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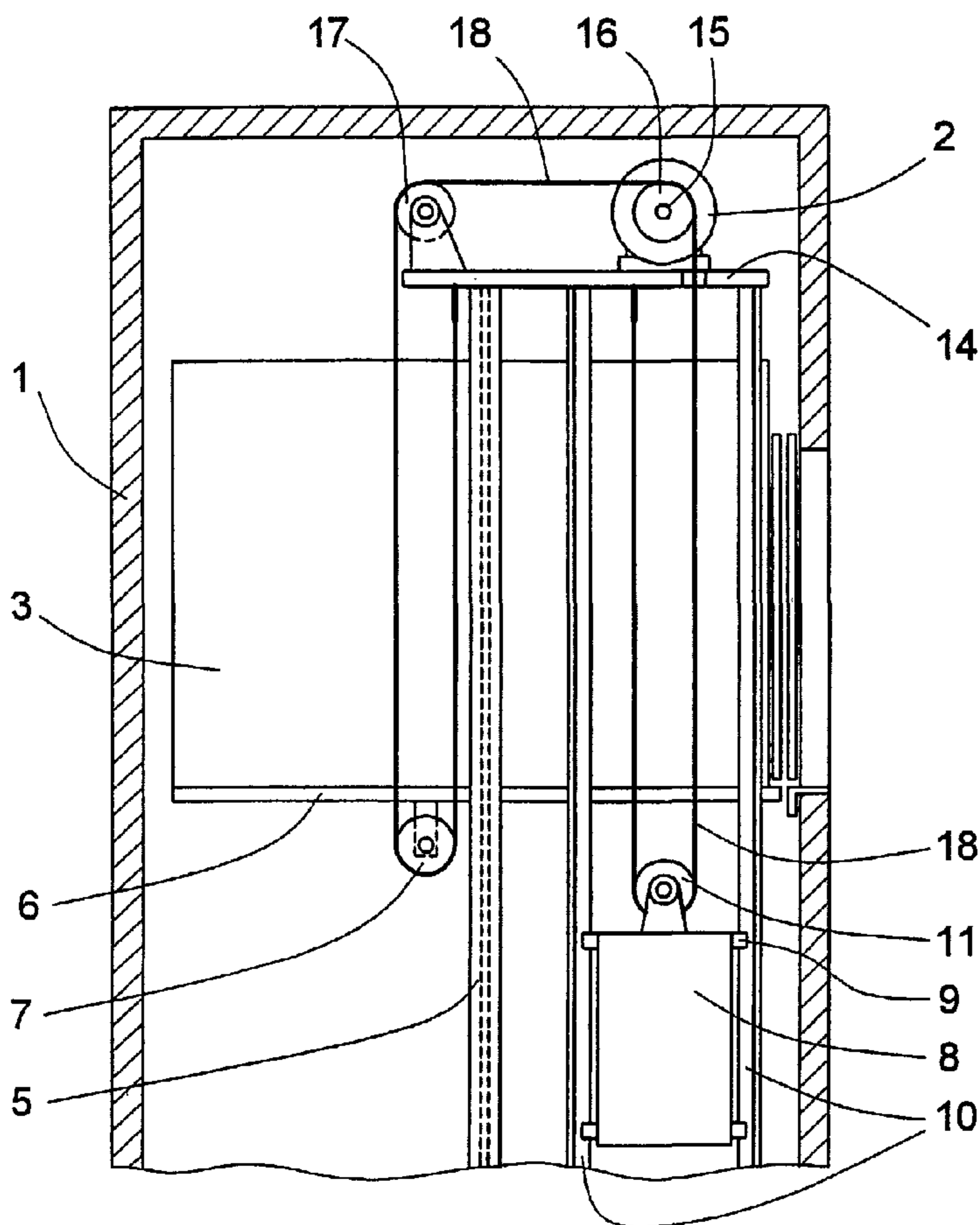
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[Fortsetzung auf der nächsten Seite]

(54) Title: ELEVATOR SYSTEM

(54) Bezeichnung: AUFZUGSSYSTEM



(57) **Abstract:** The invention relates to an elevator system comprised of at least one drive machine (2) with at least one driving pulley (16), of an elevator car (3), of at least one counterweight (8), and of at least one flexible supporting means. According to the invention, the elevator car (3) and the at least one counterweight each have at least one support roller (7, 11), and the supporting means (18) forms, with the driving pulley (16) and with the support rollers (7, 11), a 2:1 suspension system for the elevator car (3) and for the counterweight (8). The 2:1 suspension system is arranged in such a manner that the supporting means (18) is always turned in the same direction by the drive pulley (16), the support rollers (7, 11) and by deflection rollers (17) that are provided if needed.

(57) **Zusammenfassung:** Bei einem Aufzugssystem, das mindestens eine Antriebsmaschine (2) mit mindestens einer Treibscheibe (16), eine Aufzugskabine (3), mindestens ein Gegengewicht (8) sowie mindestens ein flexibles Tragmittel umfasst, bei dem die Kabine (3) und das mindestens eine Gegengewicht je mindestens eine Tragrolle (7, 11) aufweisen, und bei dem das Tragmittel (18) mit der Treibscheibe (16) und den Tragrollen (7, 11) ein 2:1-Aufhängungssystem für die Kabine (3) und für das Gegengewicht (8) bildet, ist das 2:1-Aufhängungssystem so angeordnet, dass das Tragmittel (18) durch die Treibscheibe (16),

die Tragrollen (7, 11) und durch allenfalls vorhandene Umlenkrollen (17) stets gleichsinnig gebogen wird.

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Zur Erklärung der Zweibuchstaben-Codes und der anderen Abkürzungen wird auf die Erklärungen ("Guidance Notes on Codes and Abbreviations") am Anfang jeder regulären Ausgabe der PCT-Gazette verwiesen.

Lift system

The subject of the invention is a lift system as defined in the patent claims.

5 Lift systems of the kind according to the invention usually comprise a lift cage and a counterweight, which are movable in a lift shaft or along free-standing guide devices. For producing the movement the lift system comprises at least one drive with at least one drive pulley, which supports, by way of support and drive means, the lift cage and the counterweight and transmits thereto the necessary drive forces.

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The support and drive means are termed support means in the following.

Distinction is made between lift systems in which steel cables with a round cross-section are used as support means and more modern lift systems which have a flat, belt-like support means.

