechanisms, such as electrical drive mechanisms,

[0017] By the provision of this maximum available force, a position measurement of the rollers can indicate an overload of the individual roller by the adjustment system not being able to keep the desired position

[0018] Figure 2 shows the motor M_4 for driving the die 1 and a number of motors M_1, M_2, M_3 for supply of material to the pellet mill. Preferably, individual motors for supply of material to individual rollers of the pellet mill are provided, in order to be able to provide individual control of supply of material and individual initiation of countermeasures in accordance with the present invention.

[0019] The motor control for driving the die may include a frequency converter for adjustable rotational speed of the die. This provides the possibility of adjusting the set point for the rotational speed of the die, in order to offer the possibility of maximizing the output of the pellet mill.

[0020] In connection with the above drawings, some preferred features of the present invention have been illustrated; however, it should be emphasized that not all of the above features need to be employed in order to implement the present invention, which is solely to be restricted by the appended claims. Thus, it is possible to implement the present invention with only one or preferably at least two rollers and also more than three rollers as illustrated may be used. Furthermore, the different measurements may be reduced to fewer measurements than indicated in the appended figures. Also the individual supply of material may be omitted and a common supply for the pellet mill may be used. Preferably this supply can be controlled in a suitable manner in accordance with the present invention.

Claims

1. Method of controlling a pellet mill, said pellet mill comprising

- a number of rollers (2,3,4),
- a cylindrical die (1) provided with perforations, said rollers (2,3,4) being mounted inside said cylindrical die (1) for pressing material to be pelletized through said perforations,
- an adjustment mechanism (5,6,7) for adjusting the distance between the rollers and the die,
- a drive mechanism (M_4) for rotationally driving said die (1) and said rollers (2,3,4), said method of controlling comprising the steps of
- providing a measurement of a parameter ($x, y, z, w_1, w_2, w_3, w_4$), said parameter indicating if an overload of the pellet mill is arising, and
- in case of such indication being detected, reducing the load on the pellet mill by suitable

countermeasures.

2. Method of controlling a pellet mill in accordance with claim 1, wherein the provision of a measurement of said parameter is performed by measuring the rotational speed of each roller W_1, W_2, W_3 , respectively, and

- detecting if a roller is non-rotating and taking this as an indication of an overload of the pellet mill.

3. Method of controlling a pellet mill in accordance with claim 1, wherein the provision of a measurement of said parameter is performed by

- measuring (11,12,13,14) the rotational speed (W_4) of the die and the rollers (w_1, w_2, w_3), respectively,
- calculating the slip between the rollers (2,3,4) and the die (1), when said calculated slip for a specific roller (2,3,4) is larger than a predefined limit, this is taken as an indication of an overload of the pellet mill.

4. Method of controlling a pellet mill in accordance with claim 1, 2 or 3, further comprising

- measuring (8,9,10) the position (x,y,z) of the rollers (2,3,4),
- controlling the position (x,y,z) of the rollers (2,3,4) by means of the adjustment mechanism (5,6,7) to a predetermined distance between the roller (2,3,4) and the die (1)

5. Method of controlling a pellet mill in accordance with claim 1, wherein the providing of a measurement of said parameter is performed by

- measuring (8,9,10) the position (x,y,z) of the rollers,
- controlling the position (x,y,z) of the rollers (2,3,4) by means of the adjustment mechanism (5,6,7) to a predetermined distance between roller (2,3,4) and die (1),
- limiting the available forces for said adjustment mechanism (5,6,7), whereby the rollers (2,3,4) will give way (yield) if larger forces are necessary for maintaining the position (x,y,z) of the rollers,

if the position (x,y,z) of a roller (2,3,4) cannot be maintained, this is taken as an indication of an overload of the pellet mill.

6. Method of controlling a pellet mill in accordance with claim 5, wherein the limitation of the available forces for the adjustment mechanism (5,6,7) is performed by using a hydraulic piston cylinder adjustment

mechanism (5,6,7) for the rollers (2,3,4) and limiting the available hydraulic pressure for controlling the position (x,y,z) of the rollers (2,3,4).

7. Method of controlling a pellet mill in accordance with claim 5 or 6, wherein the limited available forces for said adjustment mechanism (5,6,7) is set to a level equal to the level necessary for keeping the position (x,y,z) under normal conditions plus a predefined value, preferably e.g. 10% thereof

8. Method of controlling a pellet mill in accordance with any of the claim 2-7, wherein the suitable countermeasures comprises

- reducing the supply (M_1, M_2, M_3) of material to the pellet mill and/or to a specific roller (2,3,4), for which an indication of overload has been registered.

