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## (54) Method for raising a building

(57) A method for raising a building (1) provided with a number of load-bearing elements (4); a horizontal cut is made through each load-bearing element (4) along a cutting line to define a lower portion and an upper portion of the load bearing element (4) reciprocally separated by the cutting line; making a series of niches (11) immediately underneath the cutting line and through the load-bearing elements (4); at least one thrust device (12) is arranged at each niche; each thrust device is operated so as to apply an upward thrust between the lower portion and the upper portion of the load-bearing element (4) and determine the progressive raising of the upper portion of the load-bearing element (4); at the end of the raising operation, a series of supporting piles (19) is arranged between the lower portion and the upper portion of load-bearing elements (4); and finally the thrust devices (12) are removed.

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## Description

**[0001]** The present invention relates to a method for raising a building.

**[0002]** In the construction sector, the need to raise a building frequently arises. For example, a raising intervention is needed when one wants to elevate a building standing near waterways or near the sea over the level reached by the waters by effect of floods or tides; a typical example of this situation occurs in the City of Venice, where the ground floor of buildings is cyclically subject to flooding by high tides, commonly called 'high-water' events.

**[0003]** Alternatively, a raising intervention is needed when making an underground room under a building when one either cannot or does not want to excavate under the building itself. Another raising operation is required when one wants to increase the working height of a floor so as to the make the floor itself fully accessible.

**[0004]** In order to raise a building resting on the ground it was proposed to form a building foundation structure provided with a plurality of through holes and a plurality of connection elements, each of which is fixed to the foundation structure near a hole; later, a pile is then arranged through each hole, which pile presents a lower end resting on the supporting body and an upper end protruding from the hole. At this point, a thrust device is applied to each pile, which device on one side rests on the upper end of the pile and on the other side is fastened to the corresponding connection element; finally a thrust is applied to each of the piles by means of the thrust devices to raise the building with respect to the supporting body. Once raised, each pile is axially fastened to the foundation structure.

**[0005]** The method for raising a building described above requires the making of a new building foundation structure; however, in some situations, it may not be economically advantageous to make the new foundation structure.

**[0006]** It is the object of the present invention to provide a method for raising a building which is simple and cost effective to make and in particular does not require the making of the new building foundation structure.

**[0007]** According to the present invention, a method for raising a building as recited in the attached claims is provided.

**[0008]** The present invention will now be described with reference to the accompanying drawings illustrating some non-limitative embodiments, in which:

- figures 1-5 are schematic frontal section views of a building which is being raised using the method according to the present invention; and
- figure 6 schematically shows a different embodiment of a raising station in figures 3 and 4.

**[0009]** In figure 1, number 1 indicates as a whole a building, which rests on the ground 2 by means of a foundation structure 3 and which must be raised with respect to the ground 2. Building 1 presents a number of load-bearing walls 4, each of which rests on foundation structure 3 and up to a roof 5 supporting four floors 6. Building 1 also presents non-load-bearing walls, which are not shown in the attached figures.

**[0010]** As shown in figure 2, during a first step, a horizontal cut along a cutting line is made through each load-bearing wall 4 to define a lower portion and an upper portion of the load-bearing wall 4 reciprocally separated by the cutting line itself. Subsequently, an upper edge 7 is made immediately over the cutting and line and through each load-bearing wall 4, which edge is horizontal and concerns either part or all of the extension of the load-bearing wall 4 both in width and in depth. Similarly, a lower edge 7 is made under the cutting line and through each load-bearing wall 4, which edge is horizontal and parallel to the upper edge 7 and concerns either part or all of the extension of the load-bearing wall 4 both in width and in depth.

**[0011]** Each edge 7 or 8 consists of a series of reinforced concrete or steel beams 9, which are inserted in the load-bearing walls 4 and connected together at least along the same load-bearing wall 4. The insertion of a beam 9 within a load-bearing wall 4 envisages the formation through the load-bearing wall 4 itself of a through slot 10 and therefore the arrangement of beam 9 within slot 10. Typically, at least two beams 9 in different instants are inserted for each load-bearing wall 4 and for each edge 7 and 8, so that a through slot 10 never concerns more than half the load-bearing wall 4 itself.

**[0012]** As shown in figure 3, a series of niches 11 is formed after ending the formation of the edges 7 and 8 along all the load-bearing walls 4, between edges 7 and 8, each of which is upperly delimited by edge 7 and lowerly delimited by edge 8. At least one thrust device 12 is arranged within each niche 11, which device on one side rests on lower edge 8 and on the other side is carried supportingly carried by upper edge 7. In other words, each thrust device 12 is arranged within a niche 11 so as to exert a vertical thrust between lower edge 8 and upper edge 7, i.e. between the lower portion and the upper portion of load-bearing wall 4.

**[0013]** Each thrust device 12 is defined by a hydraulic jack, which presents a body 13 and an axially mobile rod 14 with respect to body 13 with an adjustable intensity force; in particular, body 13 rests on lower edge 8 while rod 14 is carried in contact with upper edge 7.