15

A lift system with a flat-belt-like support means in different arrangements is known from PCT Patent Application WO 99/43593. The lift according to this patent application comprises a drive motor which is arranged in the shaft space above the lift cage and so acts by way of at least one drive pulley on the variously arranged flat support means disposed in operative connection with the lift cage that the lift cage is moved upwardly and downwardly. In order to halve the tensile force arising in the support means and the traction force required at the drive pulley, in some of the disclosed arrangements of the support means the suspensions of lift cage and counterweight are executed as a 2:1 suspension system.

25

By the expression '2:1 suspension system' there is understood a system in which support means driven by way of a drive pulley move a lift cage and/or a counterweight, wherein the support means are so arranged that the section thereof disposed in contact with the drive pulley moves twice as fast as the lift cage and/or the counterweight. The support means in that case are so arranged that they loop around at least one drive pulley and at least one respective deflecting roller at each of the lift cage and counterweight and that they are fixed at their ends in the upper region of the lift shaft.

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Additional deflecting or diverting rollers are required in all variants, which are illustrated in WO 99/43593, with a 2:1 suspension system.

In the interests of optimum utilisation of space and the use of drive motors with minimum drive torque, the drive pulley and also the deflecting or diverting rollers
5 have smallest possible diameters.

Experience with lift installations of that kind has shown that expectations with respect to the service life of the support means employed are not fulfilled, i.e. due to arising material defects these often have to be replaced prematurely, this evidently being attributable to loading of the support means in bending.

10 The object of the invention is to be seen in creating an improved lift system of the aforesaid kind which reduces or avoids the disadvantages of the known systems, i.e. of creating a lift system in which, with maintenance of the stated advantages with respect to utilisation of space and required torque at the drive motor, the loading of the support means in bending is significantly reduced.

15 The lift system according to the invention comprises at least one drive with at least one drive pulley, a lift cage and at least one counterweight as well as preferably flat-belt-like support means. The lift cage and also the at least one counterweight have at least one support roller. The support means forms together with the drive pulley and the drive rollers at least one 2:1 suspension system for the cage and the
20 counterweight, wherein depending on the respective form of arrangement of the 2:1 suspension system one or more further deflecting rollers are required.

The drive pulley, the deflecting rollers present as may be required as well as the lift cage and the counterweight together with their support rollers are in that case so arranged that the support means when running around the drive pulley as well as
25 the support and deflecting rollers are always bent in the same sense.

The lift system according to another aspect of the invention comprises a lift system, which comprises a lift cage and a counterweight each with a respective support means pulley, at least one support means pulley installed in a lift shaft to be non-displaceable, and flat-belt-like support means, wherein the support means together
30 with the support means pulleys form a 2:1 suspension system for the lift cage and for the counterweight, characterised in that the at least one support means pulley, installed in the lift shaft to be non-displaceable as well as the lift cage and the counterweight together with the support means pulleys mounted thereat are so arranged that the support means when running around all support means pulleys
35 are always bent in the same sense.

The invention is described in the following on the basis of examples of embodiment and with reference to the drawing, in which:

- 5 Fig. 1 shows a lift system according to the invention with a respective drive motor and a respective 2:1 suspension system on either side of the lift cage, in side view,
- Fig. 2 shows the lift system according to Fig. 1 as a plan view,
- 10 Fig. 3 shows the lift system according to Figs. 1 and 2, but with only one drive motor as well as one connecting shaft between two drive pulleys,
- Fig. 4 shows a lift system according to the invention with a single drive motor and a 2:1 suspension system mounted on one side of the lift cage, in side view,
- 15 Fig. 5 shows the lift system according to Fig. 4 as a plan view,
- Fig. 6 shows a lift system according to the invention with a single drive motor, wherein the 2:1 suspension system carries the lift cage in the form of an underlooping, in side view,
- 20 Fig. 7 shows the lift system according to Fig. 6 as a plan view,
- 25 Fig. 8 shows a lift system according to the invention in accordance with Fig. 6, but with two drive motors, in side view,
- Fig. 9 shows the lift system according to Fig. 8 as a plan view,
- 30 Fig. 10 shows a support means, which is constructed as a wedge-ribbed belt, for a lift system according to the invention,
- Fig. 11 shows a support means, which is constructed as a cogged belt, for a lift system according to the invention,

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Fig. 12 shows a support means constructed as a cogged belt with herringbone tothing and

Fig. 13 shows a support means constructed as a cogged belt with curved tothing.

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Figs. 1 and 2 show in side view and as a plan view a lift system according to the invention, which is arranged in a lift shaft 1, with a respective drive motor 2 and a respective 2:1 suspension system on each one of the two sides of a lift cage 3. The lift cage 3 is guided by cage guide shoes 4 at two cage guide rails 5 and is vertically displaceable along these cage guide rails 5. It is equipped in the lower region of the lift cage 3 on each of the two sides with a respective cage support roller 7, the planes of which extend parallel to the side walls of the lift cage 3 and at a small spacing therefrom.

On either side of the lift cage 3 a respective counterweight 8 is guided by means of counterweight guide rails 9 at two counterweight guide rails 10 and is movable in upward and downward direction. Each counterweight 8 has a counterweight support roller 11.

The drive motors 2 are each mounted on a respective motor platform 14 which is laterally arranged in the lift shaft head and which, as illustrated in Fig. 1, is supported on the guide rails 5, 10, which are fixed in the lift shaft 1, of the lift cage 3 and the counterweight 8, but could also be directly fastened to the shaft walls. Their driven shafts 15, which are each time directed towards a side wall of the lift shaft 1 and aligned with one another, are each equipped with a respective drive pulley 16. These drive pulleys 16 are arranged between the respectively associated drive motor 2 and the adjacent side wall of the lift shaft 1 and vertically above the counterweight support roller or rollers 11 of the respectively associated counterweight 8, wherein their planes extend parallelly to the side walls of the lift cage 3 and at the same lateral spacing therefrom as the afore-mentioned cage support rollers 7. On either side of the lift cage 3 a respective deflecting roller 17 is fastened on the motor platform 14 to be in the same plane as the drive pulley 16 and the cage support rollers 7 and vertically above the latter.

The lift cage 3 and the two counterweights 8 are so connected together by means of support means 18 via at least one further support means pulley that raising of the lift cage 3 causes lowering of the counterweight 8 and vice versa. For raising and lowering of lift cage 3 and counterweight 8 the support means 8 are set in motion by the drive pulley 16.

