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(54) Elevator with reduced head and pit, even without machine room

(57) A traction sheave elevator with reduced pit and head, even without machine room, is described, in which the elevator car is suspended to elongated connectors by means of two or more suspension pulleys, mounted on the same side of the elevator car. With such a disposition, a compact elevator is obtained, which allows to optimize the available space in the shaft. Moreover, in this way an elevator which can be used both in new buildings and in pre-existent buildings, both where the elevator shaft is present and in case of modernization and realization of a new elevator in pre-existent buildings, is obtained.

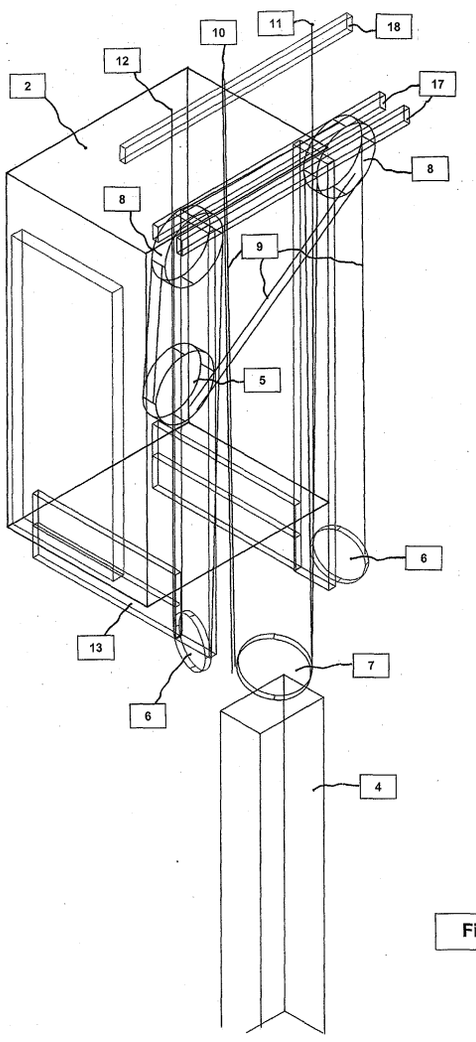

Fig 4

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Description

[0001] The present invention is about a traction sheave elevator, as defined in the preamble of claim 1, an elevator car, as defined in the preamble of claim 11, a method as defined in the preamble of claim 12 and a use of suspension pulleys, as defined in the preamble of claim 13, to suspend an elevator car on suspension pulleys.

[0002] In the prior art, document EP 0 631 967 discloses a traction sheave elevator without the machine room, in which an elevator car moves in a shaft guided by vertical elevator car guide rails, while the counterweight moves along guide rails on the same side of the elevator car on which the elevator car guide rails are disposed. Such a suspension system, where all the guide rails are disposed like a compact structure on the same side of the elevator car, is called Rucksack or "backpack" suspension. The activation machine, provided with a traction sheave, is mounted on the upper part of the elevator car guide rails. Two elevator car pulleys are connected to the elevator car and placed at two opposite ends under the lower part of said elevator car. The first end of the suspension rope is connected to an upper fixed structure placed in the higher part of the elevator shaft, on the same side of the elevator car on which the elevator car guide rails and the counterweight are disposed. From the fixing point of its first end, the rope is let down to the suspension pulley connected to the counterweight, from which it is redirected upward and passed across the traction sheave of the activation motor, from which it is furthermore deviated downward and conduced around the two suspension pulleys mounted under the elevator car, so that the rope passes under the elevator car from the side on which the guide rails are disposed to the opposite side, and it is deviated upward to an upper fixed structure, to which the other end of the rope is fixed. In this way, an advantageous 2: 1 ratio suspension type is obtained, which allows to design the machine for a lower torque request.

[0003] A problem with the prior art elevator is that the two suspension pulleys under the elevator car require a certain space in the vertical direction of the elevator. This is a problem particularly felt in those buildings where it is not possible to extend a lot the elevator shaft under the level of the lowest floor, in order to grant enough space for the suspension pulleys under the elevator car when said car is located at the lowest floor. This problem is often encountered in case of modernization of old elevator shafts, where a scarce space had been provided at the lower end of the elevator shaft. In old buildings, the construction of a new elevator shaft, or the extension of the existing one at a lower level with respect to the lowest floor, is an element of considerable cost. Similarly, an insufficient head of the shaft at its upper end can be an obstacle for the installation of suspension pulleys in the upper part of the elevator car. An elevator shaft requiring the least possible space in vertical direction can be an advantage also for new buildings.

[0004] A further problem with the prior art elevator is that, on the opposite elevator car side with respect to the side on which the car and counterweight guide rails are placed, enough space for the passage of the ropes between the shaft's wall and the elevator car's wall has to be provided, this being a limitation for the width size of the elevator car, not allowing an effective utilization of the plan section of the shaft.

[0005] Document EP 1 024 105 illustrates an elevator system having a car guided on one side by means of guide rails placed on the same side of the elevator car on which the guide rails and the counterweight are disposed. The activation takes place by means of a pulley fixed on the same side of the elevator car on which the guide rails and the counterweight are disposed. The activation takes place by means of a traction sheave driven by a motor placed inside the shaft and fixed to the upper part of the guide rails. The suspension pulley of the elevator car reduces the available space for the counterweight, while the position of the traction sheave and the related activation motor, at the upper part of the counterweight, limits its vertical development, requiring as a matter of fact a vertical extension of the shaft, which can not be reduced under the limits imposed by the counterweight minimum height, dependent from its plan dimensions and its total weight, and from the size of the traction sheave and the related motor, as well as from the safety vertical free spaces.