**[0014]** A shown in figure 4, once thrust devices 12 are arranged within niches 10, each thrust device 12 is operated to generate an intensity force determined between its body 13 and its rod 14; the result of the generation of such force is the static application of a vertical thrust of intensity equal to the value of the force itself, between lower edge 8 and upper edge 7, i.e. between the lower portion and the upper portion of load-bearing wall 4, to determine the progressive raising of the upper portion of load-bearing wall 4.

**[0015]** A control unit 15 is connected to thrust devices 12 for transmitting a control signal of the thrust to be applied to each thrust device 12; the control unit 15 is also connected to a series of pressure sensors 16, each of which is associated to a thrust device 12 for measuring the instantaneous pressure value exerted by thrust device 12 itself, and is connected to a series of wide base strain gauges 17 applied to the load-bearing walls of the building 1 and which are adapted to measure the strain induced by the raising of the building 1 itself. By using pressure sensors 16, control unit 15 can control by feedback thrust devices 12 and is adapted to detect the intensity of the thrust exerted by thrust devices 12 instant-by-instant. More in general, several control units 15 can be used (also redundant to prevent a calculation error from causing structural damage to the building 1), each of which controls a group of thrust devices 12.

**[0016]** Once thrust devices 12 are installed in the manner described above, the situation shown in figure 3 is presented; at this point, control unit 15 (automatically or under the supervision of an operator) operates each thrust device 12 entirely independently so as to apply a determined thrust between lower edge 8 and upper edge 7 and so as to raise upper edge 7 (carrying the upper part of load-bearing wall 4) with respect to lower edge 8, i.e. with respect to the lower portion of load-bearing wall 4. The instantaneous thrusts applied by a thrust device 12 are generally different from those applied by the other thrust devices 12 and are calculated instant-by-instant according to the type of raising required for building 1 and according to the signals from strain gauges 17.

**[0017]** According to the raising height to be reached, when a thrust device 12 reaches its maximum extension, supporting piles are arranged around the thrust device 12, the thrust device is compressed and spacers 18 (shown in figure 4) are inserted between thrust device 12 and upper edge 7 and/or lower edge 8; at this point, the raising cycle may resume. Alternatively to spacers 18, other similar solutions may be used, such as, for example, a sand spacing method; in this case, raising devices 12 are of the known type called 'sand jacks'.

**[0018]** As shown in detail in figure 5, once the raising of building 1 is complete, between upper edges 7 and lower edges 8, i.e. between the lower portion and the upper portion of load-bearing walls 4, supporting piles 19 are arranged capable of supporting with the due safety margin building 1 and then thrust devices 12 are removed. Finally, the empty spaces between supporting piles 19 and inside the niches 11 are closed by means of common brickwork.

**[0019]** The function of edges 7 and 8 is to uniformly distribute the thrusts along the entire section of load-bearing walls 4 so as to avoid the concentration of thrusts in limited areas which could locally collapse. It is clear that according to the structural features of building 1, the formation of lower edge 8 and/or upper edge 7 may not be necessary.

**[0020]** According to a different embodiment shown in figure 6, a pair of thrust devices 12 is arranged at each niche 11 outside niche 11 on opposite bands of the niche 11 itself. Furthermore, within each niche 11 is arranged a horizontal thrust I-beam 20 (or other steel element) perpendicular to load-bearing wall 4; the two thrust devices 12 associated to each niche 11 are supportingly carried by upper edge 7 through thrust I-beam 20. It is apparent that in this second embodiment, niches 11 are very small in size, because each niche 11 does not need to contain a thrust device 12 but only needs to allow the passage of thrust I-beam 20. Furthermore, according to this embodiment, the formation of lower edge 8 is practically never required, because thrust devices 12 do not rest on the lower portion of load-bearing wall 4; consolidation or reinforcement of the floor 6 underneath on which trust devices 12 rest may be required instead.

**[0021]** According to a further embodiment (not shown), no niches 11 are made through load-bearing walls 4 and each thrust device 12 rests on a lower floor 6 and is supportingly carried by an upper floor 6; in order to better distribute thrusts on each floor 6, a relatively large steel plate is generally interposed between each thrust device 12 and floor 6. In this case, load-bearing walls 4 are cut immediately underneath upper floor 6 and consolidation of the two concerned floors 6 is generally required; for example, upper floor 6 may be remade by incorporating upper edge 7 itself in the remade floor 6.

**[0022]** According to a different embodiment (not shown), foundation structure 3 may not rest directly on the ground 2 but instead rest on a further foundation structure provided with a high number of piles driven into the ground 2 underneath a waterway or a water basin (e.g. a lagoon); such constructive solution is typical of a building 1 made over water, because the piles of the further foundation structure are fixed into the ground underneath the water level and maintain building 1 over the water level.

**[0023]** It is important to underline that before performing the raising operations described above, static analysis of the building 1 must be performed, so as to ensure that the building 1 itself is capable of withstanding the stress induced by the raising operation; if required, consolidation and strengthening works may be performed on building 1, in particular on load-bearing walls 4, before raising. By the way of example, such consolidation works may envisage the installation of tie-rods between two load-bearing walls 4, the installation of bracing, the installation of cages which enclosure a load-bearing wall 4 or a portion of load-bearing wall 4, or the remaking of a floor 6 incorporating upper edge 7 in the remade floor 6 itself.