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In the present lift system the support means 18 present on the two sides of the lift cage 3 are each time arranged as shown in the side view according to Fig. 1. The support means 18 visible here are fixed at one end thereof below the lefthand side of the drive pulley 16 to the motor platform 14, from where they extend vertically downwards, loop around the counterweight roller 11 in anticlockwise sense through 180°, run vertically upwards to the righthand side of the drive pulley 16, loop around the drive pulley 16 in anticlockwise sense through 90°, extend horizontally above the drive pulleys 16 to the left to the upper side of the deflecting roller 17, loop around this in anticlockwise sense through 90°, run vertically downwards to the lefthand side of the cage support roller 7, loop around this in anticlockwise sense through 180° and extend from the righthand side of the cage support roller vertically upwards to its second fixing point disposed below the righthand side of the deflecting roller 17. The drive pulley 16, deflecting roller 17, cage support roller 7, counterweight support roller 11 and support means 18 form a 2:1 suspension system for the lift cage 3 and one of the counterweights 8.

The mentioned support means are illustrated in figures in each instance as single support means strands. Usually, however, in realised lift systems several parallel support means strands are arranged adjacent to one another, wherein they run around support means pulleys of corresponding width.

By the term "support means pulley" there are subsumed in the following all pulleys cooperating with the support means 18, such as drive pulleys, deflecting rollers and support rollers.

It is readily recognisable from Fig. 1 and the foregoing description that such a 2:1 suspension system ensures that the support means 18 on running around the drive pulley 8, the support rollers and the deflecting rollers are always bent in the same sense. This has the consequence that the stress which loads the support means 18 occurs as a pulsating stress and not as an alternating stress, whereby the number of bending stresses leading to fatigue fracture and thus the service life of the support means 18 significantly increase.

There is recognisable from Fig. 2, which illustrates a plan view of the lift system described by Fig. 1, that in the case of the afore-described lift variant a second 2:1 suspension

system with a second drive motor 2 is present on the opposite side of the lift cage 3 and is arranged symmetrically with respect to the centre plane 20.

The possibility exists of synchronising the rotational movement of the driven shafts 15 of the two drive motors 2 according to Figs. 1 and 2 with one another by means of a connecting shaft.

Fig. 3 shows a lift variant which substantially corresponds with the lift system illustrated in Figs. 1 and 2, but comprises, instead of two separate drive motors 2, only a single drive motor 2. This comprises a driven shaft 21 acting on both the drive pulley 16, or drives one such.

By Figs. 4 and 5 there is illustrated a lift system according to the invention in which the lift cage 3 is guided by means of a cantilever frame 23 with cage guide shoes 4 at laterally arranged cage guide rails 5. Serving for the drive of the lift is a drive motor 2 which is fitted substantially on one side of the lift cage 3 and mounted on a motor platform 14, which is supported on the guide rails of the lift cage 3 and the counterweight 8. The drive motor 2 in that case acts by way of the drive pulley 16 on a 2:1 suspension system for the lift cage 3 and the counterweight 8, which corresponds with the 2:1 suspension system illustrated in Figs. 1 and 2 and described in the foregoing and in which the support means are always bent in the same sense.

In order to improve the traction capability of the 2:1 suspension system, i.e. to increase the tensile force available in the support means 18, the deflecting rollers 17 can in the case of the lift systems illustrated in Figs. 1 to 5 be replaced by additional drive motors 2, or transmission means - for example belt drives - which transmit the torque from the driven shaft 15 to the deflecting rollers 17 can be provided. Such a transmission means 30 is illustrated in Figs. 6 and 7 and described in connection with these figures.

Figs. 6 and 7 show a further form of embodiment of a lift system according to the invention which similarly comprises a 2:1 suspension system for a lift cage 3 and a counterweight 8, in which the support means 18 are always bent in the same sense. The support means 18 are here so arranged that they loop virtually completely around the lift cage 3, wherein mounted below the cage floor on both sides thereof are cage support rollers 7, the peripheries of which each time protrude laterally somewhat beyond the lift cage 3 and

which transmit the support and drive forces from the support means 18 to the lift cage 3. The lift cage 3 and counterweight 8 are guided in usual manner at guide rails, which are not illustrated here.

5 In this form of embodiment of the lift system there is laterally fixed in the head region of a lift shaft 1 a drive motor 2 which acts on a driven shaft 15 with two drive pulleys 16. A brake 26 which serves the purpose of stopping the lift cage 3 and the counterweight 8 is additionally seated on this driven shaft 15. Two deflecting rollers 17, which are aligned with the said drive pulleys 16, for the support means 18 are mounted, in the lateral head
10 region of the lift shaft 1 opposite the drive motor 2, in a deflecting roller support 27, wherein these deflecting rollers 17 are arranged virtually vertically above two counterweight support rollers 11 mounted at the counterweight 8.

Several support means pulleys (drive pulleys, deflecting rollers, support rollers) are termed
15 "aligned" when the pulley planes thereof lie in a common plane.

The two ends of the support means 18 are fixed in the shaft head region at a small horizontal spacing from the lefthand cage wall. The mentioned deflecting roller support 27 offers itself as a support for the two ends. The support means 18 extend from their fixing
20 point, which lies closer to the cage wall, vertically downwards to the lefthand cage support rollers 7, loop around these in anticlockwise sense through 90°, run horizontally to the righthand cage support rollers 7, loop around these in anticlockwise sense through 90°, extend from here in vertical direction to the righthand side of the drive pulleys 16, loop around these in anticlockwise sense through 90°, run horizontally to the left to the
25 deflecting rollers 17, loop around these in anticlockwise sense through 90°, extend from the lefthand side of the deflecting rollers 17 vertically downwards to the lefthand side of the counterweight support rollers 11, loop around these in anticlockwise sense through 180° and run from the righthand side of the counterweight support rollers 11 vertically upwards to their second fixing point at the deflecting roller support 27.

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It can be readily seen that in the case of this form of embodiment of the lift system as well, the support means 18 are bent exclusively in the same sense.

In Figs. 6 and 7 a transmission means is denoted by 30 which can transmit a torque from
35 the drive shaft 15 of the drive motor 2 to the axle 31 of the deflecting rollers 17. It can

thereby be achieved that the effective looping angle by which the support means 18 loops around a driving pulley is doubled. This measure thus also has the consequence of a doubling of the traction force transmissible by the drive system to the support means 18. In the illustrated case the transmission means 30 is a belt drive which comprises, for example, a cogged belt or wedge-ribbed belt and two corresponding belt pulleys. Such a transmission means 30 is installed only when the installation conditions require this. The lift installation can also be equipped therewith subsequently.