[0006] The object of the present invention is to eliminate the aforesaid problems.

[0007] The specific object of the invention is to disclose an elevator which is as compact as possible and which requires the least possible space for the shaft, both in horizontal and in vertical direction, in order to allow the best use of the shaft's available space. A further object of the invention is to disclose an elevator which is suitable for being used both in new buildings and in pre-existent buildings, to update elevators in pre-existent shaft, or also for an elevator for which the shaft is built in a subsequent phase in a pre-existent building. Concerning the features of the traction sheave elevator, the elevator car and the method of the invention, and the use of suspension pulleys according to the invention, we make reference to the annexed claims.

[0008] The elevator object of the present invention, according to one of the possible executive embodiments and with reference to the annexed drawings, comprises elevator car guide rails 1 vertically disposed in an elevator shaft 21; an elevator car 2 designed to move along the elevator car guide rails 1; counterweight guide rails 3 disposed in the elevator shaft 21, on the same elevator car side of that in which the elevator car guide rails are placed; a counterweight 4 designed to move along the counterweight guide rails 3; one or more upper diverting pulleys 8 mounted on a structure 17 fixed to the upper part of the elevator shaft 21; two or more suspension

pulleys 6 connected to the elevator car; one or more counterweight suspension pulleys 7, connected to the counterweight 4; a traction sheave 5, activated by the lifting machine 20. A group of at least two elongated connectors, like for instance ropes 9 or flat ropes, completes the elevator, the first end of said ropes being connected to a fixed structure 18 placed in the upper part of the shaft, on the same side 14 of the elevator car on which the elevator car and counterweight guide rails are disposed, from which the ropes 9 pass, through the counterweight pulley 7, to the upper diverting pulleys 8, to the traction sheave 5 and to the elevator car suspension pulleys 6, from which they are deviated upward, leading the second end of the ropes to be fixed to the connections 11 and 12, joined to the upper fixing structure 18. According to the invention, the second end 11 and 12 of the ropes 9 is connected to the upper fixing structure 18 on the same side 14 of the elevator car on which the first end 10 is fixed, but at two opposite sides with respect to the counterweight 4 position. The elevator car suspension pulleys 6 are mounted on the same side 14 of the car on which the elevator car and counterweight guide rails are disposed, but at two opposite sides with respect to the counterweight position.

[0009] The invention has the advantage that it makes possible to carry out an elevator which is as compact as possible in vertical direction, and with the elevator car as wide as possible with reference to the horizontal section of the shaft. Furthermore, the invention has the advantage that, as well as in new buildings, it is also suitable for being used in updating projects and to provide for new elevators in pre-existent buildings. A further advantage consists in the fact that the lower end of the shaft can be made with the least possible depth. In addition, the invention has the advantage that it is suitable for being used in elevators in which the shaft head size has to be restrained within certain limits, not much greater than the height of the elevator car, plus the safety excess stroke, and it can be suitable for carrying out a machine-room-less elevator with the machine and the related traction sheave placed in a vane partially disposed inside the shaft and accessible from the outside, on the door side, at one of the floors served by the elevator, near said door.

[0010] The invention will be described in detail hereinafter, with the aid of some examples of the possible embodiments and with reference to the annexed drawings, wherein:

Figure 1 is a schematic side view of an embodiment of the elevator according to the invention;
Figure 2 is a schematic top view of the elevator according to the invention;
Figure 3 is another schematic side view of an embodiment of the elevator according to the invention;
Figure 4 is an oblique side view of an embodiment of the elevator according to the invention;
Figure 5 is a schematic side view of another embodiment of the elevator according to the invention; and
Figure 6 is an oblique side view of the embodiment of the elevator shown in Figure 5.

[0011] Figure 1 is a view of the traction sheave elevator, with the elevator car suspended according to the so called Rucksack or "backpack" principle. The elevator car guide rails 1 are vertically disposed in the elevator shaft 21, on one side with respect to the elevator car and said elevator car 2 is carried out in order to move along the elevator car guide rails 1. The counterweight guide rails 3 are disposed in the elevator shaft 21, on the same side 14 of the elevator car guide rails 1 with respect to the elevator car 2. The elevator car guide rails 1 and the counterweight guide rails 3 are mutually connected and to the shaft wall 21 (not shown in Figure 1, see Figure 2), mounted at the opposite side with respect to the fastening brackets 19, so that the guide rails 3 of the counterweight 4 are disposed within the guide rails 1 of the elevator car 2 and the sliding planes of the elevator car guide rails 1 and the counterweight guide rails 3 are both substantially parallel to the elevator car wall 14 and to the adjacent shaft wall 21. The distance between the counterweight guide rails 3 is lower than the distance between the elevator car guide rails 1, so that the counterweight 4, which moves along the counterweight guide rails 3, can have a shape with a sufficient width and a considerable depth. The diverting pulleys 8 are mounted on transversal supports 17, connected to the upper ends of the four guide rails 1 and 3 and to the upper end of the shaft wall 21 or its upper closure slab. The traction sheave 5 is disposed in a side space, it partially protrudes in the elevator shaft and it is accessible through an opening placed near the door of one of the floors served by the elevator, preferably the last upper floor.

