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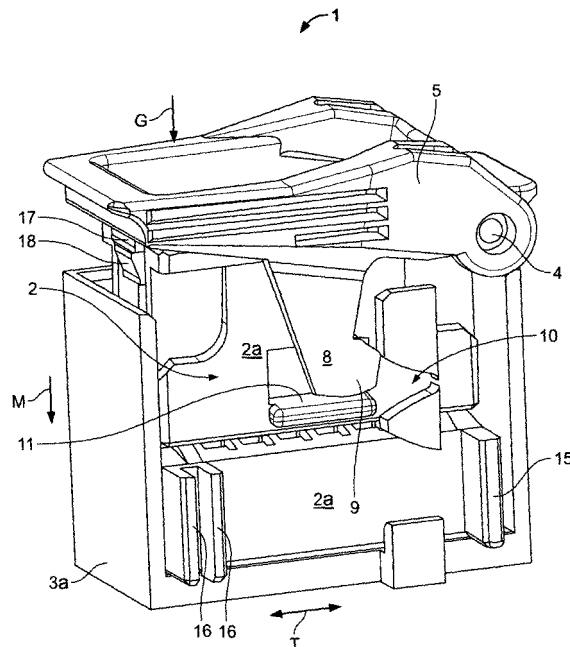
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(54) **Connector with self holding locking device**

(57) The invention relates to a connector (2) comprising at least one pivot (4) and at least one lever (5) configured to rotate on a pivot axis (P) in the locking direction (K) into a mating position. The invention relates further to a connector assembly (1) comprising a connector (2) and a counter connector (3). According to the invention the safety of a connection built up by a connector according to the invention is improved by a lever (5) which has a locking face (9a) pointing substantially against the mating direction (M), the normal vector (N) of the locking face (9a) passing the pivot axis (P) on the locking face side (L) of the lever (5) or by a lever (5) which is configured to transmit a holding force (E) from the connector to the counter connector (3) which is pointing substantially against the mating direction (M), the force vector (E') of the holding force (E) passing the pivot axis (P) on the lever side.



**Fig. 4**

## Description

**[0001]** The invention relates to a connector configured to be connected to a counter connector in a mating direction, comprising at least one pivot and at least one lever configured to rotate on a pivot axis substantially in a locking direction into a locking position. Further, the invention relates to a connector assembly comprising a connector, at least one pivot disposed on the connector, a lever configured to rotate on a pivot axis substantially in a locking direction into a locking position, a counter connector adapted to be matingly connected to the connector in the mating direction, the connector at the locking position of the lever engaging with the counter connector.

**[0002]** Connectors are used, for example, in many electronic, optic and fluid systems to connect wiring or conductor harnesses, which may consist by way of example of optical fiber cables, fluid conductors and/or electric cables. In recent years in particular electronic and optical systems have grown more complex and therefore increased the need for connectors including a plurality of terminals or poles.

**[0003]** A connector of the above-mentioned type is described for example in WO 2007/117533 A1 and in WO 2006/124127 A1. The shown electrical connectors comprise a lever which is connected pivotably to the housing of the connector. The lever rotates within a range from a pre-engagement position to a final engagement position and has a recess configured to fit a protrusion arranged on a mating connector. Further, the lever includes a locking portion disposed on a beam thereof, having a latching detent to engage with an engaging portion of the housing in the engagement position of the lever.

**[0004]** US 6,648,667 B2 discloses a device for securing a first electrical connector mounted to an electronic module to a second electrical connector supported by a support structure. The first electrical connector has a latch having a first and configured to engage the support structure and a lever portion to support a force on a first electrical connector. This force allows the first electrical connector to be urged towards the second electrical connector. The connector is provided with a catch configured to secure the latch when the connectors are mated.

**[0005]** US 2006/0270257 A1 discloses a locking lever for a connector, each of the end parts of the lever having a cam track. The locking lever can be pivoted into a position, in which one open end of each of the cam tracks can be positioned at a catch of the second plug part and a locking position in which each of the catches can be positioned in a locking portion of the cam track. A groove extends along an end portion along the cam track to allow for an elastic deformation, so that the catch can penetrate into the locking portion. The elastic portion of the cam track comprises a recess for receiving the catch of the second plug part, serving for locking the lever.

**[0006]** US 6,942,504 B2 and US 6,755,674 B2 also describe connector assemblies having a lever with a cam track. To lock the lever in a locking position, the shown

levers are provided with resilient locking piece which engage with the housing of the connector.

**[0007]** Another connector assembly having a lever with cam grooves, but without a locking device for securing the lever, is shown in US 6,422,881 B1.

**[0008]** Also the connector assembly described in US 5,344,194 has a lever with cam grooves and a locking portion which is attached to the connector having the lever. In contrast to the connector assemblies shown in US 6,942,504 B2 and US 6,755,674 B2 the cam grooves of US 5,344,194 extend linearly.

**[0009]** US 6,354,164 B1, US 6,368,125 B1, US 6,854,992 B2 and US 7,255,580 B2 show connectors with levers which are provided with pinion gears that engage a pinion gear in the receiving portion of a counter connector. The lever serves for rotating the pinion gear between a retain position at which the connector and the counter connector are next to each other and a release position at which the connector can be unmated.

**[0010]** A problem which arises in known connectors is that connectors can be released accidentally by external forces acting on the connector. An external force can be exerted onto the connector, for example, through the housing or conductors connected to the connector.

**[0011]** This problem is solved in accordance with the invention, for the connector mentioned at the outset, in that the lever has at least one locking face, said locking face pointing substantially against the mating direction, the normal vector of the locking face passing the pivot axis on the locking face side of the lever.

**[0012]** An advantage of the solution is that external forces acting on the connector or wires connected to the connector, in particular forces which are directed at least partly against a mating direction of the connector, result in a closing force which holds the lever at the locking position or mating position, preventing the lever from pivoting into a release position. External forces acting on the connector are, at the locking position of the lever, transmitted through the locking face from the connector to a counter connector.

**[0013]** The position of the locking face side of the lever may depend on the mating direction or the guidance of the connector in relation to the counter connector. The locking face side may be defined in relation to a plane, said plane comprising the pivot axis and extending in mating direction.

**[0014]** Due to the rotational degree of freedom of the lever, the resulting force affecting the locking face points to the pivot axis. Therefore, the resulting force can be divided up into two orthogonal forces: A holding force which has the direction of the normal vector of the locking face, and a closing force which points to a direction parallel or tangential to the locking face, said closing force pushing the lever in the direction of the locking position.

**[0015]** With regard to the connector assembly mentioned at the outset, the above problem is solved in accordance with the invention in that said lever is configured to transmit at the locking position a holding force from

the connector to the counter connector, said holding force pointing substantially against the mating direction, the force vector of the holding force passing the pivot axis on the lever side.

**[0016]** The holding force can be transmitted, for example, by inclined or rounded surfaces. An advantage of the solution is that a traction or pulling force exerted onto the connector assembly is divided up into a holding force and a closing force, the closing force urging the lever into the mating direction to the locking position, ensuring the connection between the connector and the counter connector.

**[0017]** The solution according to the invention may be combined in any way with the following further advantageous embodiments respectively and further improved.

**[0018]** In a further advantageous embodiment the lever can have a locking face, the locking face disposed to face a counter locking face at the locking position of the lever, the counter locking face arranged at the counter connector and pointing substantially in the mating direction, the normal vector of the counter locking face passing the pivot axis on the locking face side of the lever. At least, when external forces act on the connector assembly the locking face and the counter locking face abut each other and transmit the external forces from the connector to the counter connector. Thus, the holding force is realized by mating the locking face with the counter locking face, whereas the direction of the holding force corresponds to the normal vector of the counter locking face.

**[0019]** In another advantageous embodiment, the lever may have a stop, said stop disposed to transmit at a release position of the lever an unmating force to the housing of the connector, said unmating force directed substantially against the mating direction. The stop allows for using the lever as grip for pulling at the connector to unmate the connection. At the locking position of the lever, by pulling at the lever in a direction pointing against the mating direction the lever can be moved into the release position and serves as handle for disassembling the connection between the connector and the counter connector. Thus, the connector can be unlocked and removed in one step by holding at the lever.

**[0020]** According to a further advantageous embodiment of the connector the lever can have at least one projection extending substantially in the mating direction and in the direction of the pivot, the locking face arranged at the projection. The projection can extend into the housing of the counter connector, assuring the holding function of the locking face by disposing the locking face inaccessible from outside of the counter connector. Hence, the contact between the locking face and a counter locking face can not be interfered by objects arranged next to the connector.