9. Method of controlling a pellet mill in accordance with claim 2, 3 or 4, wherein the suitable countermeasures comprises increasing the distance between the rollers (2,3,4) and the die (1) and/or increasing the distance between a specific roller (2,3,4) and the die (1), the specific roller being the one for which an overload has been indicated

10. Method of controlling a pellet mill in accordance with any of the preceding claims, wherein measurements (8,9,10) of the position (x,y,z) of the individual rollers (2,3,4) are used in closed loop control of the positions (x,y,z) of the rollers (2,3,4).

11. Method of controlling a pellet mill in accordance with any of the preceding claims, wherein an individual position control (5,6,7) and, if present, slip measurement is performed for the individual rollers (2,3,4) and individual initiation of countermeasures are performed for each roller (2,3,4).

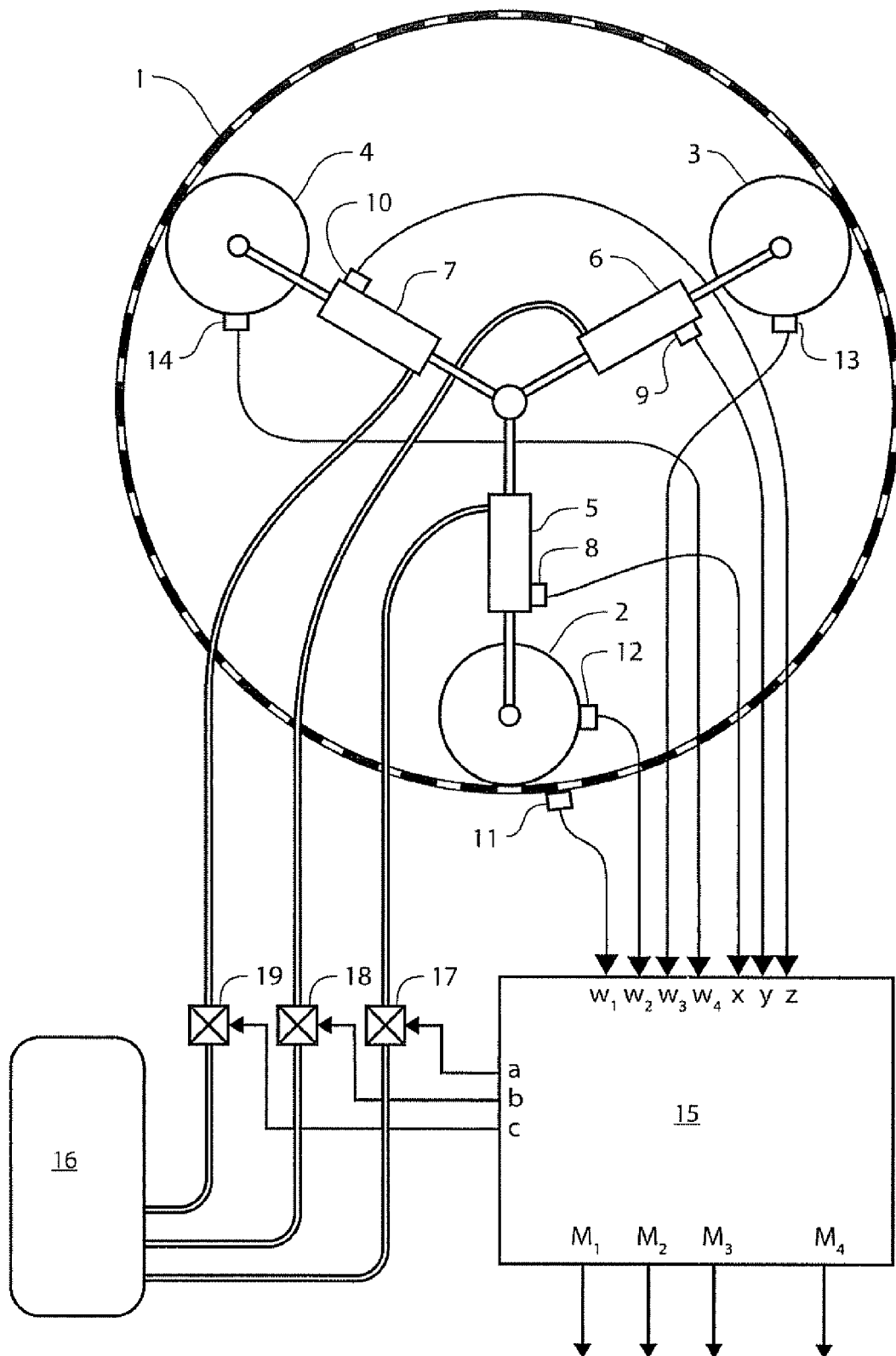


FIG. 1

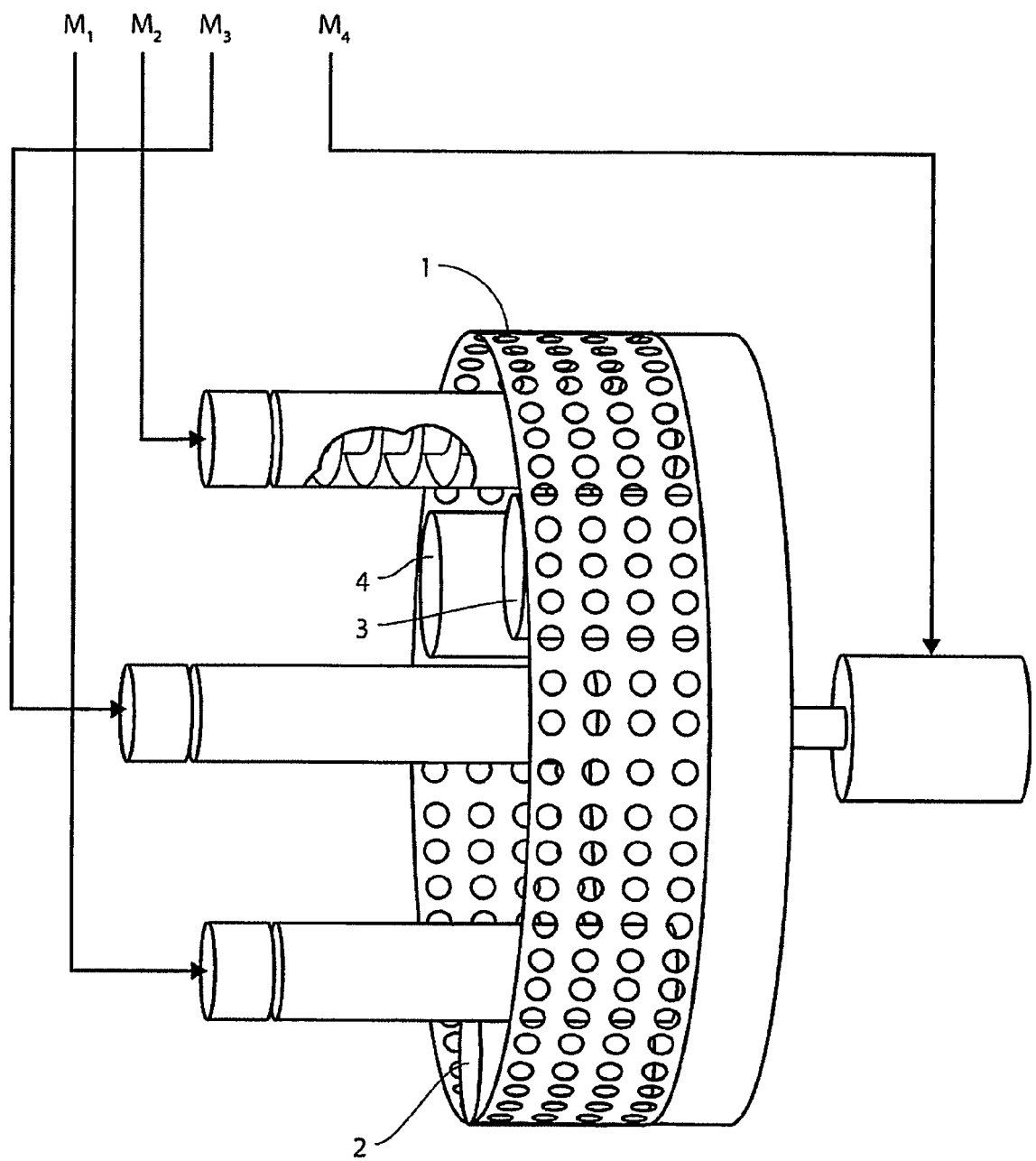


Fig.2



EUROPEAN SEARCH REPORT

Application Number
EP 11 16 4249

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Place of search The Hague		Date of completion of the search 30 September 2011	Examiner Bélibel, Chérif
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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