[0012] An L shaped bearing structure 13 is connected to the elevator car 2 and it is extended along the elevator car side wall 14, on the same side on which the elevator car guide rails 1 and the counterweight guide rails 3 are disposed, and under the elevator car lower end 15, in order to support said elevator car. The guide elements 16 which operate with the elevator car guide rails 1 are connected to the bearing structure 13. The two suspension pulleys 6 are connected to the bearing structure 13 too. The suspension pulleys 6 are disposed on a side of the elevator car 2, in its lower part, on the same side of the elevator car wall 14 on which the elevator car guide rails 1 and the counterweight guide rails 3 are disposed, so that the suspension pulleys 6 do not protrude below the elevator car 2 bearing structure 13. One of the suspension pulleys 6 is placed on a side of the bearing structure 13, while the second suspension pulley 6 is placed on the other side of the bearing structure 13, so that the two suspension pulleys 6 are disposed outside the plan overall dimensions of the bearing structure 13.

[0013] The ropes 9 have a first end 10 connected to

the support 18 between the guide rails 1 and 3. From here, they are directed downward to the counterweight suspension pulley 7, placed at the upper end of the counterweight 4, from which they are then deviated upward, they pass on the diverting pulleys 8, placed on the upper bearing structure 17, they go to the traction sheave 5 and they are deviated downward, directly or by means of a diverting pulley 8, to the suspension pulleys 6 mounted on the sides of the elevator car 2 bearing structure 13. From here, the ropes are deviated upward and sent to the anchoring points of the second end 11, 12 and to the support 18 fixed to the upper end of the shaft and the guide rails 1 and 3, externally from said guide rails. Therefore, the elevator car is suspended on the ropes, through the pulleys 6, between the traction sheave 5 and the ends 11 and 12 of the ropes 9. All the pulleys 5, 6, 7 and 8 are placed on the same side with respect to the elevator car, so that the ropes 9 can substantially run across all the path in the space comprised between the elevator car and the adjacent shaft wall, in the area in which the guide rails are placed.

[0014] To simplify, Figures 1, 2, 3, 4, 5 and 6 show a pair of ropes only, but it is obvious that, as usually happens for elevators, the pair of ropes can comprise a pair of rope groups or a plurality of adjacent ropes, preferably but not necessarily in even number. Also the pulleys 5, 6, 7 and 8 ere presented as single race pulleys, but it is obvious that, when a plurality of adjacent ropes is employed, the rope pulleys have more races, or different pulleys can be placed side by side. The rope pulleys can be provided with races of semicircular type, and the traction sheave can have races with notch to improve adherence.

[0015] In an embodiment of the elevator, the elevator car guide rails 1 and the counterweight guide rails 3 are mutually connected and to the shaft wall through fastening brackets 19, said guide rails being placed on the opposite sides of each bracket, with the counterweight guide rails 3 disposed within the elevator car 2 guide rails 1.

[0016] In an embodiment of the elevator, the distance between the counterweight guide rails 3 is lower than the distance between the elevator car guide rails 1. The conventional shape of the counterweight is such to counterbalance the elevator car weight, increased of not more than the half of the nominal weight to transport. By disposing the counterweight guide rails 3 within the elevator car guide rails 1 and placing the two elevator car suspension pulleys 6 on the opposite side with respect to the structure 16 which controls the elevator car 1 movement on the guide rails 1, all the space located between the elevator shaft wall 21 and the elevator car wall 14 is available for arranging the counterweight 4, thus allowing to carry out an extremely compact and with reduced height counterweight 4.

[0017] In an embodiment of the elevator, the elevator car suspension pulleys 6 are placed in the lower part of the bearing structure 13 of the elevator car 2, at its lower end. The elevator car 2 suspension pulleys 6 are preferably disposed outside the space defined by the elevator car 2 and its bearing structure 13, in order to maximize the available space for the counterweight 4 keeping an optimal use of the available space in the elevator shaft 21.

[0018] In a further embodiment of the elevator, shown in Figures 5 and 6, said elevator comprises a C-shaped bearing structure 13 fixed to the elevator car, extending along the side wall 14 of the elevator car 2 on that side on which the elevator car guide rails 1 and the counterweight guide rails 3 are disposed, as well as above the roof and beneath the lower part 15 of the elevator car. The guide elements 16, which operate together with the elevator car guide rails 1 and the elevator car 2 suspension pulleys 6, are fixed to the same element of the elevator car bearing structure 13.

[0019] In another embodiment of the elevator, the traction sheave 5 is disposed in a space which is near the elevator door at the highest floor. This space is accessible from the outside, from the landing at the elevator door.

[0020] In a traction sheave elevator, the use of suspension pulleys placed on one side of the elevator car, in a substantially symmetrical way with respect to the counterweight position, allows to install the elevator in a shaft whose total height is considerably lower than the height of a conventional elevator shaft. In principle, this solution can be employed both in an elevator with the machine room high above and in an elevator with the machine room at the bottom, and in an elevator without the machine room. To obtain the greatest space saving in the elevator shaft plan section, the suspension pulleys connected to the elevator car can be perpendicular or almost perpendicular to the elevator car wall, or even rather inclined with respect to the perpendicular to the wall, however not more than 45°/50°. A cheap solution is also that of using a single pulley for suspending the elevator car, but this solution reduces the transversal space available for the counterweight, requiring the use of counterweights with greater height and thus requiring the construction of elevator shafts having minimum height of greater dimensions. When the elevator suspension is provided using two pulleys disposed on the elevator car side, the elevator car height can be reduced at the least by placing the diverting pulleys in the head, at a height in the elevator shaft such that the upper part of the elevator car can reach a higher position with respect of the lowest point of the diverting pulleys.