**[0021]** To further increase the safety of the connection between connector and counter connector the lever can comprise a locking portion and the connector can be provided with an engaging portion, the locking portion adapt-

ed to engage with the engaging portion at the locking position of the lever. This exemplary embodiment enables locking the lever at the locking position.

**[0022]** According to a further embodiment of the invention the lever can have a release position, the locking portion, at the release position of the lever, disposed to rest on the engaging portion. The locking portion serves as stop and the lever is held at its release position until the locking portion of the lever and/or the engaging portion of the connector is engaged with the engaging portion or the locking portion. In a further exemplary embodiment the engaging portion and the locking portion can form a snap on connection, the locking portion disposed to rest on the engaging portion until the locking portion and/or the engaging portion is elastically deflected by the user to build up an engagement. An advantage of these embodiments is that the release position of the lever is clearly defined thereby connecting and disconnecting of the connector is facilitated. In addition, supporting the lever at its release position allows for connecting the connector by pushing onto the lever and using the lever as handle for mounting the connector respectively.

**[0023]** To allow for a symmetrical arrangement of the lever on the connector the lever can comprise an aperture or a window for receiving conductors or wires connected to the connector. The window can be formed by an upper lever arm and to side arms, the upper lever arm and the side arms surrounding the conductors connected to the first and/or the counter connector. Alternatively, the lever can form a closed frame.

**[0024]** In a further advantageous embodiment of the invention the lever can be configured to abut an adjacent portion of the connector at the locking position and in a mating direction. An advantage of this embodiment is that the adjacent portion of the connector provides a stop which clearly defines the locking position of the lever. In addition, it is a great advantage that the lever and thereby the locking face cannot be moved in mating direction as soon as the lever has arrived at the locking position. Hence, the stiffness of the connection between connector and counter connector is improved.

**[0025]** To avoid that the connector moves sideways in relation to the counter connector the connector can comprise guiding organs, the guiding organs extending in the mating direction and at least at a mating position of the connector engaging counter guiding organs of the counter connector, said guiding organs guiding the connector to the mating position.

**[0026]** In another advantageous embodiment the locking face and/or the counter locking face can be curved, the centre of the radius of curvature situated offset from the pivot in a direction pointing substantially against the mating direction and on the locking face side of the pivot. A radius of curvature allows for reducing the distance between the locking face and the counter locking face without interfering the rotation of the lever from the release position to the locking position. Further, the radius of curvature of the locking face and/or the counter locking

face can be used to realize a cam mechanism, the cam mechanism supporting the mating of the connector assembly. The lever and or the counter connector can have a cam face, the cam face adapted to exert a force directed to the mating direction while rotating the lever from the release position to the locking position.

**[0027]** To avoid that the locking face interferes with the counter locking face when the lever is moved from the release position to the locking position, the distance between the locking face and the pivot axis at a mated state of the connector assembly can be at least as long as the longest distance between the pivot axis and the counter locking face.

**[0028]** In a further advantageous embodiment the lever can have a positioning face and the counter connector can have a counter positioning face, said positioning face pointing substantially against the mating direction and configured to abut the counter positioning face at the locking position of the lever. This allows for a clearly defined position of the lever in mating direction. The position face and the locking face as well as the counter positioning face and the counter locking face can be arranged wedge-shaped so that the position of the lever is centered between counter locking face and counter positioning face. By inclining the positioning face in opposite direction of the locking face the mating of the positioning face and counter positioning face supports the contact between locking face and counter locking face.

**[0029]** To increase the holding force between locking face and counter locking face, the locking face can be disposed to come into interference with the counter locking face. The lever can be elastically deformed to position the locking face on the counter locking face so that a resilient force from the lever presses the locking face onto the counter locking face.

**[0030]** In another advantageous embodiment of the invention the locking face or the counter locking face can comprise a cam track and the counter connector or the lever can be provided with a cam pin, said cam pin adapted to slide on the cam track while pivoting the lever. The cam track can be adapted to realize complex courses of movement of the connectors and provide a double sided guidance of the lever.

**[0031]** To facilitate mounting of the lever on the connector, the lever can have at least one central hinge portion, said central hinge portion comprising an elastically expandable recess, the recess adapted to receive at least a portion of the pivot. At least the portions of the hinge portion situated at the opening of the recess can be elastically deflectable to allow for widening the opening to insert the pivot into the recess. The recess can be configured to encompass the pivot to prevent the pivot from leaving the recess. The central hinge portion according to the invention allows for a fast and/or an automatic mounting process.

**[0032]** To increase the safety against a loss of the lever, the lever may have at least one hinge arm, said hinge arm being elastically deflectable substantially in the di-

rection of the pivot axis and having an opening, the opening adapted to receive an end portion of the pivot. Preferably, the lever has two hinge arms, each hinge arm connected pivotally to one end of the pivot.

**[0033]** The invention will be described hereinafter in greater detail and in an exemplary manner using advantageous embodiments and with reference to the drawings. The described embodiments are only possible configurations in which, however, the individual features as described above can be provided independently of one another or can be omitted in the drawings:

Fig. 1 is a schematic cross-sectional view of a exemplary embodiment of the invention;

Fig. 2 is a further cross-sectional view of the exemplary embodiment of the invention;

Fig. 3 shows in greater detail the section III of the cross-sectional view of Fig. 1;

Fig. 4 is a perspective schematic view of the exemplary embodiment with the lever at a release position;

Fig. 5 is a perspective schematic view of the first embodiment of the invention with the lever in a pre-engagement position;

Fig. 6 is a schematic perspective view of the first embodiment of the invention with the lever in a locking position;

Fig. 7 is a schematic top view of the exemplary embodiment of the invention;

Fig. 8 is a cross-sectional view taken along line VIII - VIII of Fig. 7.

Fig. 9 is a cross-sectional view taken along line IX - IX of Fig. 7.

Fig. 10 corresponds to the cross-sectional view taken along line IX - IX of Fig. 7 with the lever in a locking position.

**[0034]** First of all, the connector assembly 1 configured according to the invention will be described with reference to Fig. 1, which shows a cross-sectional view of a first embodiment of the invention.

**[0035]** The connector assembly 1 comprises a connector 2 which is connected to a counter connector 3. The connector 2 has a first housing 2a which is received by a second housing 3a of the counter connector 3. The first housing 2 or socket housing 2 is provided with a pivot 4 and a lever 5 connected to the pivot 4 and configured to rotate on the pivot 4. The lever 5 has at both of its ends, each end pointing to a transversal direction T, protrusions 6, 7 which serve as grips 6, 7 for pulling or push-

ing the lever.

**[0036]** The lever 5 comprises a projection 8, which extends in a mating direction M and, at its end pointing to the mating direction M, is provided with a protrusion 9. The protrusion 9 extends in a transversal direction T and perpendicular to the mating direction M into a recess 10 of the second housing 3. The protrusion 9 has a locking face 9a which points substantially against the mating direction M and slanted to the mating direction M.

**[0037]** The connector 2 is moved into the counter connector 3, up to the shown mating position of the connectors 2, 3. The lever 5 is situated in a locking position at which the first housing 2 is engaged with the second housing 3. In this locking position of the lever 5 the locking face 9a of the protrusion 9 abuts a counter locking face 10a of the recess 10. While the locking face 9a is formed planar the counter locking face 10a is provided with a curvature. The curvature is defined by a radius R. The centre C of the radius R is positioned next to the pivot 4, offset from a pivot axis E. The counter locking face 10a and the locking face 9a abut at a boundary line B which extends in the direction of the planar projection of Fig. 1.

**[0038]** Opposite to the locking face 9a the protrusion 9 is provided with a positioning face 9b. The positioning face 9b extends slanted to the locking face 9a and, as the locking face 9a, substantially perpendicular to the mating direction M. As the locking face 9a and the positioning face 9b form a wedge-shaped portion of the protrusion 9. The recess 10 has a counter positioning face 10b which, in the shown second position of the lever 5, abuts the positioning face 9b of the protrusion 9. The counter positioning face 9b, which has the same radius of curvature as the counter locking face 10a, forms together with the counter locking face 10a a wedge shaped reception for the protrusion 9.

**[0039]** The connector 2 comprises a guiding means which extends perpendicular to the mating direction M and guides the projection 8 and the protrusion 9 within the housing 2a while the lever 5 is pivoted. The guiding means 11 avoids a relation of the protrusion on its ray into the recess 10. The guiding means 11 is arranged at an inner surface 12 of the housing and extends in a transversal direction T.