Figs. 8 and 9 show a further form of embodiment of the lift system according to the invention which, with respect to the arrangement of the support means 18, is identical with the form of embodiment illustrated in Figs. 6 and 7. In the form of embodiment to be described here, a second drive motor 2 with a brake 26 is installed in place of the deflecting roller 17. A doubling of the traction force transmissible to the traction means 18 is thereby similarly achieved. This solution offers on the one hand the advantage of increased operational safety thanks to a doubly present brake and on the other hand enables maintenance of a restricted operation with a single drive motor 2 in the case of a defect at one of the drive motors 2.

It is recognisable from the lift systems in accordance with the invention illustrated by Figs. 1 to 9 that in principle any of the support means pulleys 7, 11, 16, 17 can exercise the function of a drive pulley driven by a drive motor 2, i.e. that a drive motor 2 can be fixedly installed in the lift shaft 1 and can act on a drive pulley 16 installed to be non-displaceable or on a deflecting roller serving for deflecting the support means 18, or that a drive motor 2 can be mounted at the lift cage 3 or at the counterweight 8 and act on a cage support roller 7 or on a counterweight support roller 11.

All support means known in lift construction, such as wire cables, synthetic fibre cables, flat belts with wire or synthetic fibre reinforcement, etc., are suitable as support means 18 for a lift system according to the invention.

Particular advantages can be achieved with all afore-described lift systems in that flat belts or flat-belt-like support means are used as support means. Flat-belt-like support means enable the use of support means pulleys (drive pulleys, deflecting rollers and support rollers) with, by comparison with support means pulleys for wire cables, significantly reduced diameters. Thus, on the one hand the installation space required for the 2:1

suspension systems according to the invention can be reduced and on the other hand drive motors 2 with substantially smaller dimensions can be used, since the torque required at the drive pulley is similarly reduced in proportion to the reduction in the drive pulley diameter.

5

The use of wedge-ribbed belts 32 or cogged belts 36, 37 as support means 18 brings additional advantages. Fig. 10 shows the principle of a wedge-ribbed element 32 which has several wedge-shaped grooves 33 and wedge ribs 34, which are arranged in parallel in longitudinal direction, and reinforcing tensile carriers 35. Used in combination with

10 correspondingly constructed drive pulleys 16 these wedge-shaped grooves 33 and wedge ribs 34 enable, by their wedge action, a force transmission between drive pulley 16 and support means 18 (wedge-ribbed belt 32) which is substantially increased relative to usual flat belts.

15 It is a further advantage of the wedge-ribbed belt 32 that it self-centres on the support means pulleys which drive or guide it and which have at the periphery thereof a counter-profile corresponding with the rib/groove profile of the wedge-ribbed belt 32.

It is of advantage for the use as support means 18 in lift systems according to the

20 invention if the wedge-shaped grooves 33 of the wedge-ribbed belt have a groove angle b of 80 degrees to 100 degrees. The groove angle b is preferably 90 degrees. This groove angle b is substantially greater than in the case of conventional wedge-ribbed belts. Due to the larger groove angle b there is achieved a reduction in running noise. The self-centring property as also the increased force transmission between drive pulley 16 and

25 support means 18 (wedge-ribbed belt 32) is in that case retained to sufficient extent.

Similar advantages as with wedge-ribbed belts can also be achieved in a lift system according to the invention with cogged belts which co-operate with toothed drive pulleys, support rollers and deflecting rollers. Fig. 11 shows a cogged belt 36 with a tothing 37

30 and reinforcing tensile carriers 35. Cogged belts are similarly suitable for operation and combination with pulleys and rollers which have particularly small diameters. They offer in general extremely high traction capability and self-centre on the toothed pulleys and rollers if they have, for example, a herringbone tothing or a curved tothing. Fig. 12 shows such a cogged belt with herringbone tothing 38 and Fig. 13 shows a cogged belt with curved

35 tothing 39.

Claims:

1. Lift system, which comprises a lift cage (3) and a counterweight (8) each with a respective support means pulley (7, 11), at least one support means pulley (16, 17) installed in a lift shaft (1) to be non-displaceable, and flat-belt-like support means (18), wherein the support means together with the support means pulleys (7, 11, 16, 17) form a 2:1 suspension system for the lift cage (3) and for the counterweight (8), characterised in that the at least one support means pulley (16, 17) installed in the lift shaft (1) to be non-displaceable as well as the lift cage (3) and the counterweight (8) together with the support means pulleys (7, 11) mounted thereat are so arranged that the support means (18) when running around all support means pulleys are always bent in the same sense.
2. Lift system according to claim 1, characterised in that the 2:1 suspension system comprises, above the range of movement of the support means pulleys (7, 11) mounted at lift cage (2) and counterweight (8), two support means pulleys (16, 17) aligned with one another and installed in the lift shaft to be non-displaceable, and that each time one of the support means pulleys (7, 11) mounted at the lift cage and at the counterweight is arranged approximately vertically underneath a respective one of the support means pulleys (16, 17) installed to be non-displaceable and is arranged in alignment with the support means pulleys (7, 11), wherein each time two end sections of a support means (18) are fixed above the range of movement of the support means pulleys (7, 11) mounted at the lift cage and the counterweight and run from there downwardly in the zone extending vertically between the support means pulleys (7, 11) at the lift cage (3) and those at the counterweight (8).
3. Lift system according to claim 1 or claim 2, characterised in that the support means pulleys (7, 11, 16, 17) are present in the form of a drive pulley (16) driven by a drive motor (2) and installed to be non-displaceable, in the form of a deflecting roller (17) serving for deflecting the support means (18) or in the form of a cage support roller (7) or a counterweight support roller (11).
4. Lift system according to claim 3, characterised in that each of the support means pulleys (7, 11, 16, 17) can exercise the function of the drive pulley (16) driven by the drive motor (2), where the drive motor (2) can be fixedly installed in the lift shaft (1) and can act on the drive pulley (16) installed to be non-displaceable or on the deflecting roller (17) serving for deflection of the support means (18), or that the drive motor (2) can be mounted at the lift cage (3) or at the counterweight (8) and can act on the cage support roller (7) or on the counterweight support roller (11).