**[0024]** It is important to underline that while raising building 1, foundation structure 3 is not subjected to particularly high stress because it must support the weight of the building 1 increased by the weight of edges 7 and 8 and of thrust devices 12; it is important to stress that the weight of building 1 is generally much higher than that of edges 7 and 8 and of thrust devices 12, therefore the presence of edges 7 and 8 and of thrust devices 12 generally does not require consolidation interventions on the foundation structure.

**[0025]** In the embodiments shown in the attached figures, building 1 presents only load-bearing walls 4; according to a different embodiment (not shown), the building 1 may also have other load-bearing elements (typically load-bearing columns) in combination with or instead of load-bearing walls 4.

**[0026]** If building 1 has one or more load-bearing walls 4 in common with other contiguous buildings, it is necessary to detach from the load-bearing wall 4 in common all floors 6 connected to the load-bearing wall 4 so as to allow the raising of the floors 6 with respect to the common load-bearing wall; at the end of the raising operation, the floors 6 must be reconnected to the common load-bearing wall 4. Obviously, before detaching a floor 6 from a common load-bearing wall 4, the floor 6 itself must be appropriately supported by means of a temporary metallic frame next to, but not in contact with, load-bearing wall 4 in common. The method described above may be applied also to particularly large buildings (indicatively with a base larger than 1000 $m^2$), which are divided into parts raised independently one from the other.

## Claims

1. A method for raising a building (1) provided with a number of load-bearing elements (4); the method comprising the steps of:

    making a horizontal cut through each load-bearing element (4) along a cutting line to define a lower portion and an upper portion of the load-bearing element (4) reciprocally separated by the cutting line itself;
    arranging a plurality of thrust devices (12), each of which is adapted to exert a vertical thrust between the lower portion and the upper portion of the load-bearing element (4);
    operating each thrust device (12) so as to apply between the lower portion and the upper portion of load-bearing element (4) an upward thrust and determine the progressive raising of the upper portion of the load-bearing element (4);
    arranging, at the end of the raising operation, a series of supporting piles (19) between the lower portion and the upper portion of load-bearing elements (4); and
    removing the thrust devices (12).

2. A method according to claim 1, and comprising the further steps of:

    making a series of niches (11) immediately underneath the cutting line and through the load-bearing elements (4); and
    arranging at each niche at least one thrust device (12), which is adapted to exert a vertical thrust between the lower portion and the upper portion of the load-bearing element (4).

3. A method according to claim 2, and comprising the further step of making through each load-bearing element (4) an upper horizontal edge (7) at the cutting line; each niche (11) is made immediately underneath the upper edge (7) so that the niche (11) itself is upperly delimited by the upper edge (7); each thrust device (12) is supportingly carried by the upper edge (7).

4. A method according to claim 3, and comprising the further step of making through each load-bearing element (4) a lower edge (8), which is horizontal and parallel to upper edge (7); each niche (11) is made between the lower edge (8) and the upper edge (7) so that the niche itself (11) is upperly delimited by the upper edge (7) and lowerly delimited by the lower edge (8); each thrust device (12) is supported on one side by the lower edge (8) and on the other side is supportingly carried by the upper edge (7).

5. A method according to claim 3 or 4, wherein each edge (7; 8) consists of a series of beams (9), which are inserted within the load-bearing elements (4).

6. A method according to claim 5, wherein at least along one same load-bearing element (4) the beams (9) are connected together.

7. A method according to claim 5 or 6, wherein the insertion of a beam (9) within a load-bearing element (4) envisages the formation through the load-bearing element (4) itself of a through slot (10) and therefore the arrangement of beam (9) within slot (10).

8. A method according to claim 7, wherein for each load-bearing element (4) and for each edge (7; 8) are inserted at least two beams (9) in two different moments, so that a through slot (10) never concerns more than half of the load-bearing element (4) itself.

9. A method according to one of the claims from 5 to 8, wherein the beams (9) are made of reinforced concrete.

10. A method according to one of the claims from 5 to 8, wherein the beams (9) are made of steel.

11. A method according to one of the claims from 2 to 10, wherein each niche (11) accommodates within at least one thrust device (12).

12. A method according to one of the claims from 2 to 10, wherein at least a pair of thrust devices (12) is

arranged at each niche (11) outside niche (11) on opposite bands of the niche (11) itself.

**13.** A method according to claim 12, wherein within each niche (11) is arranged a horizontal thrust element (20) perpendicular to the load-bearing element (4); the two thrust devices (12) associated to each niche (11) are supportingly carried by the upper portion of the load-bearing element (4) by means of thrust device (20).

**14.** A method according to claim 2, wherein each thrust device (12) rests on a lower floor (6) and is supportingly carried by an upper floor (6).

**15.** A method according to claim 14, wherein a steel plate is arranged between each thrust device (12) and each floor (6).