**[0040]** The second housing 3a is provided with counter guiding organs 13, 14 formed as guiding recesses 13, 14. The counter guiding organs 13, 14 serve for receiving guiding organs 15, 16 which are formed as guiding protrusions 15, 16. The guiding protrusions 15, 16 are arranged at the housing 2a of the connector 2. The guiding recesses 13, 14 have openings 13a, 14a pointing against the mating direction M for inserting the guiding protrusions 15, 16 of the connector 2 into the guiding recesses 13, 14 of the counter connector 3. To facilitate the insertion of the guiding protrusion 15 into the guiding recess 14 and of the guiding protrusions 16 into the guiding recess 13 the edges of the openings 13a, 14a are chamfered.

**[0041]** Fig. 2 shows the connector assembly with the

lever 5 situated at the release position.

**[0042]** The lever 5 is provided with a locking portion which, at the release position of the lever 5, rests on an engaging portion 18 of the connector 2. At the release position of the lever 5, the engaging portion 18 serves as stop 18 for the lever 5 to transmit a mating force G. The mating force G, which is exerted onto the lever 5, is directed to the mating direction M to the housing 2a of the connector 2. At the shown release position of the lever 5 the lever 5 and its projection 8 and/or its protrusion 9 do not interfere with the counter connector 3, so that the connector 2 can be moved freely in mating direction M into the counter connector 3, up to the mating position of the connector 2, at which the connector 2 and the counter connector 3 are connected to each other and at which the lever 5 can be rotated on the pivot 4 in a locking direction K, up to the locking position.

**[0043]** Figure 3 shows an enlarged cross-sectional view of detail III of Fig. 1.

**[0044]** The counter locking face 10a is provided with a radius of curvature R. The radius R is a little bit smaller than the distance between the locking face 9a and the pivot axis P. The centre C of the radius R is arranged offset from the pivot axis P, and has in a transversal direction T a distance X from the pivot axis P.

**[0045]** A movement of the connector 2 against the mating direction M at the locking position of the lever 5 may result from friction forces which are accidentally or unintentionally exerted on the wires (not shown) connected to the connector 2. If the connector 2 is moved upwards against the mating direction M, the locking face 9a of the lever 5 abuts the counter locking face 10a of the counter connector 3 at a touch point A. Irrespective of the direction of an external force exerted on the connector 2 or the counter connector 3, the connector 2 can at the mating position, due to the guiding protrusions 15, 16 and guiding recesses 13, 14 shown in Fig. 1, only move against the mating direction M. Components of pulling forces which are extending substantially transversally to the mating direction M are compensated by reaction forces or guiding forces acting on the connector 2 from the counter connector 3 through the side walls of the guiding recesses 13, 14. For this reason, only a component of a pulling force which is directed against the mating direction M can move the connector 2 against the mating direction M. A movement of the connector 2 in a transversal direction T is therefore not possible.

**[0046]** Due to the connection to the pivot 4 the lever has a rotating degree of freedom allowing the lever 5 for rotating on the pivot axis P. Therefore, an external force which acts on the connector 2 and which is directed against the mating direction M results in a bearing force D. The bearing force D is transmitted by the lever 5 at the touch point A from the locking face 9a to the counter locking face 10a. As the centre C of the radius of a curvature R of the counter locking face 10a is arranged on the locking face side L of the lever 5. The position of the locking face side L of the lever may depend on the mating

direction M or the guidance of the connector 2 in relation to the counter connector 3. While mating the connector 2 to the counter connector 3, the connector 2 can be guided by guiding protrusions 15, 16, as shown in fig. 1, or by contact pins 27, as shown in fig. 9 and 10. Thus, the mating direction M may be the guiding direction or the extension direction of the guiding protrusions 15, 16. The locking face side L may be defined in relation to a plane, said plane comprising the pivot axis P and extending in mating direction M.

**[0047]** The resulting bearing force D can be divided up into two orthogonal forces: A holding force E which has the direction of the normal vector E' of the locking face, and a closing force F which points to a direction parallel or tangential to the locking face, said closing force F pushing the lever 5 in the direction M to the locking position. Thus, the closing force F induces a closing torque, the closing torque pushing the lever 5 into the locking direction K.

**[0048]** The arrangement of the pivot axis P in relation to the contact tangent or the orientation of the locking face 9a at the touch point A determines the intensity and the direction of the closing force F or the intensity of the closing torque. The normal defined by the normal vector E' preferably passes the pivot axis P on the locking face side L of the lever 5.

**[0049]** The closing force F equals the bearing force D minus the holding force E. By increasing the distance X between the pivot axis P and the centre of curvature C in a transversal direction T, the closing force F can be enlarged. If the distance between the pivot axis and the centre of curvature C in a transversal direction T is zero there will be no closing force F.

**[0050]** Fig. 4 shows a schematic perspective view of a connector assembly according to the invention.

**[0051]** The lever 5 is situated in a release position. At the release position of the lever 5 the locking portion 17 of the lever 5 rests on the engaging portion 18 of the connector 2. Thereby the lever 5 does not rotate if a mating force G directed to the mating direction M which acts on the lever 5. Thus, the lever 5 may serve as enlargement of the surface of the connector 2 to facilitate inserting the connector 2 to the counter connector 3.

**[0052]** At the release position of the lever 5 the protrusion 9 is situated outside the recess 10 and the locking face 9a does not face the counter-locking face 10a, so that the connector 2 can move freely in a mating direction M into the counter connector 3 or against the mating direction M out of the counter connector 3. By pulling at the locking portion 17 of the lever 5 the lever can be elastically deflected to allow for moving the locking portion 17 over the engagement portion 18 to a pre-engagement position of the lever 5.

**[0053]** Figure 5 shows the connector assembly of Fig. 4 with the lever 5 in a pre-engagement position.

**[0054]** At the pre-engagement position the lever 5 the locking portion 17 abuts a face of the engagement portion 18 pointing to a transversal direction T. At the pre-en-

gagement position, the lever 5 can rotate freely in or against the mating direction M. At least a portion of the protrusion 9 of the lever 5 is positioned within the recess 10. Hence, at the pre-engagement position of the lever 5, an external force acting on the connector 2 against the mating direction M generates a contact between the locking face 9a and the counter locking face 10a, resulting in a closing force F which turns the protrusion 9 in a transversal direction T and the lever 5 into the mating direction M.

**[0055]** In Figure 6 the lever 5 of the connector assembly 1 is situated in a locking position or mating position. At the locking position of the lever 5 the locking portion 17 engages the engaging portion 18 of the housing of the connector 2 and thereby ensures the locking position of the lever 5. At the locking position the protrusion 9 is received by the recess 10. The locking face 9a faces the counter locking face 10a and the positioning face 9b faces the counter positioning face 10b.

**[0056]** While positioning the locking face 9a at the counter locking face 10a avoids disconnecting of the connector assembly by accident, arranging the positioning face 9b at the counter positioning face 10b stabilizes the lever 5 at the locking position. Together with the counter locking face 10a, the counter positioning face 10b forms a wedge-shaped recess 10 for receiving the also wedge-shaped protrusion 9. Due to the wedge-shape of the recess 10 the protrusion 9 is centered between the counter locking face 10a and the counter positioning face 10b.

**[0057]** Fig. 7 shows a schematic top view of the connector assembly 1. The lever 5 is provided with elastically flexible hinge arms 19, 20 with openings 19a, 20a for receiving protrusions 4a which are arranged at both ends of the pivot 4. The edge at the end of the protrusion 4a is rounded to facilitate mounting the lever 5 on the pivot 4. Between the hinge arms 19 and 20 the lever 5 is provided with a central hinge portion 21 which builds together with the pivot 4 a snap-on connection for connecting the lever 5 by the pivot 4 to the housing 2a of the connector 2. The central hinge portion 21 of the lever 5 has a slot like opening for receiving the pivot 4 so that the central hinge portion 21 encompasses the middle portion of the pivot 4. Thus, the central hinge portion 21 forms a half shell snap on connection.

**[0058]** Alternatively, to reduce the manufacturing costs, the lever 5 can be mounted to the connector 2 only by a half shell snap on connection, as a half shell snap on connection will serve the purpose to carry the appearing bearing reactions.