5. Lift system according to claim 3 or claim 4, comprising two counterweights (8) and two 2:1 suspension systems.
6. Lift system according to any one of claims 3 to 5, characterised in that a respective counterweight (8) and a respective 2:1 suspension system are arranged on each of two opposite sides of the lift cage (3), wherein the 2:1 suspension systems each comprise at least one of said drive pulley (16), the support means (18) as well as at least one of said respective cage support roller (7) and said counterweight support roller (11).
7. Lift system according to claim 3 or claim 4, characterised in that the counterweight (8) and the 2:1 suspension system are arranged only on one side of the lift cage, wherein the 2:1 suspension system comprises at least one of said drive pulley (16), the support means (18) as well as one of said respective cage support roller (7) and the counterweight support roller (11).
8. Lift system according to any one of claims 3 to 5, characterised in that the 2:1 suspension system is so constructed that the support means (18) loops under the lift cage (3), wherein at least one of said cage support roller (7) is mounted at the underside of the lift cage.
9. Lift system according to any one of claims 3 to 8, characterised in that respective additional drive motors (2) are present instead of the deflecting rollers (17).
10. Lift system according to any one of claims 3 to 9, characterised in that a transmission means, is present and transmits a torque from a driven shaft (15) of the drive motor (2) to the deflecting roller (17).
11. Lift system according to claim 1 or claim 2, characterised in that only a single drive motor (2) is present and comprises one or two driven shafts (15) each with at least one drive pulley (16).
12. Lift system according to any one of claims 3 to 10, characterised in that two of said drive motors (2) are present and each comprise a respective driven shaft (15) with at least one respective drive pulley (16).
13. Lift system according to any one of claims 3 to 10, characterised in that two of said drive motors (2) are present, wherein the two drive motors (2) each comprise two driven shafts (15), of which one carries at least one of said drive pulley (16) and the other serves for mechanical synchronisation of the rotational movement of the two drive motors (2).
14. Lift system according to any one of claims 1 to 13, characterised in that the support means (18) are constructed as flat belts.

15. Lift system according to any one of claims 1 to 13, characterised in that the support means (18) are constructed as wedge-ribbed belts (32).
16. Lift system according to claim 15, characterised in that the wedge-ribbed belts (32) have groove angles (b) of 80° to 100°.
17. Lift system according to any one of claims 1 to 13, characterised in that the support means (18) are constructed as cogged belts (36, 38, 39).
18. Lift system according to claim 17, characterised in that the cogged belts are selected from cogged belts with herringbone tothing (38) and cogged belts with curved tothing (39).