**16.** A method according to claim 14 or 15, wherein the load-bearing elements (4) are immediately cut underneath the upper floor (6).

**17.** A method according to claim 14, 15 or 16 and comprising the further steps of:

making through each load-bearing element (4) an upper horizontal edge (7) at the cutting line; and

remaking the upper floor (6) incorporating the upper edge (7) in the remade floor (6) itself.

**18.** A method according to one of the claims from 1 to 17, wherein each thrust device (12) is defined by a hydraulic jack, which presents a body (13) and a rod (14) axially mobile with respect to the body (13) with an adjustable intensity force.

**19.** A method according to one of the claims from 1 to 18, wherein the raising is controlled by at least one control unit (15), which is adapted to drive the thrust devices (12) and is connected to a number of strain gauges (17) fixed to the building (1).

**20.** A method according to claim 19, wherein the control unit (15) is connected to sensors (16) fitted on thrust devices (12) to detect instant-by-instant the intensity of the thrusts exerted by the thrust devices themselves (12).

**21.** A method according to claim 20, wherein the control unit (15) is adapted to control the thrust devices (12) in feedback.

**22.** A method according to claim 21, wherein the instantaneous thrusts applied to each thrust device (12) are generally different from those applied by other thrust devices (12) and are calculated instant-by-instant according to the type of raising required for the building (1) and on the basis of the signals from the strain gauges (17).