**[0059]** For mounting the lever 5 onto the pivot 4 the opening of the central portion can be pressed onto the pivot. The hinge arms 19, 20 are deflected side ways to position them on the protrusions 4a of the pivot 4. In a mounted state of lever 5 the central hinge portion 21 forms a pivotable connection of the lever 5 to the housing 2a. The connection of the lever 5 to the pivot 4 through the hinge arms 19, 20 is a second pivotable connection of the lever 5. Hence, the lever 5 is connected to the pivot

4 by two redundant pivotable connections, both assuring that swivel axis of the lever 5 corresponds to the position of the pivot axis P.

**[0060]** The lever 5 comprises an aperture 22 or window 22 to let pass the wires of conductors connected to the connector 2. The housing 2a of the connector 2 has on its top side a plurality of terminal slots 23. The plurality of terminal slots 23 are linked to a plurality of terminal slots on the bottom side through passage ways within the housing 2a (not shown).

**[0061]** At its end pointing away from the pivot 4 the lever is provided with the locking portion 17 configured to abut the engaging portion 18 of the housing 2a in mating direction M, allowing the fingers of the user to exert a mating force onto the connector 2 through the top surface of the lever 5.

**[0062]** Figure 8 is cross-sectional view of the connector assembly taken along line VIII-VIII of the Fig. 7. The lever 5 is molded in one step together with the connector 2 and mounted to the connector 2 while opening the molding tool by an in-mold-assembly. The lever 5 may be deformed elastically for mounting it to the connector 2. After mounting the lever 5 it can not be removed or lost. The lever 5 includes at both sides of the window 22 webs 24 to reinforce the lever 5 or the window frame surrounding the window 22. At the inner side of the window 22 the lever 5 is provided with stops 25 which are formed as shoulders 25. The shoulders 25 are configured to engage with engaging surfaces 26 of the housing 2a when the user pulls at the lever 5. A unmating force G directed against the mating direction M exerted onto the lever, in particular at the grip 7 of the lever 5 is transmitted through the shoulders 25 onto the engaging surfaces 26 and thereby, in the release position of the lever 5, can move the connector 2 against the mating direction M out of the counter connector 3.

**[0063]** The projections 8 extend on the both sides of the lever 5 in the mating direction M into the housing 3a of the counter connector 3. At the shown release position of the lever 5 the projections 8 are positioned above the guiding means 11. The ends of the projections are tapering in mating direction M to facilitate passing the guiding means 11.

**[0064]** Fig. 9 shows a cross-sectional view of the connector assembly taken along line IX-IX of Fig. 7.

**[0065]** The housing 3a of the counter connector 3 includes a plurality of contact pins 27 which are received by the terminal slots 23 of the connector 2 to build up an electrical connection between wires or electrical conductors connected to the connector 2 and electrical connectors connected to the counter connector 3.

**[0066]** The lever 5 is positioned at the release position. Thus, the locking portion 17 rests on the engaging portion 18. The engaging portion 18 includes a support surface 18a configured to abut at the release position a stop surface 17a of the locking portion 17. A front portion of the engaging portion 18 has a shape tapering in mating direction M to produce a interference force with the locking

portion 17. A recess 17b is formed in a top section of the locking portion 17, adapted to receive at least a part of the engaging portion 18. The engaging portion 18 includes a recess 18b configured to receive an insertion portion 17c of the locking portion 17.

**[0067]** The central hinge portion 21 comprises a slot-like recess 21a for receiving the middle portion of the pivot 4. The recess 21 a is elastically expandable and adapted to receive at least a portion of the pivot 4. At least the portions of the hinge portion 21 situated at the opening of the recess 21 a are configured elastically deflectable, to allow for widening the opening to insert the pivot 4 into the recess 21a. The recess 21a is configured to encompass the pivot 4 to prevent the pivot from leaving the recess 21 a. The central hinge portion 21 according to the invention facilitates the mounting of the lever 5 and thereby allows for a fast and/or an automatic mounting process.

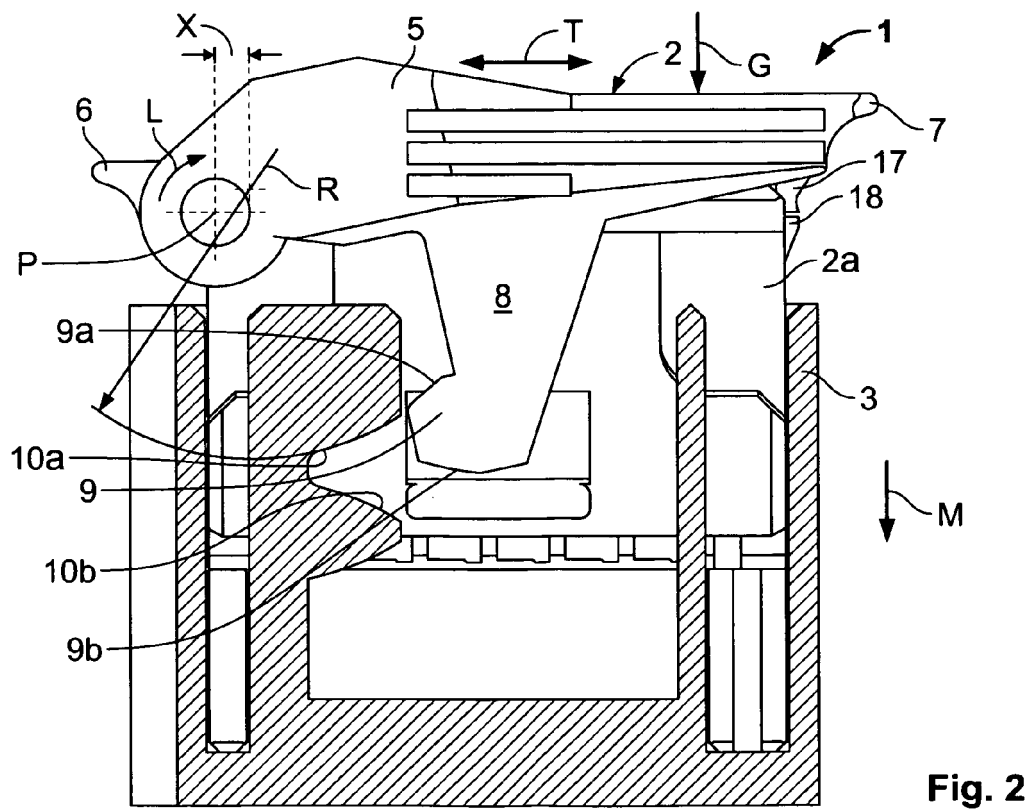
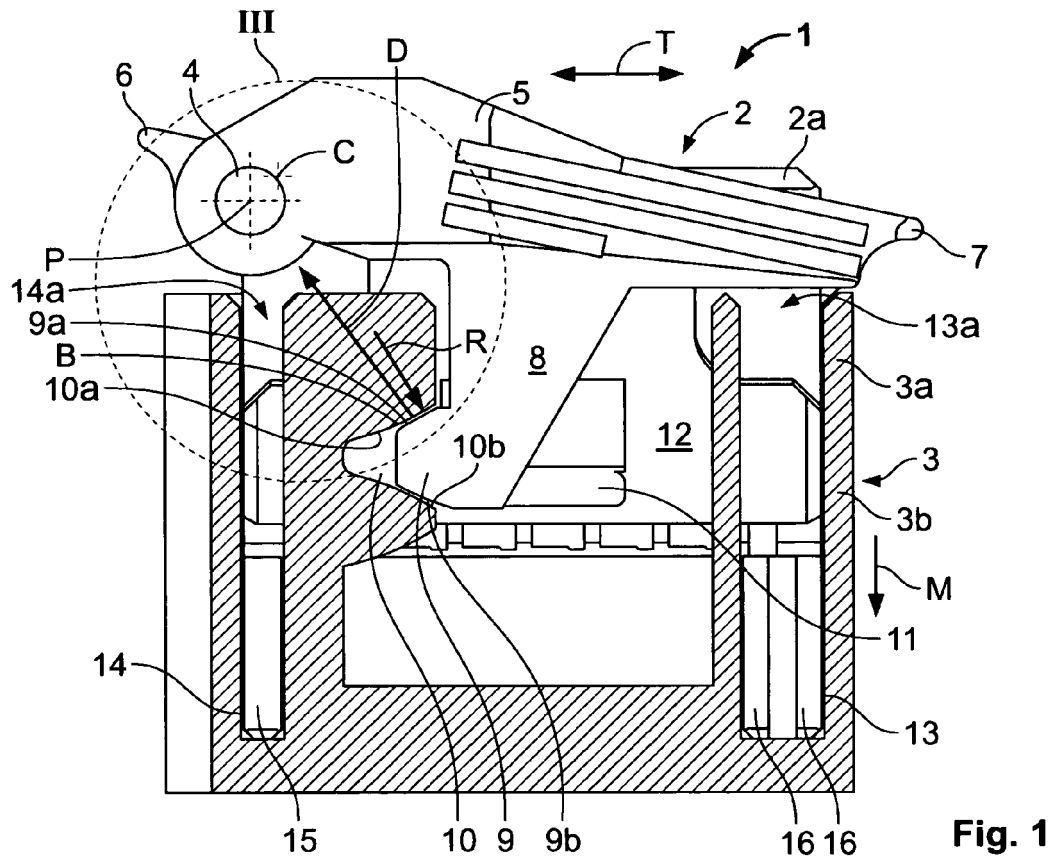
**[0068]** Figure 10 shows a cross-sectional view of the connector assembly according to Fig. 7 taken along by IX-IX of Fig. 7 at a locking position of the lever. At this position the insertion portion 17c of the locking portion 17 is inserted into the recess 18b of the engaging portion 18. A support surface 17d of the locking portion 17 rests on a support surface 28 of the housing 3a. The insertion portion 17c of the locking portion 17 is arranged within the recess 18b. As the recess 18b is closed by the housing wall 3b of the counter connector 3 the insertion portion 17c can not interfere with objects outside the housing 3b.