Fig. 1

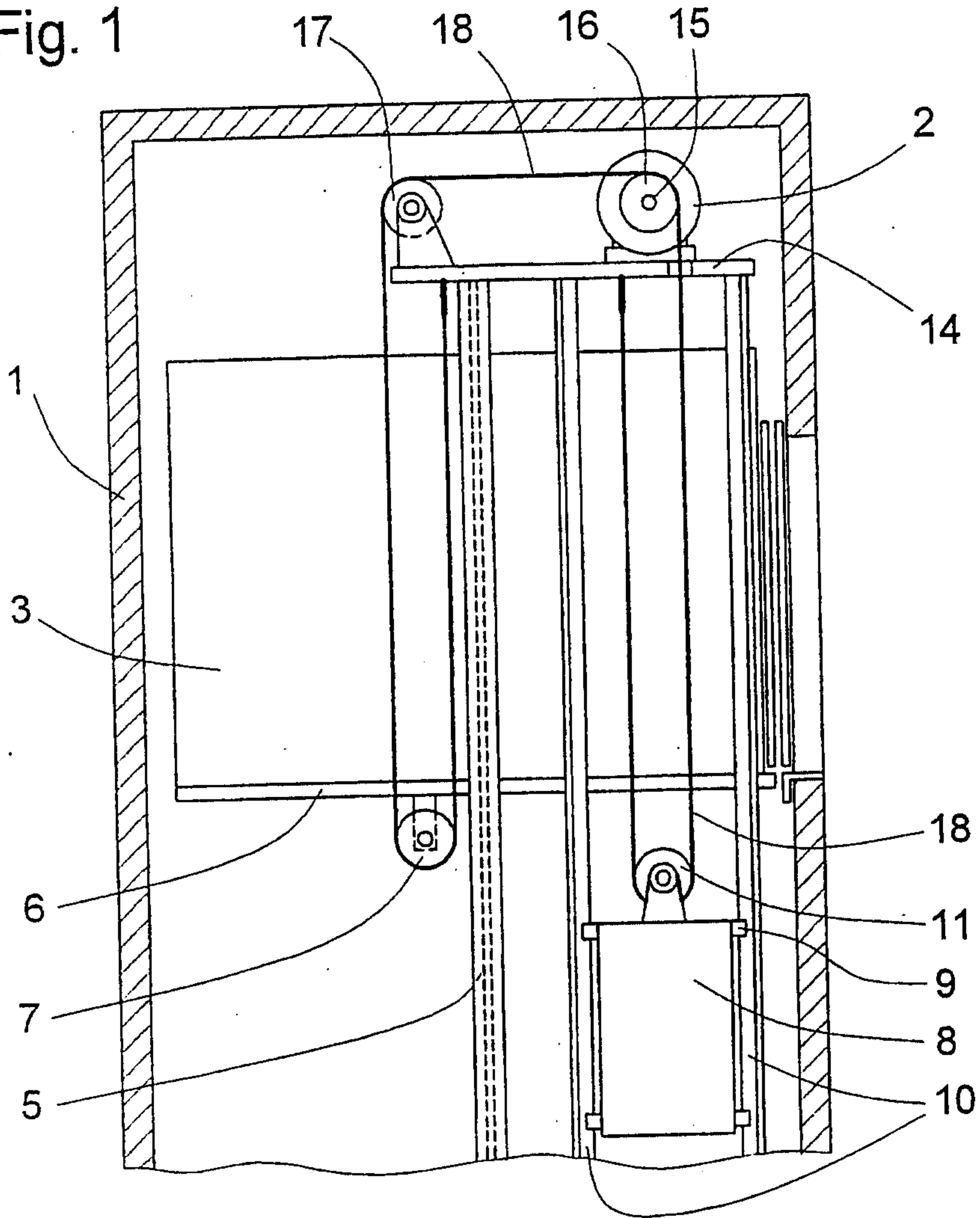


Fig. 2

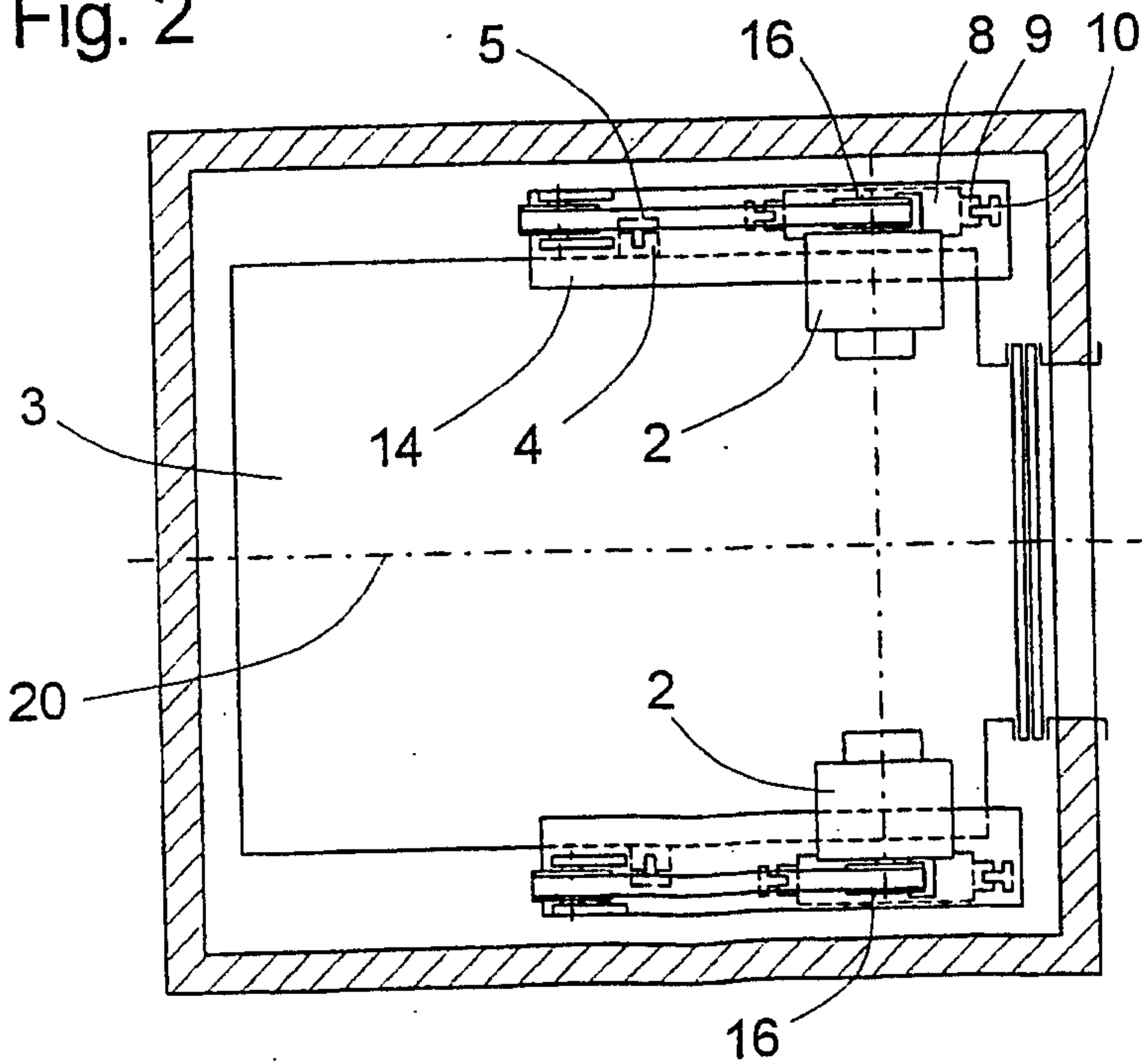