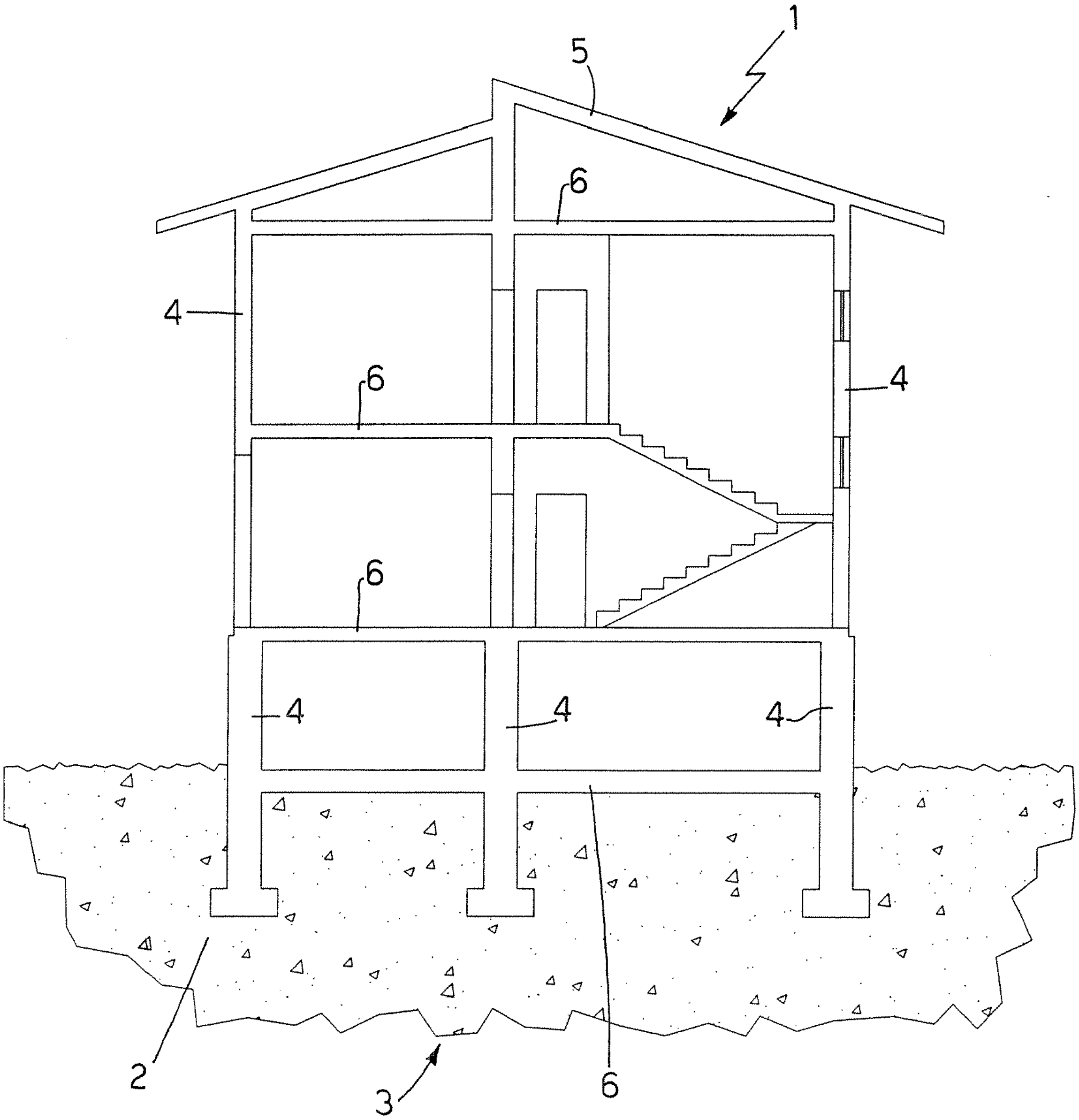


Fig.1

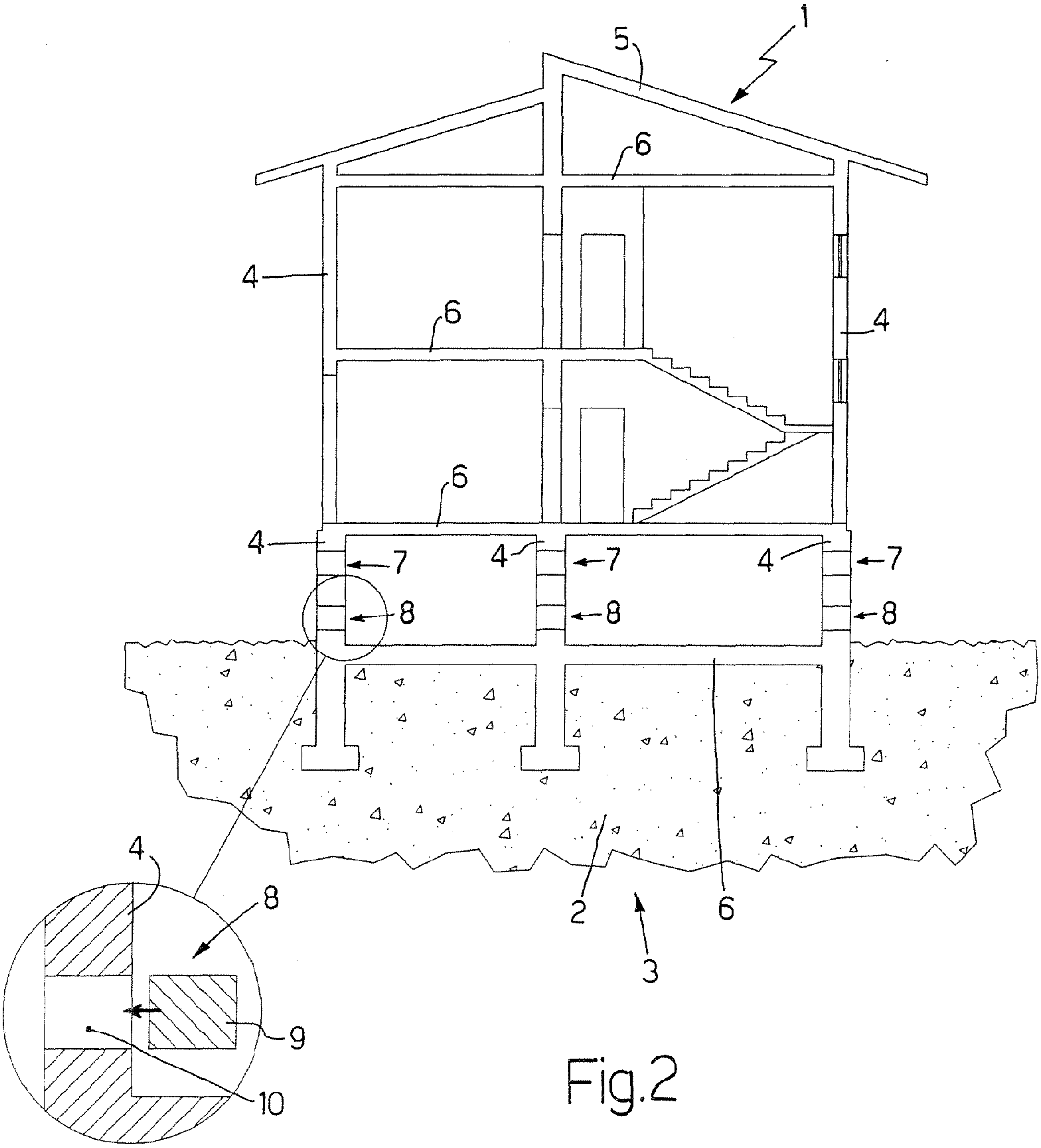


Fig.2