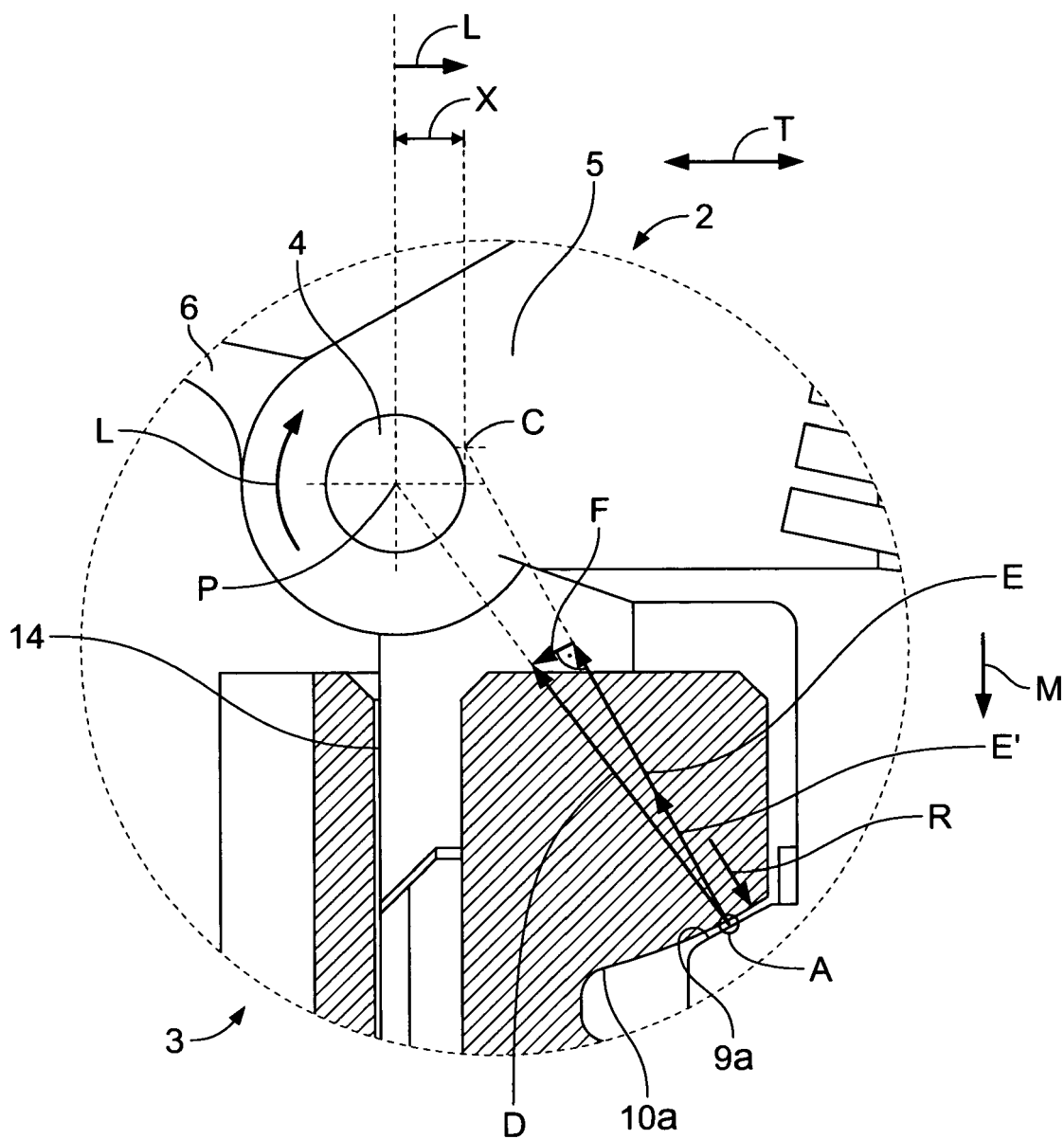
## Claims

1. Connector (2) configured to be connected to a counter connector (3) in a mating direction (M), comprising at least one pivot (4) and at least one lever (5) configured to rotate on a pivot axis (P) substantially in a locking direction (K) into a locking position, **characterized in that** the lever (5) has at least one locking face (9a), said locking face (9a) pointing substantially against the mating direction (M), the normal vector (N) of the locking face (9a) passing the pivot axis (P) on the locking face side (L) of the lever (5).
2. Connector assembly (1) comprising:
  - a connector (2),
  - at least one pivot (4) disposed on the connector (2),
  - at least one lever (5) configured to rotate on a pivot axis (P) substantially in a locking direction (K) into a locking position,
  - a counter connector (3) adapted to be matingly connected to the connector (2) in a mating direction (M), the connector (2) at the locking position of the lever (5) engaging with the counter connector (3),

- characterized in that** said lever (5) is configured to transmit at the locking position a holding force (E) from the connector to the counter connector (3), said holding force (E) pointing substantially against the mating direction (M), the force vector (E') of the holding force (E) passing the pivot axis (P) on the lever side.
3. Connector (2) according to one claim 1 or 2, **characterized in that** said lever (5) has a locking face (9a), said locking face (9a) disposed to face a counter locking face (10a) at the mating position of the of the lever (5), the counter locking face (10a) arranged at the counter connector (3) and pointing substantially in the mating direction (M), the normal vector (N) of the counter locking face (10a) passing the pivot axis (P) on the locking face side (L) of the lever (5).
  4. Connector assembly (1) according to one of the claims 1 to 3, **characterized in that** the connector (2) comprises guiding organs (15, 16), the guiding organs (15, 16) extending in the mating direction (M) and at least at the mating position engaging counter guiding organs (13, 14) of the counter connector (3).
  5. Connector assembly (1) according to one of the claims 1 to 4, **characterized in that** the locking face (9a) and/or the counter locking face (10a) is curved, the centre (C) of the radius of curvature (R) situated offset from the pivot (4) in a direction pointing substantially against the mating direction (M) and on the locking face side (L) of the pivot.
  6. Connector assembly (1) according to one of the claims 1 to 5, **characterized in that** at a mated state of the connector assembly (1) the distance between the locking face (9a) and the pivot axis (P) is at least as long as the longest distance between the pivot axis (P) and the counter locking face (10a).
  7. Connector (2) according to one of the claims 1 to 6, **characterized in that** the lever (5) has at least one stop (25), said stop (25) disposed to transmit at a release position of the lever an unmating force (H) to the housing (2a) of the connector (2), said unmating force (H) directed substantially against the mating direction (M).
  8. Connector (2) according to one of the claims 1 to 7, **characterized in that** said lever (5) has at least one projection (8) extending substantially in the mating direction (M), the locking face (9a) arranged at the projection (8).
  9. Connector (2) according to one of the claims 1 to 8, **characterized in that** the lever (5) comprises a locking portion (17) and the connector (2) has an engaging portion (18), the locking portion (17) adapted to engage with the engaging portion (18) at the locking position of the lever (5).
  10. Connector (2) according to one of the claims 1 to 9, **characterized in that** the lever (5) has a release position, the locking portion (17) disposed to rest on the engaging portion (18) at the release position of the lever (5).
  11. Connector (2) according to one of the claims 1 to 10, **characterized in that** the lever (5) has a pre-engagement position, the locking portion (17) configured to interfere with the engaging portion (18) in the pre-engagement position, the engaging portion (18) and/or the locking portion being elastically deflected.
  12. Connector (2) according to one of the claims 1 to 11, **characterized in that** said lever (5) is configured to abut an adjacent portion of the connector (2) at the locking position in a mating direction (M).
  13. Connector (2) according to one of the claims 1 to 12, **characterized in that** the lever (5) has a positioning face (9b) and the counter connector (3) has a counter positioning face (10b), said positioning face (9b) pointing substantially against the mating direction (M) and configured to abut the counter positioning face (10b) at the locking position of the lever (5).
  14. Connector (2) according to one of the claims 1 to 13, **characterized in that** the lever (5) has at least one central hinge portion (21), said central hinge portion (21) comprising an elastically expandable recess (21 a), the recess (21 a) adapted to receive at least a portion of the pivot (4).
  15. Connector (2) according to one of the claims 1 to 14, **characterized in that** the lever (5) has at least one hinge arm (19), said hinge arm (19) being elastically deflectable substantially in the direction of the pivot axis (P) and having an opening (19a), the opening adapted to receive an end portion (4a) of the pivot (4).