Fig. 3

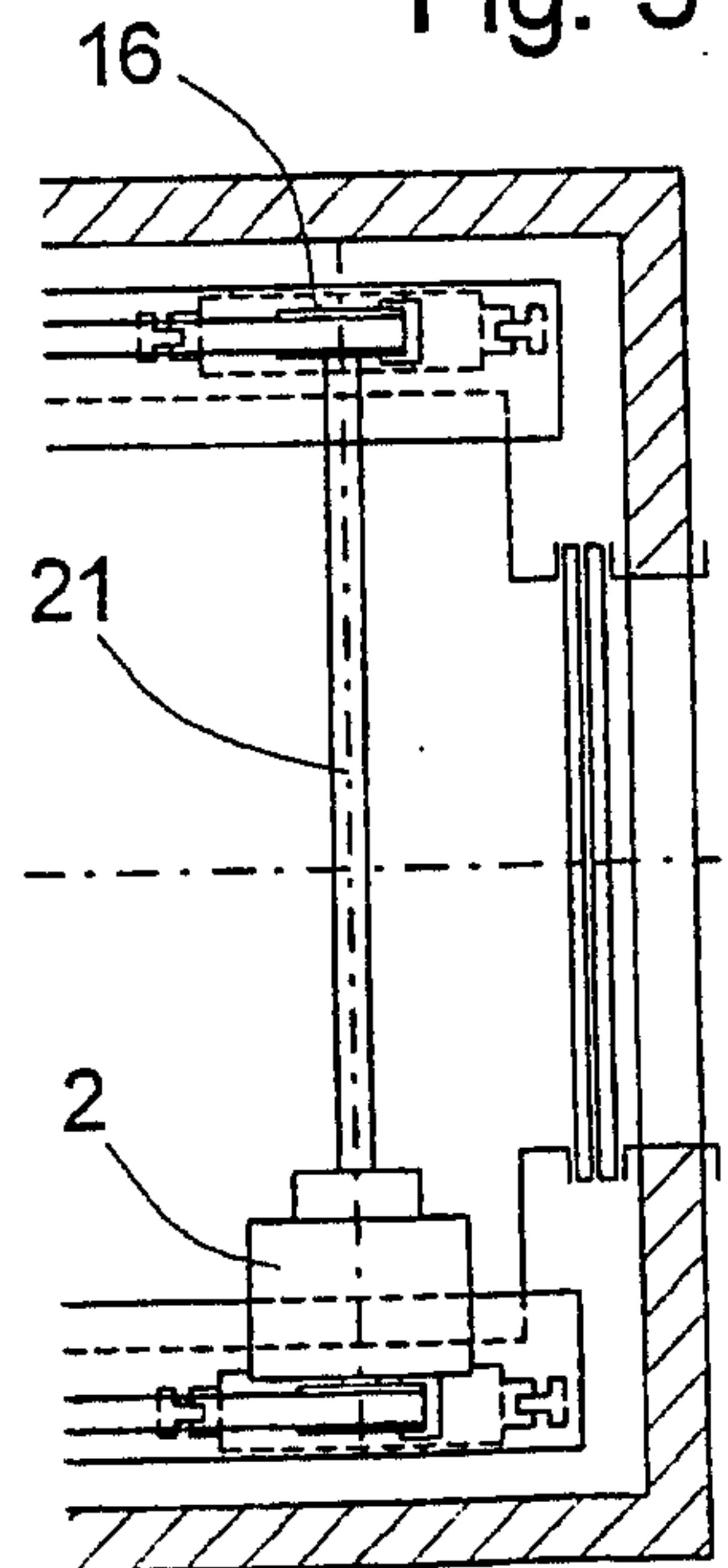


Fig. 4

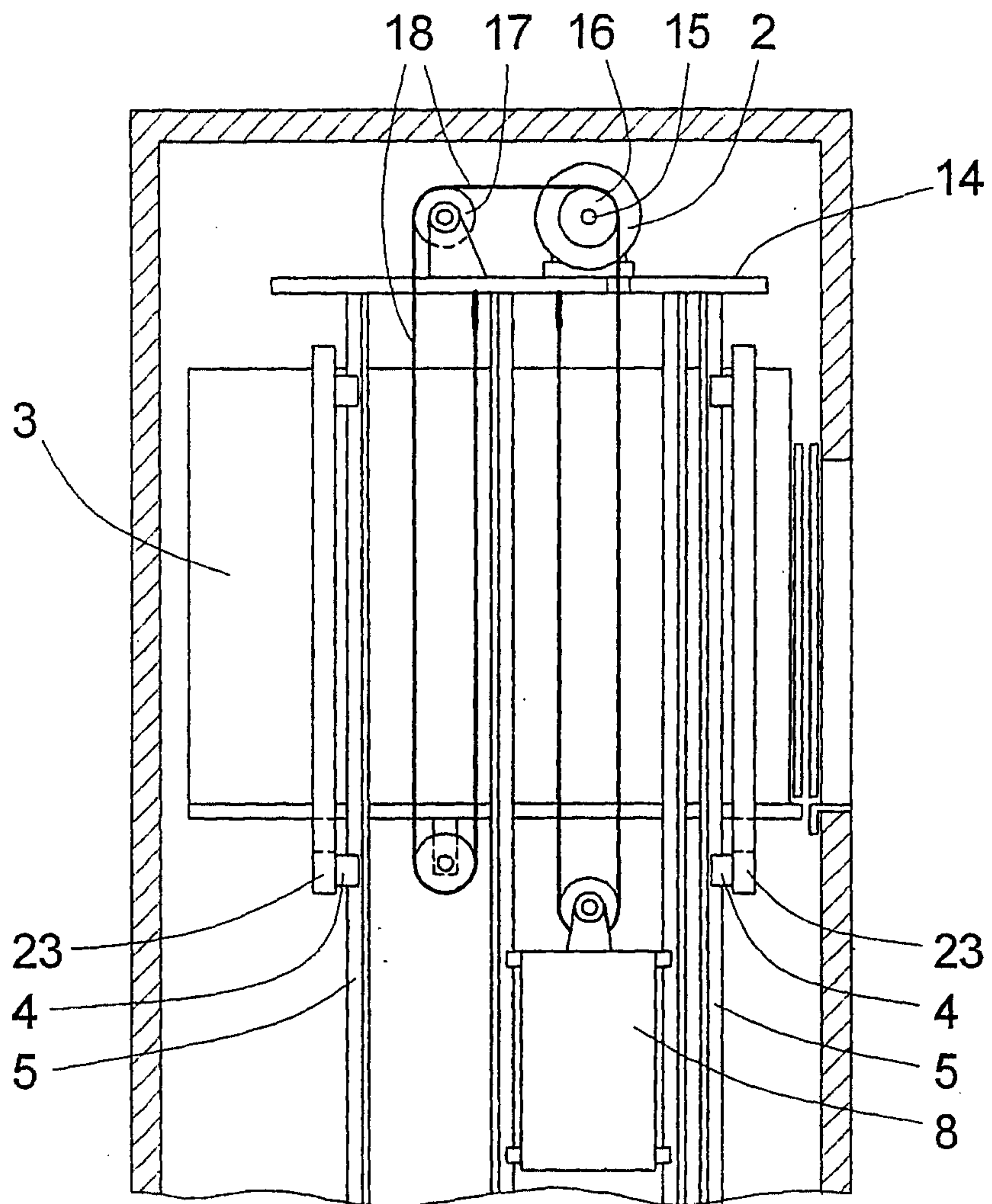


Fig. 5