[0021] The embodiment with the elevator car and counterweight suspension with 2:1 ratio is described with explanatory and not limiting purpose only, because the suspension could also be of 1:1 ratio type, or 4:1 ratio or more, and the counterweight suspension could also be different from the elevator car suspension, being in particular of 3:1 ratio type, 5:1 ratio or more.

Claims

1. A traction sheave elevator, in which the elevator car is suspended to elongated connectors by means of two or more suspension pulleys (6), **characterized in that** said two or more suspension pulleys (6) are mounted on the same side of the elevator car.

2. The traction sheave elevator according to claim 1, **characterized in that** the elevator lifting machine is at least partially disposed in the elevator shaft.

3. The traction sheave elevator according to claims 1 or 2, comprising:

   - elevator car guide rails (1) disposed in a vertical direction in the elevator shaft, on one side of the elevator car;
   - an elevator car (2) designed to move along the elevator car guide rails;
   - counterweight guide rails (3) disposed in the elevator shaft on the same side of the elevator car on which the elevator car guide rails are placed;
   - a counterweight (4) designed to move along the counterweight guide rails; and
   - upper diverting pulleys (8) mounted on an upper fixed structure in the high up portion of the elevator shaft on the guide rails side,

   characterized in that it comprises:

   - two or more elevator car suspension pulleys (6) connected to the elevator car;
   - one or more counterweight suspension pulleys (7) connected to the counterweight;
   - a traction sheave (5) connected to a lifting machine (20);
   - a plurality of elongated connectors (9), whose first end (10) is fixed to a bearing structure (18) in the upper portion of the elevator shaft, on the same side of the elevator car on which the elevator car and the counterweight guide rails are placed, from which said elongated connectors pass, through the counterweight pulley, to the traction sheave and to the elevator car suspension pulleys, and whose second end (11) and (12) is fixed to the bearing structure (18);
   - the second end (11) and (12) of said elongated connectors (9) is fixed to the bearing structure (18) on the same side of the elevator car on which the first end (10) is fixed, and the elevator car suspension pulleys (6) are mounted on support elements on the elevator car (2) side wall, on the same side of the elevator car on which the elevator car and the counterweight guide rails are placed.

4. The traction sheave elevator according to claims 1 to 3, **characterized in that** the elevator car guide rails (1) and the counterweight guide rails (3) are mutually connected and fixed to the elevator shaft wall, and disposed according to substantially parallel planes, in order that the counterweight guide rails (3) are disposed within the elevator car guide rails (1).

5. The traction sheave elevator according to claims 1 to 4, **characterized in that** it comprises a L-shaped elevator car bearing structure (13), which is extended along the elevator car side wall (14), on the same side on which the elevator car guide rails and the counterweight guide rails are disposed, and under the elevator car lower portion (15), the elevator car suspension pulleys (6) and the guide elements (16) coupled with the elevator car guide rails being connected to said bearing structure (13).

6. The traction sheave elevator according to claim 5, **characterized in that** the elevator car bearing structure (13) is provided with support elements also in the portion over the elevator car roof, so that said bearing structure (13) becomes C-shaped.

7. The traction sheave elevator according to claims 1 to 6, **characterized in that** the elevator car suspension pulleys (6) are disposed in the lower part, next to the elevator car bearing structure (13) ends.

8. The traction sheave elevator according to claims 1 to 7, **characterized in that** the elevator car suspension pulleys (6) are disposed outside the space defined by the elevator car bearing structure.

9. The traction sheave elevator according to claims 1 to 8, **characterized in that** the elevator car suspension pulleys (6) have a rotation plane substantially perpendicular to the elevator car wall (14) on whose side they are disposed.

10. The traction sheave elevator according to claims 1 to 8, **characterized in that** the elevator car suspension pulleys (6) have an inclined rotation plane with respect to the elevator car wall (14) on whose side they are disposed.

11. An elevator car (2) **characterized in that** said elevator car (2) comprises a two or more pulleys (6), disposed on one side of the elevator car, to support said elevator car (2) on the suspension elongated connectors.

12. A method for suspending an elevator car on suspension ropes, **characterized in that** the elevator car (2) is provided with two or more suspension pulleys (6) disposed on one side (14) of the elevator

car, the suspension elongated connectors (9) forming two or more loops opened in a vertical direction and the elevator car being suspended in these two or more loops by means of the pulleys placed on its side.

13. A use of two or more suspension pulleys mounted on one side of an elevator car to suspend the elevator car to the suspension elongated connectors.

14. The use according to claim 13, **characterized in that** the elevator car belongs to a traction sheave elevator without machine room.