**Fig. 3**

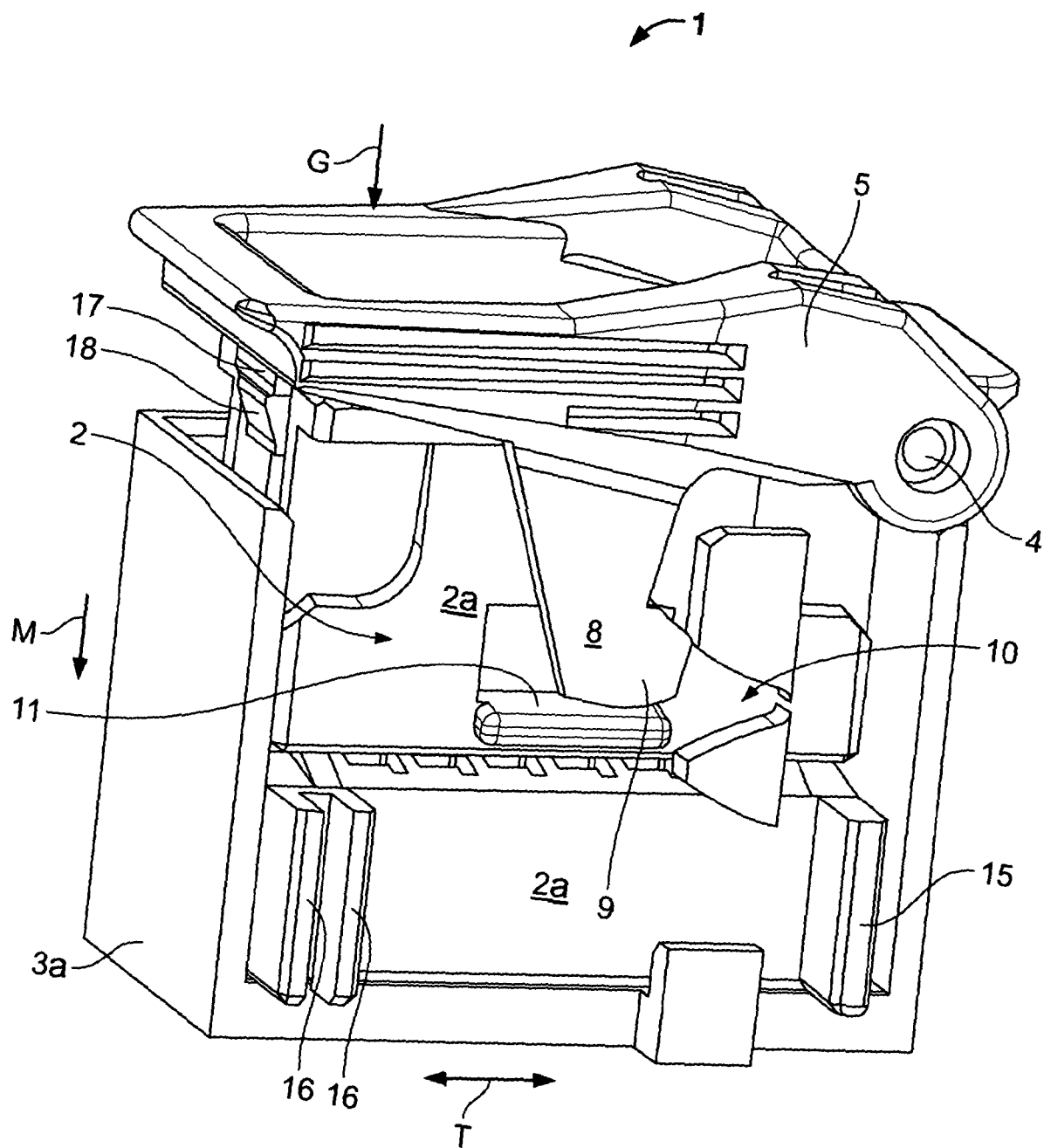
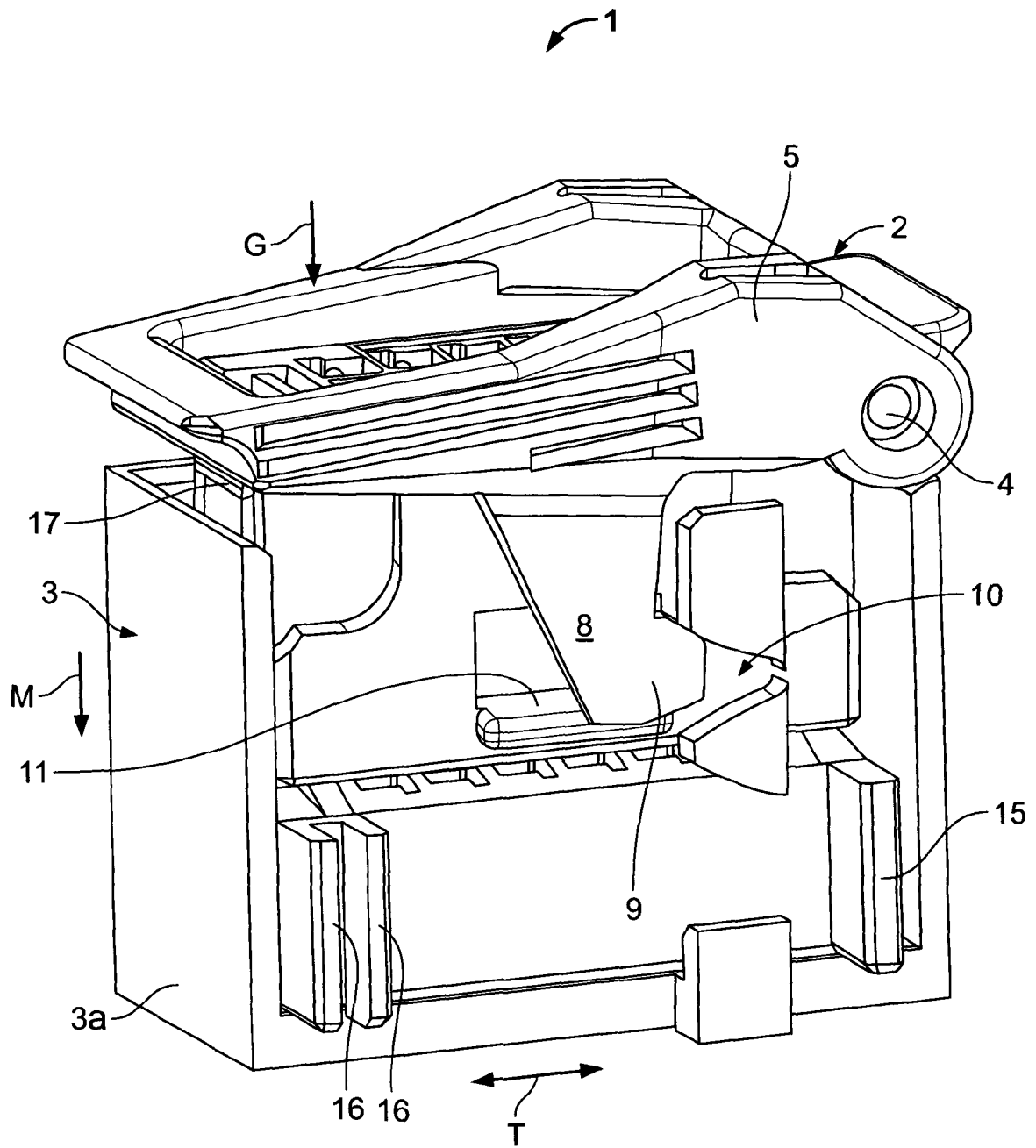