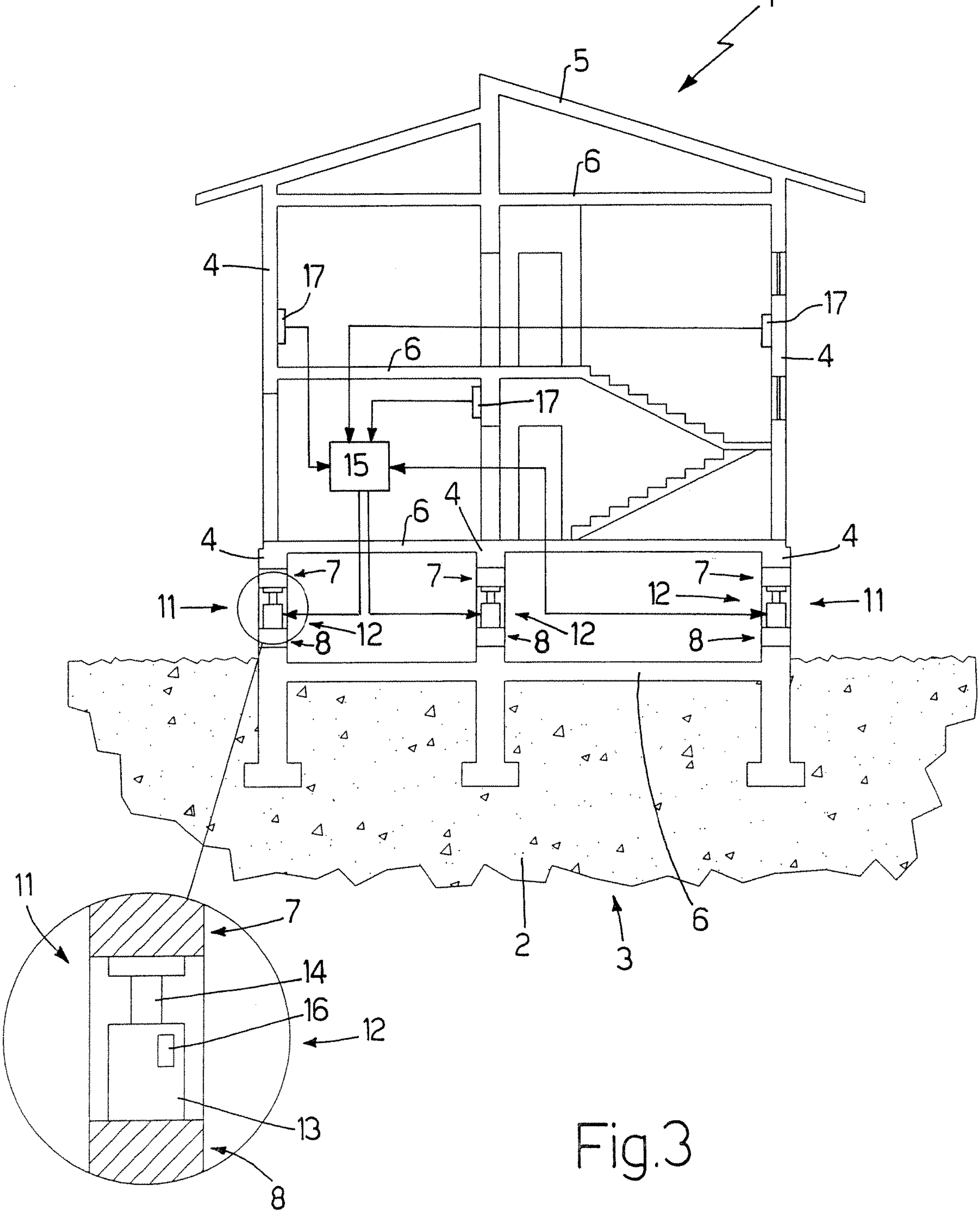
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Fig.3