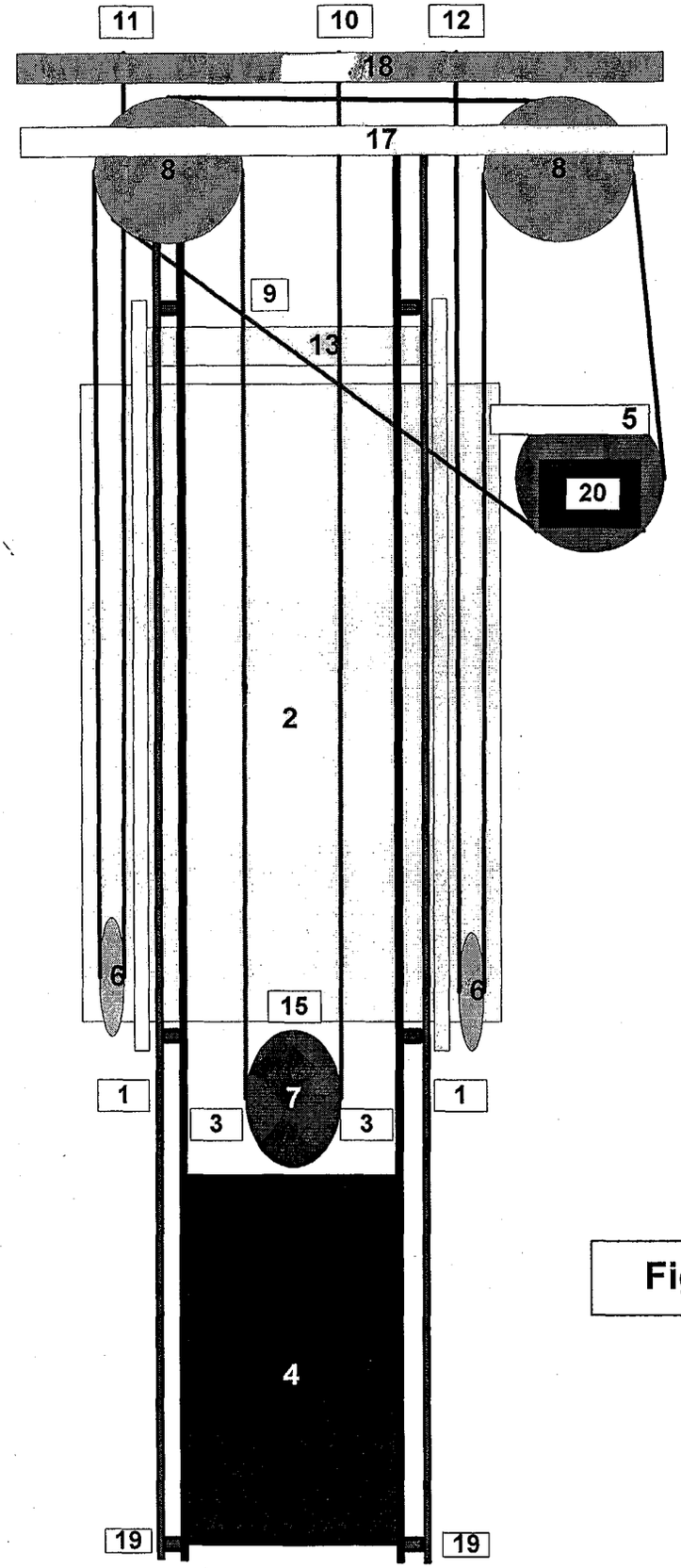

Fig 1

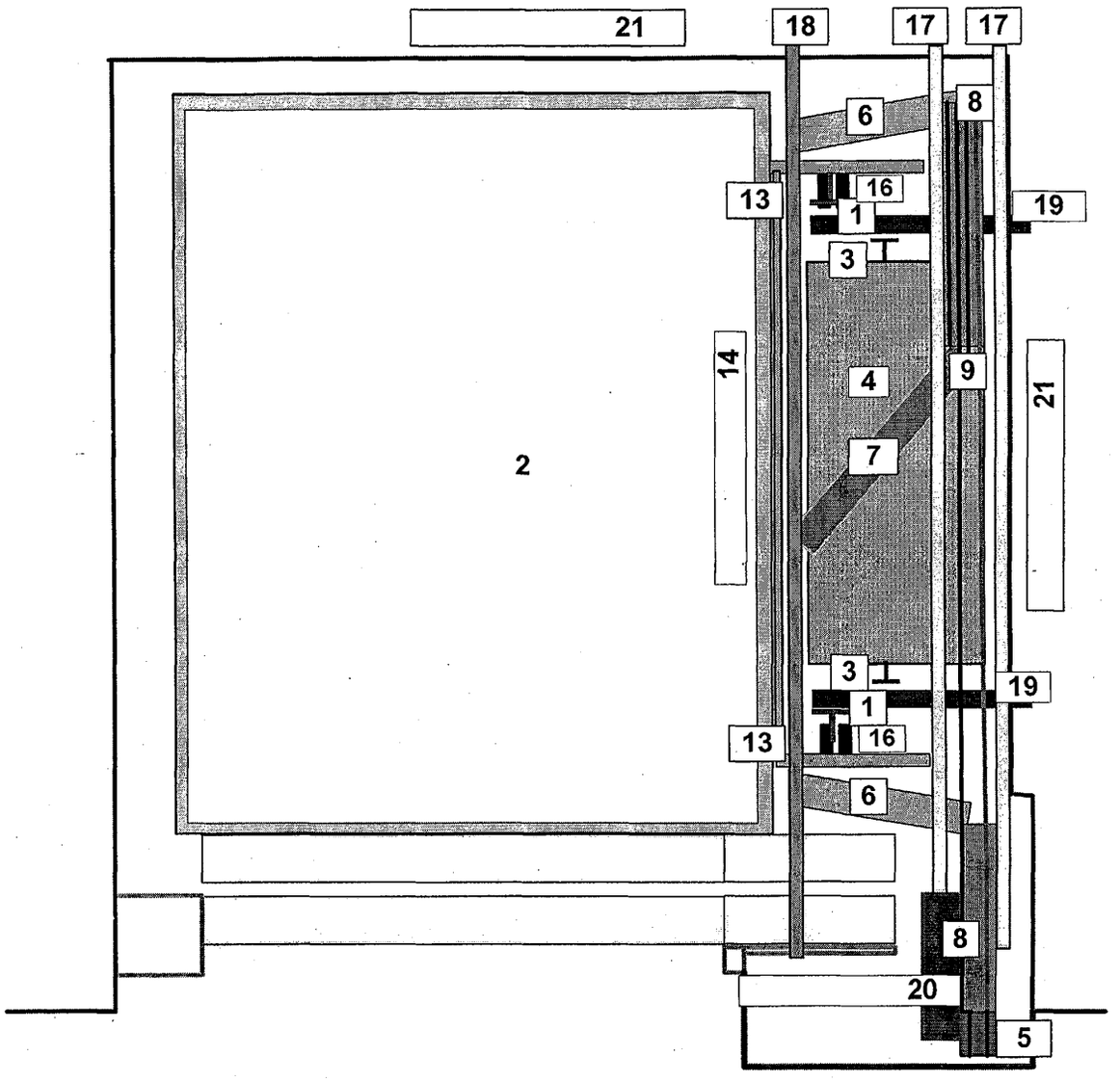

Fig 2

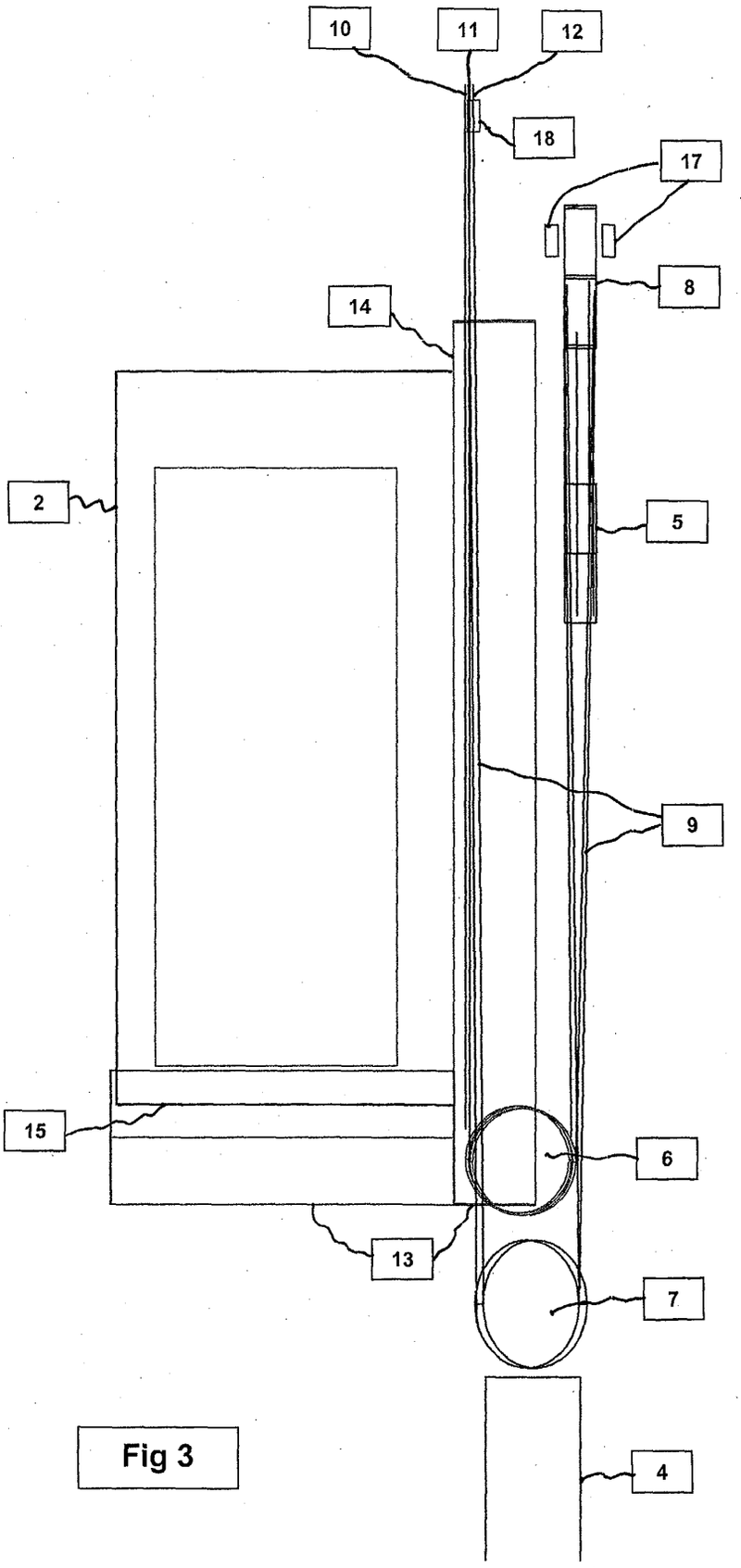

Fig 3

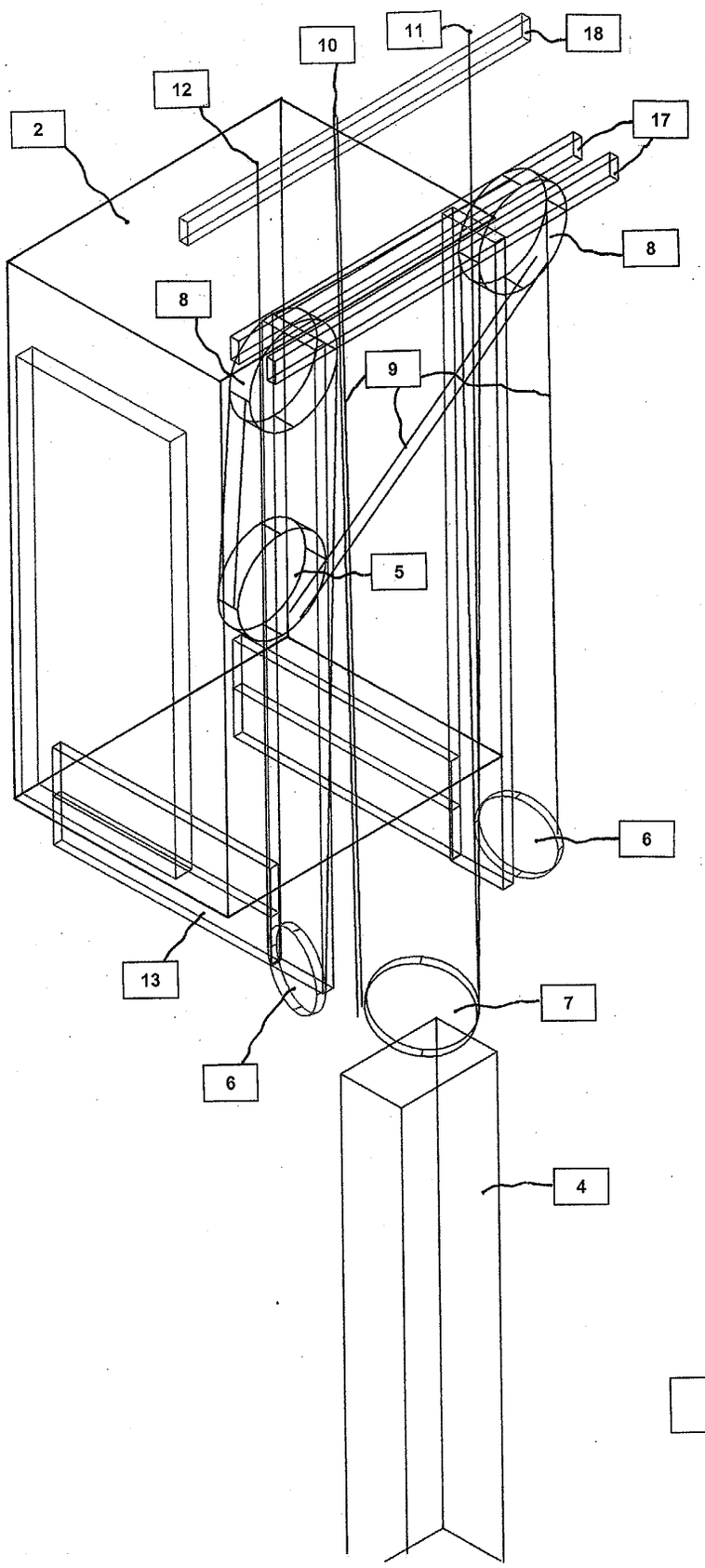