Fig. 4



**Fig. 5**

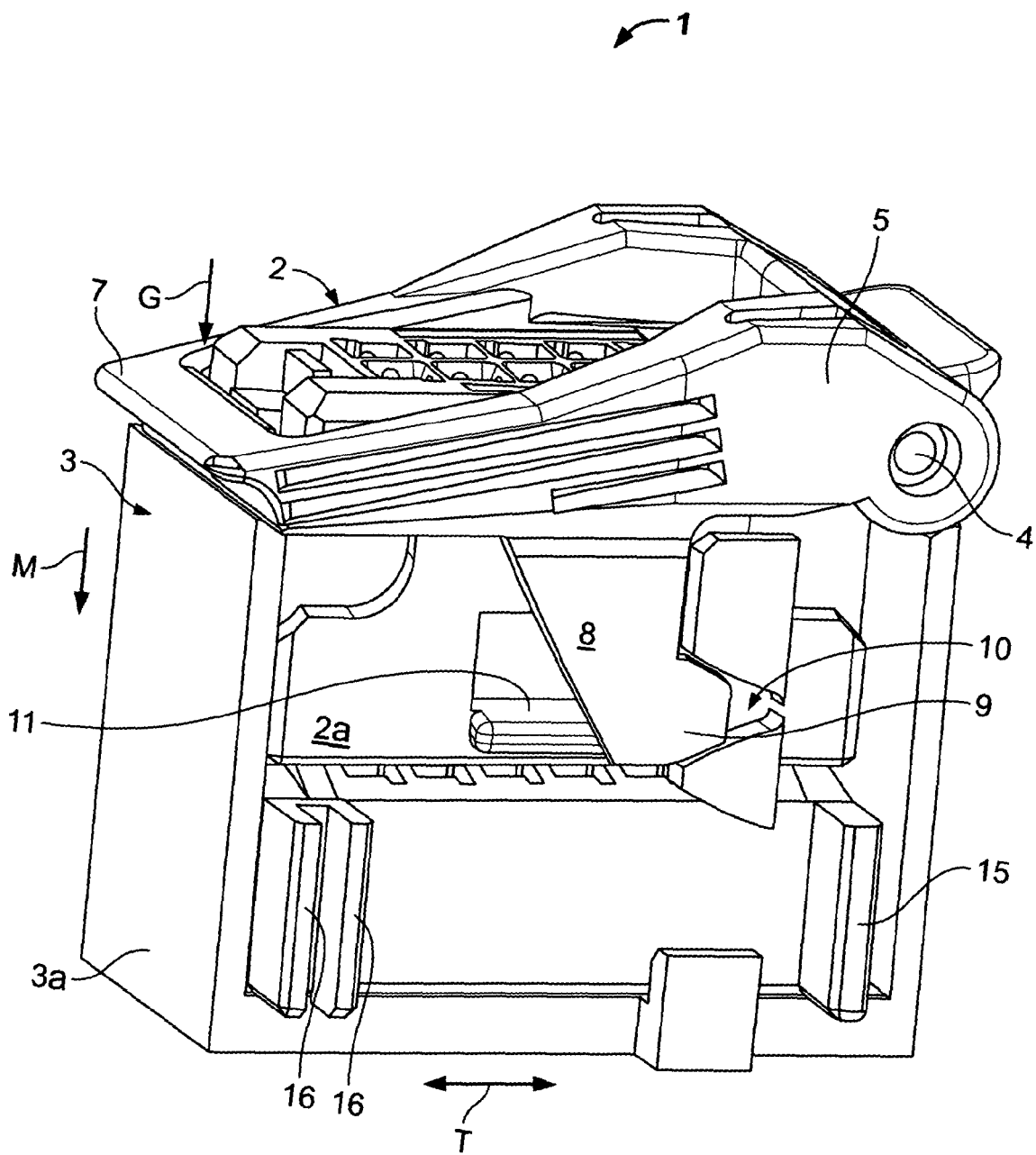


Fig. 6

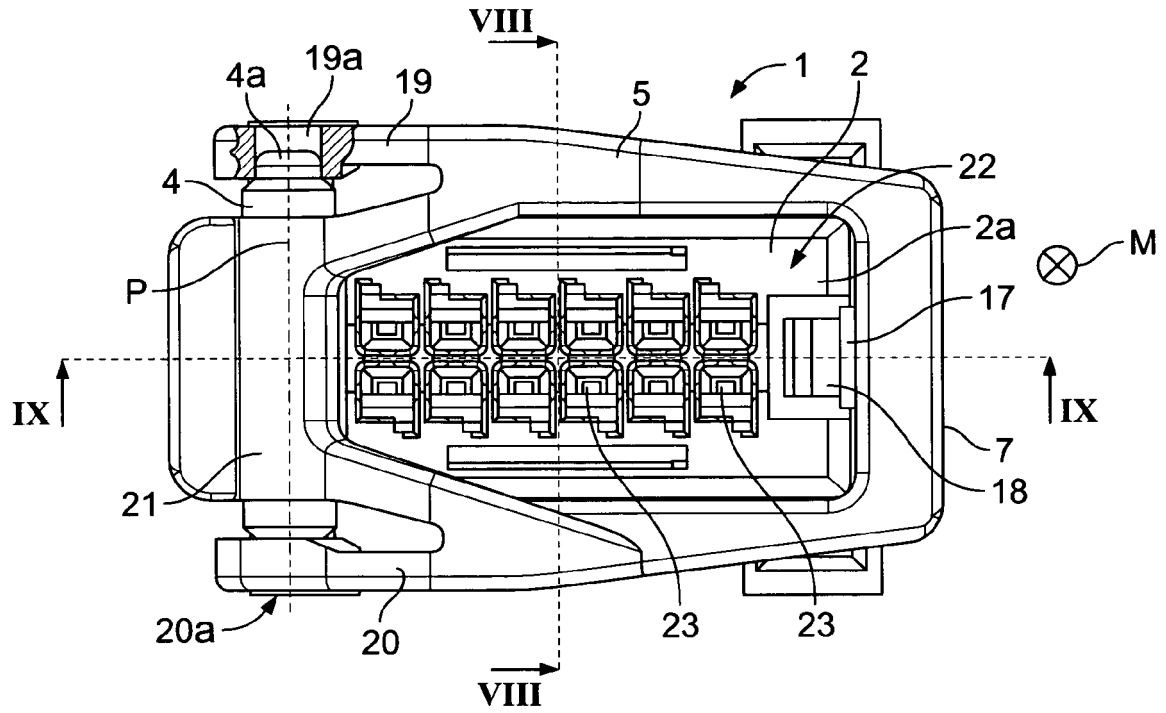


Fig. 7

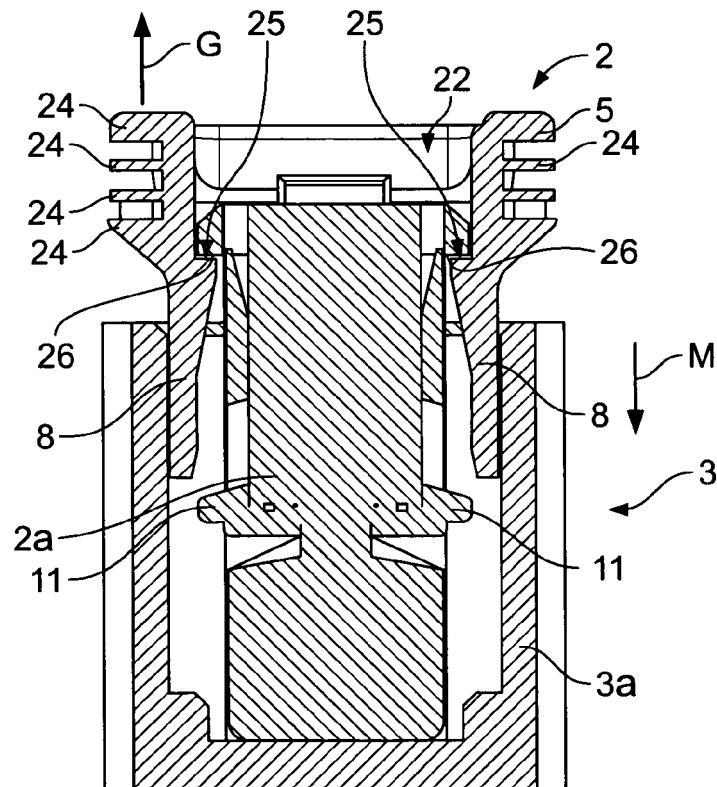


Fig. 8

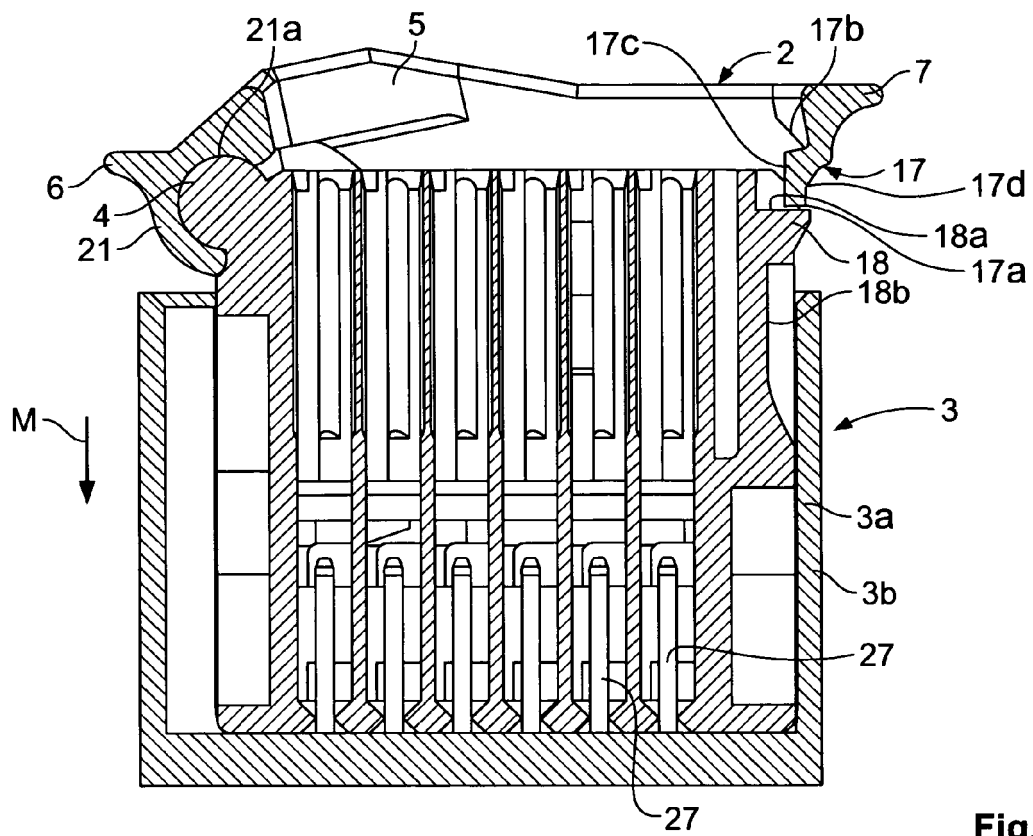


Fig. 9

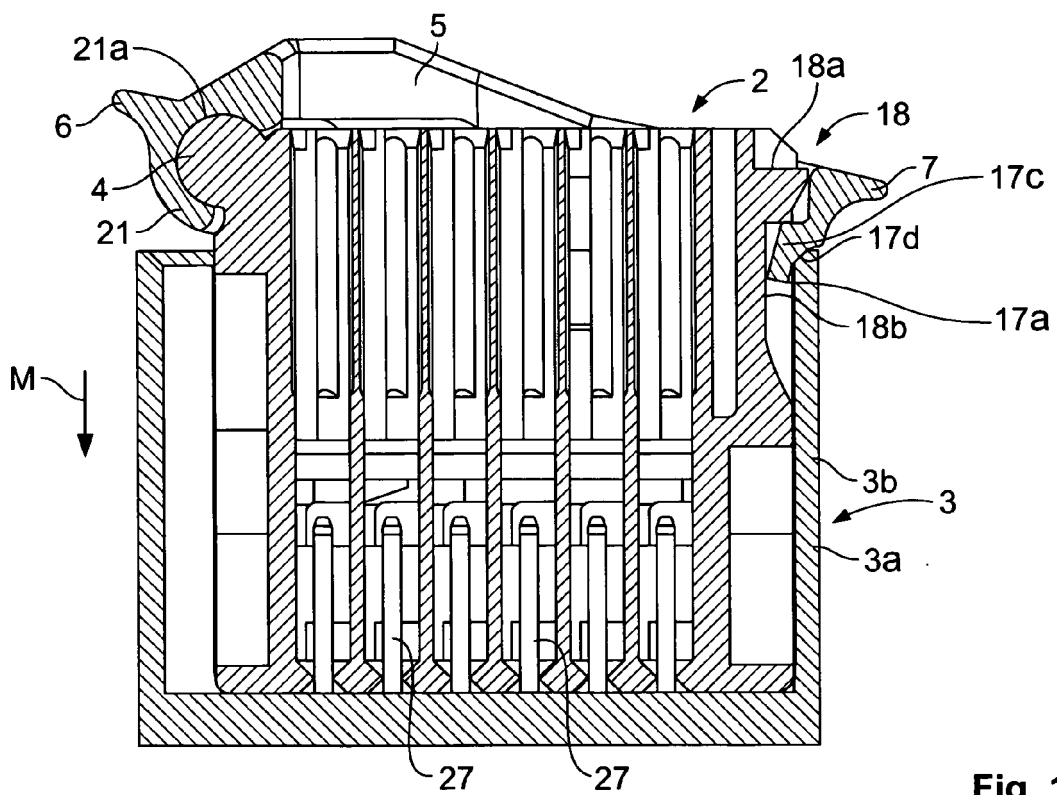


Fig. 10



## EUROPEAN SEARCH REPORT

Application Number  
EP 08 01 8555

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                             |                                                   |                                         |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Citation of document with indication, where appropriate, of relevant passages                                               | Relevant to claim                                 | CLASSIFICATION OF THE APPLICATION (IPC) |
| X,D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | US 7 090 518 B1 (OSADA TSUYOSHI [US] ET AL) 15 August 2006 (2006-08-15)<br>* the whole document *                           | 1,3,4,<br>8-13,15                                 | INV.<br>H01R13/629<br>H01R13/639        |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | DE 195 28 074 A1 (AMP GMBH [DE])<br>6 February 1997 (1997-02-06)<br>* column 3, lines 47-65 *<br>* figures 2a-2d *<br>----- | 2,4-6,13                                          |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                   | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                             |                                                   | H01R                                    |
| <p>2 <del>The present search report has been drawn up for all claims</del></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                             |                                                   |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                             | Date of completion of the search<br>25 March 2009 | Examiner<br>Ledoux, Serge               |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>.....<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                             |                                                   |                                         |

EPO FORM 1503 (03.82 (P04C01))





Application Number

EP 08 01 8555

**CLAIMS INCURRING FEES**

The present European patent application comprised at the time of filing claims for which payment was due.

☐ Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due and for those claims for which claims fees have been paid, namely claim(s):

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for those claims for which no payment was due.

**LACK OF UNITY OF INVENTION**

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

☐ All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

☐ As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

☐ Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

☒ None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:

1-6, 8-13, 15

☐ The present supplementary European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims (Rule 164 (1) EPC).



**LACK OF UNITY OF INVENTION**  
**SHEET B**

Application Number

EP 08 01 8555

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1-6, 8-13, 15

a connector or a connector assembly

1.1. claim: 2

connector assembly providing a particular holding force

1.2. claim: 5

a connector assembly with a curved locking and/or counter locking face

1.3. claim: 6

a connector assembly with a particular configuration between the locking face, the counter locking face and the pivot axis

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2. claim: 7

a connector with a stop on the lever

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3. claim: 14

a connector with a lever having a central hinge portion

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Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 08 01 8555

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  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

25-03-2009

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**REFERENCES CITED IN THE DESCRIPTION**

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