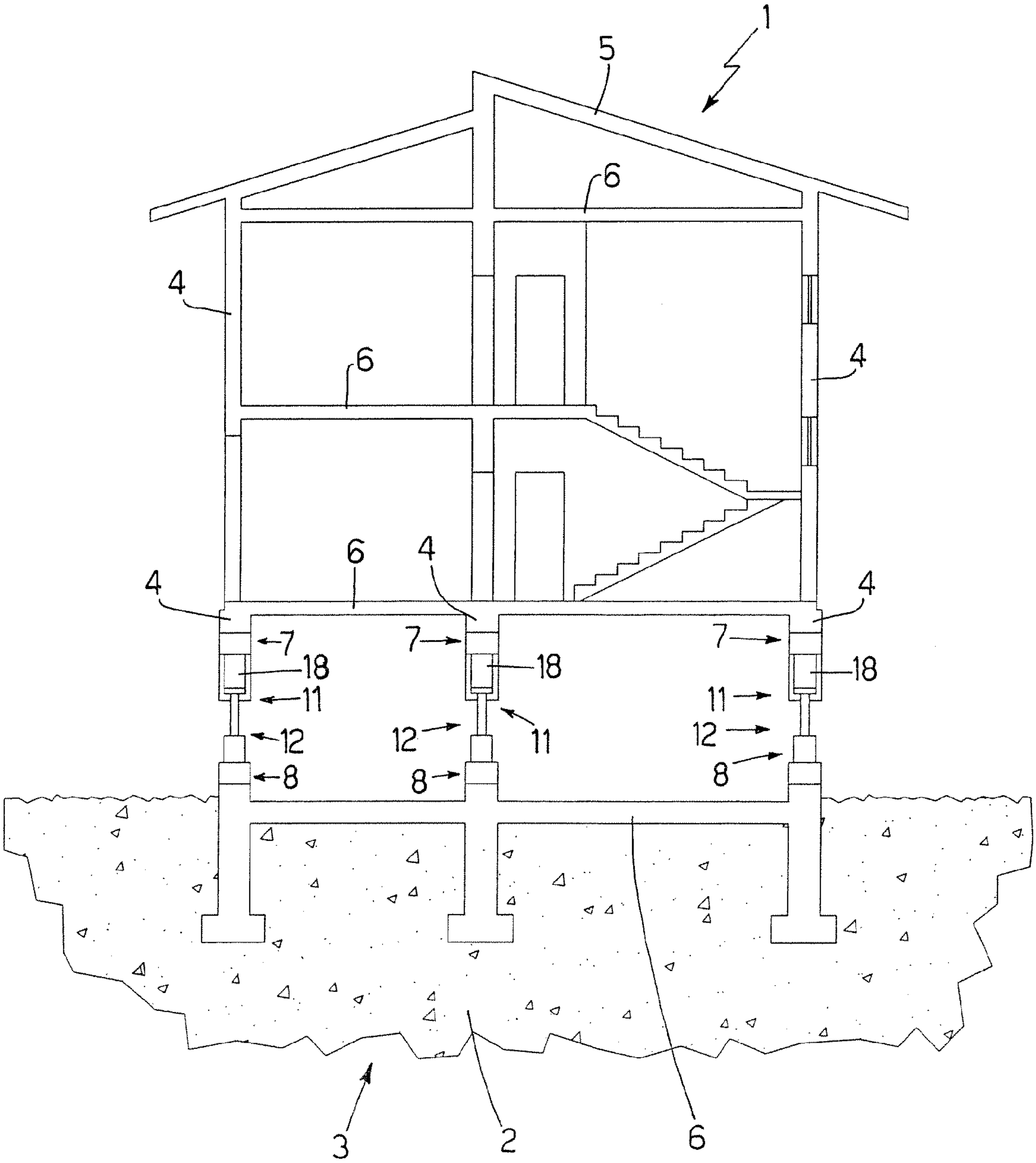


Fig.4

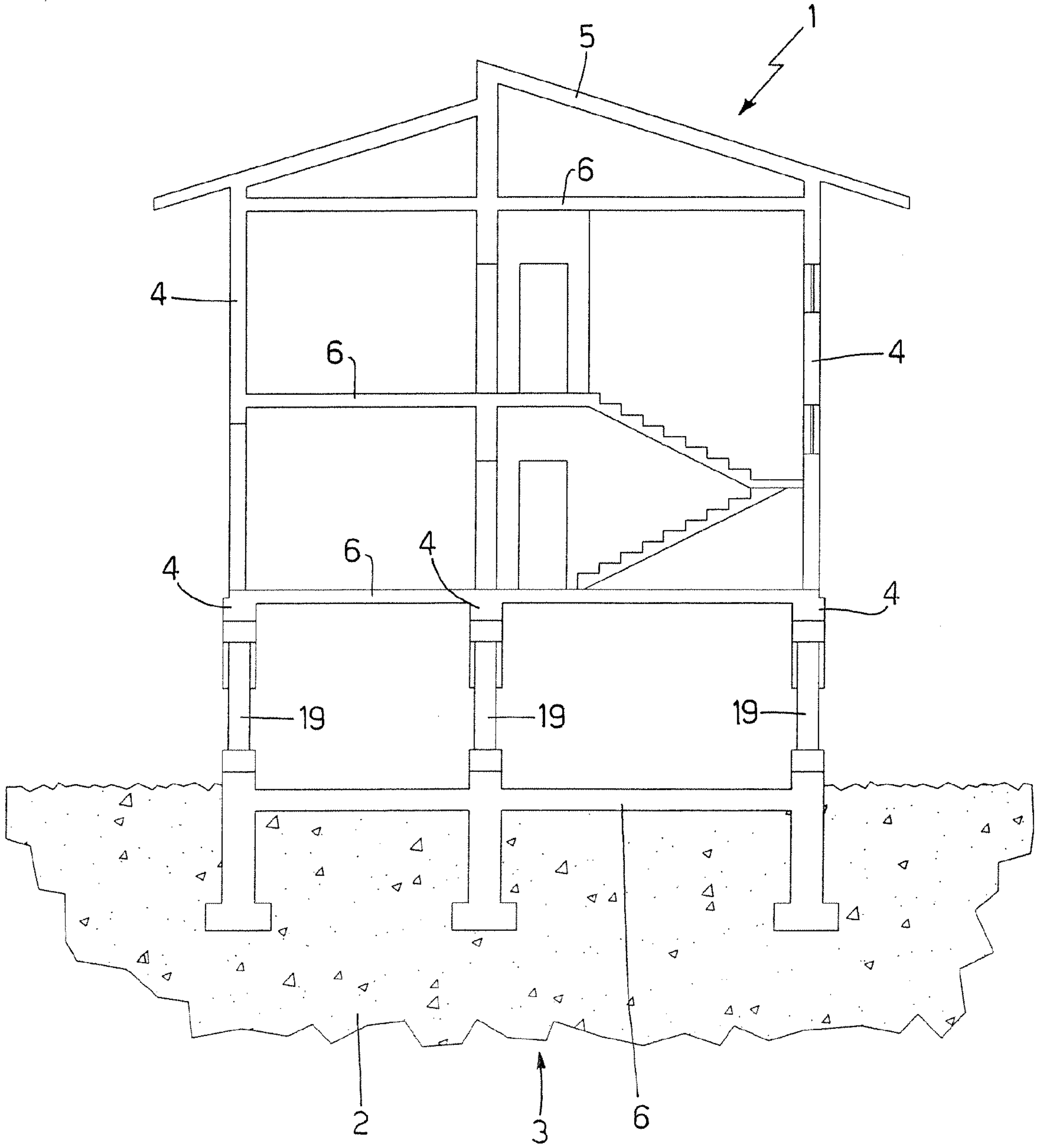


Fig.5

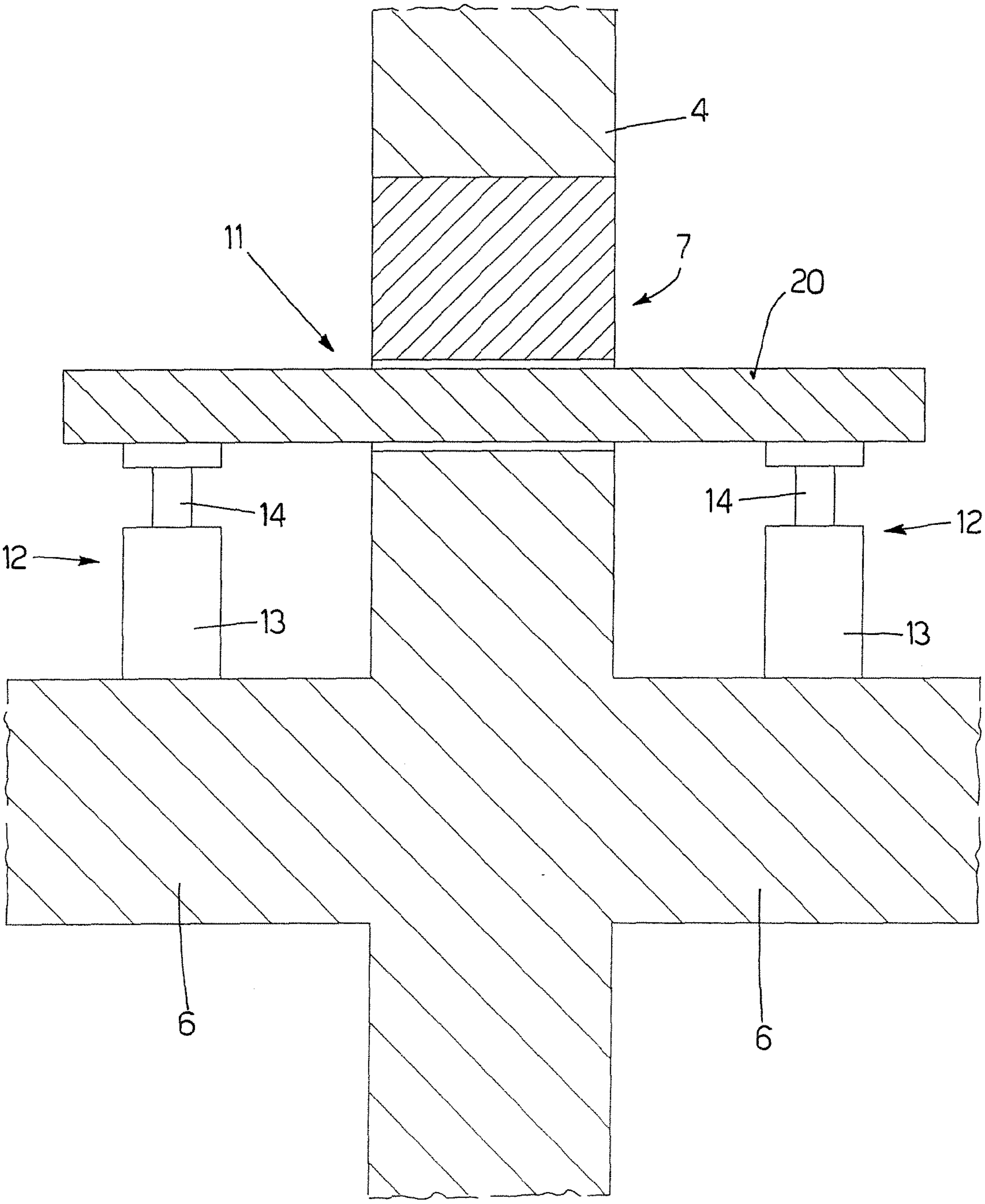


Fig.6

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# EUROPEAN SEARCH REPORT

Application Number
EP 06 12 0139

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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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TECHNICAL FIELDS SEARCHED (IPC)
E02D
E04G

The present search report has been drawn up for all claims

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| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 3 January 2007 | Geiger, Harald |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 06 12 0139

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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