Fig 4

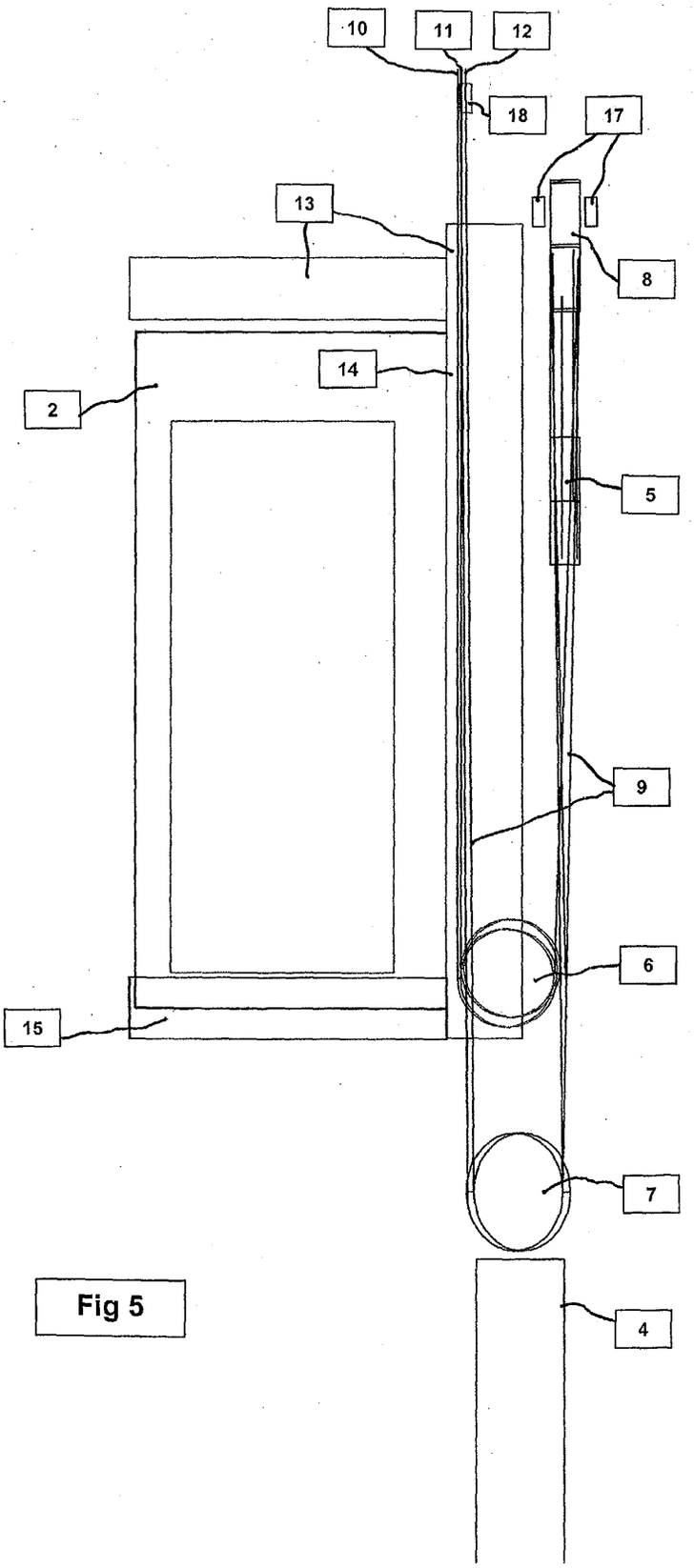

Fig 5

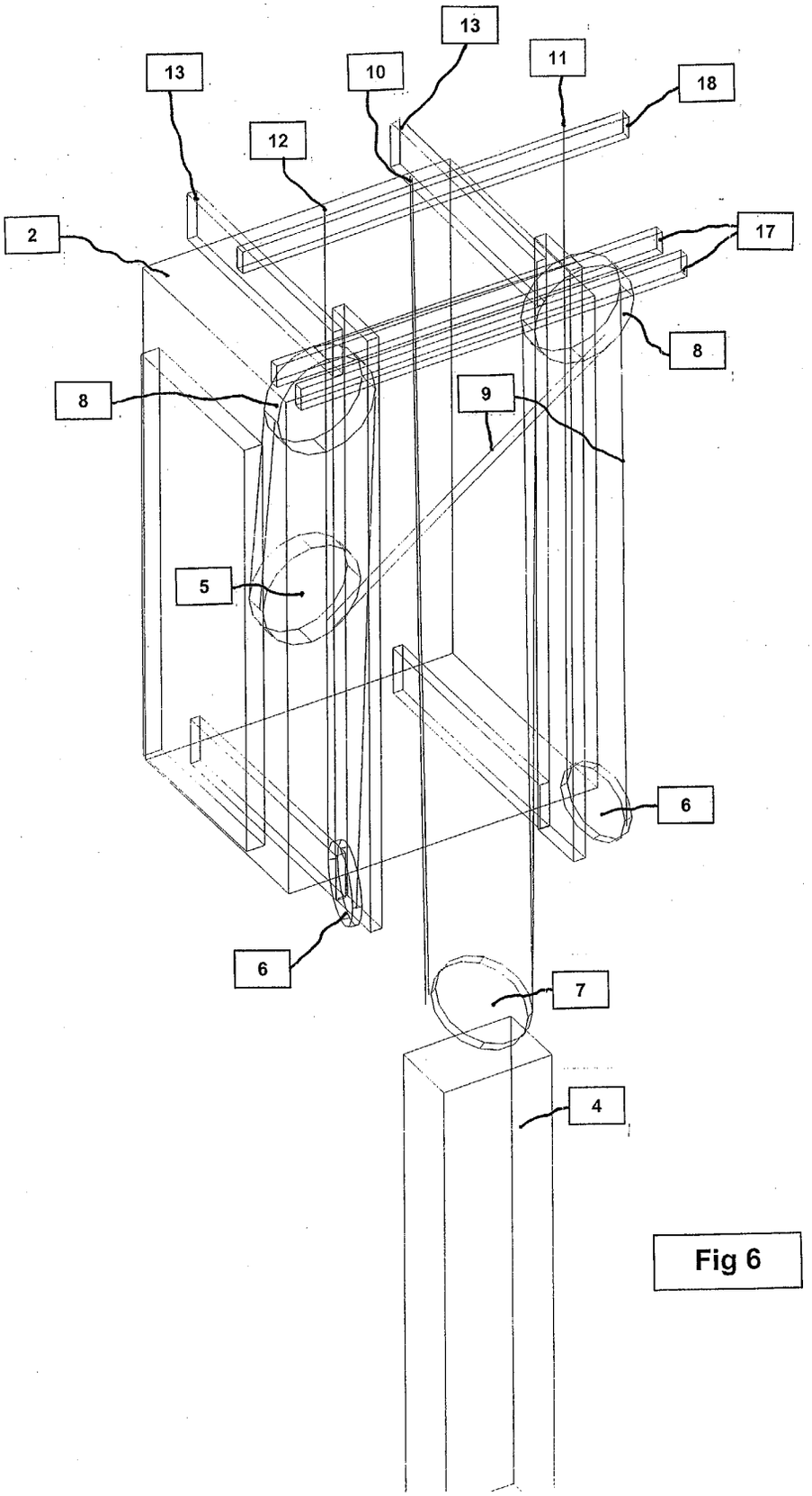

Fig 6

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EUROPEAN SEARCH REPORT

Application Number
EP 04 07 7694

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TECHNICAL FIELDS SEARCHED (Int.Cl.7)

B66B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	12 January 2005	Eckenschwiller, A

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 07 7694

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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