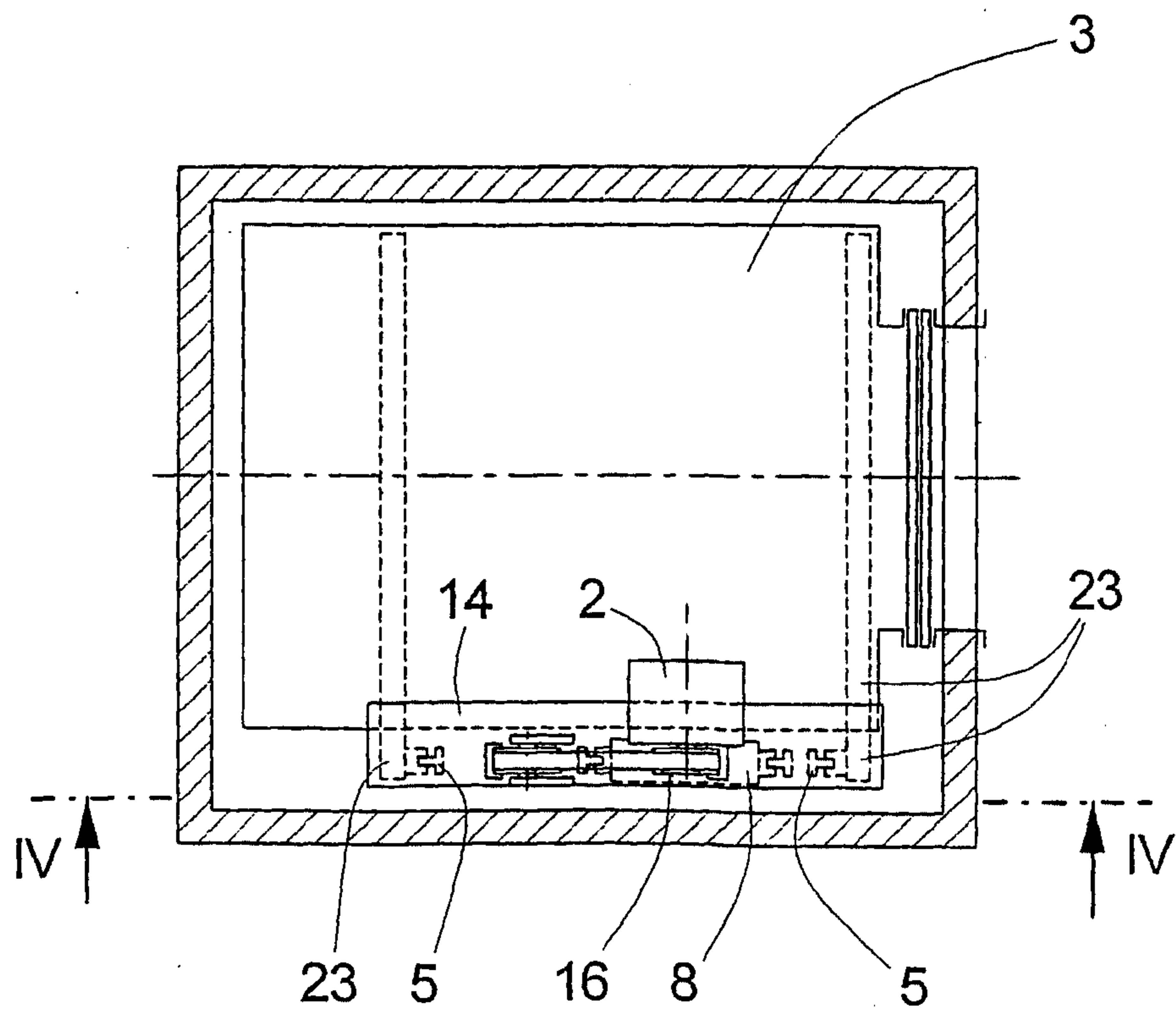


Fig. 8

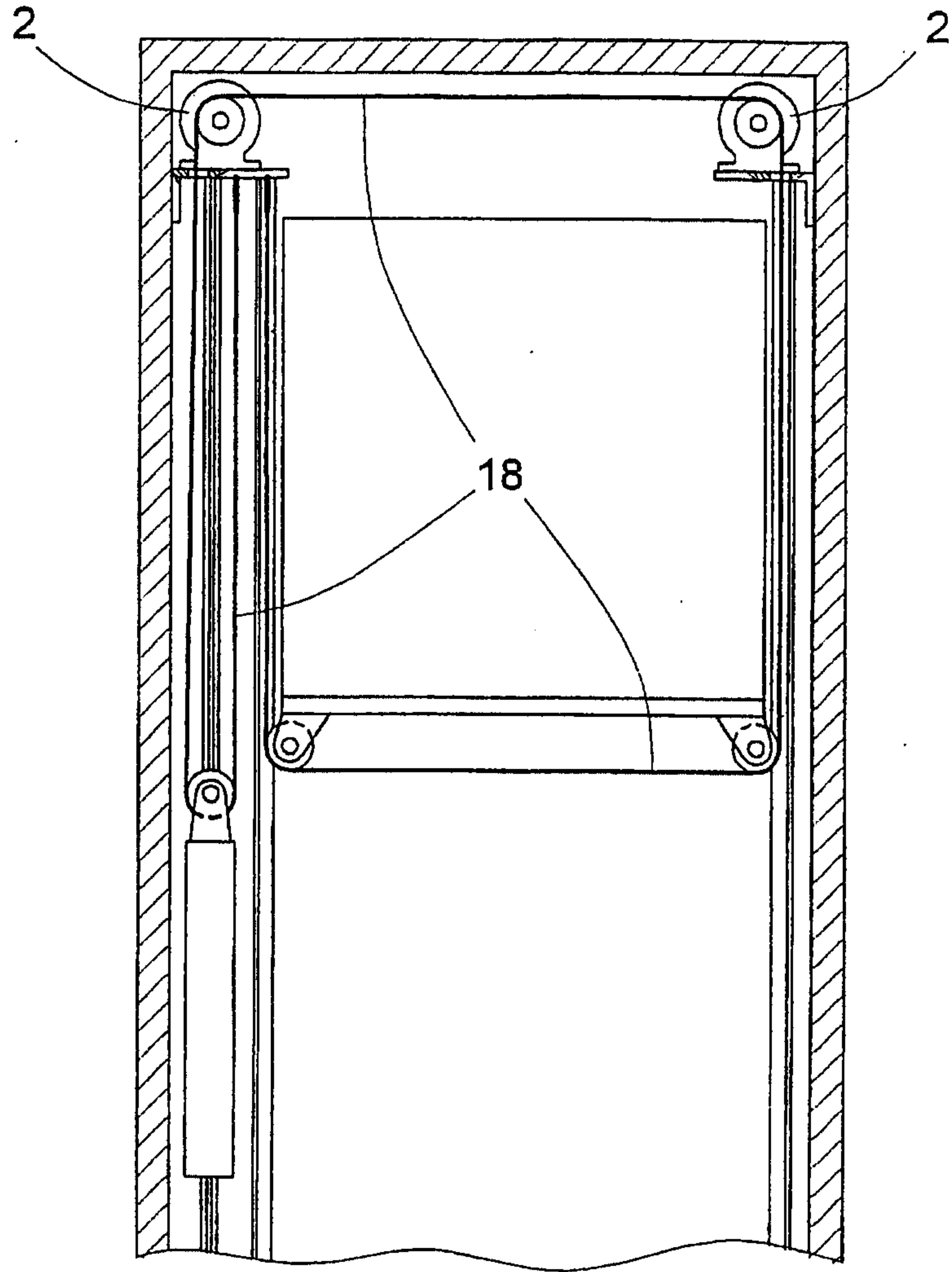


Fig. 9

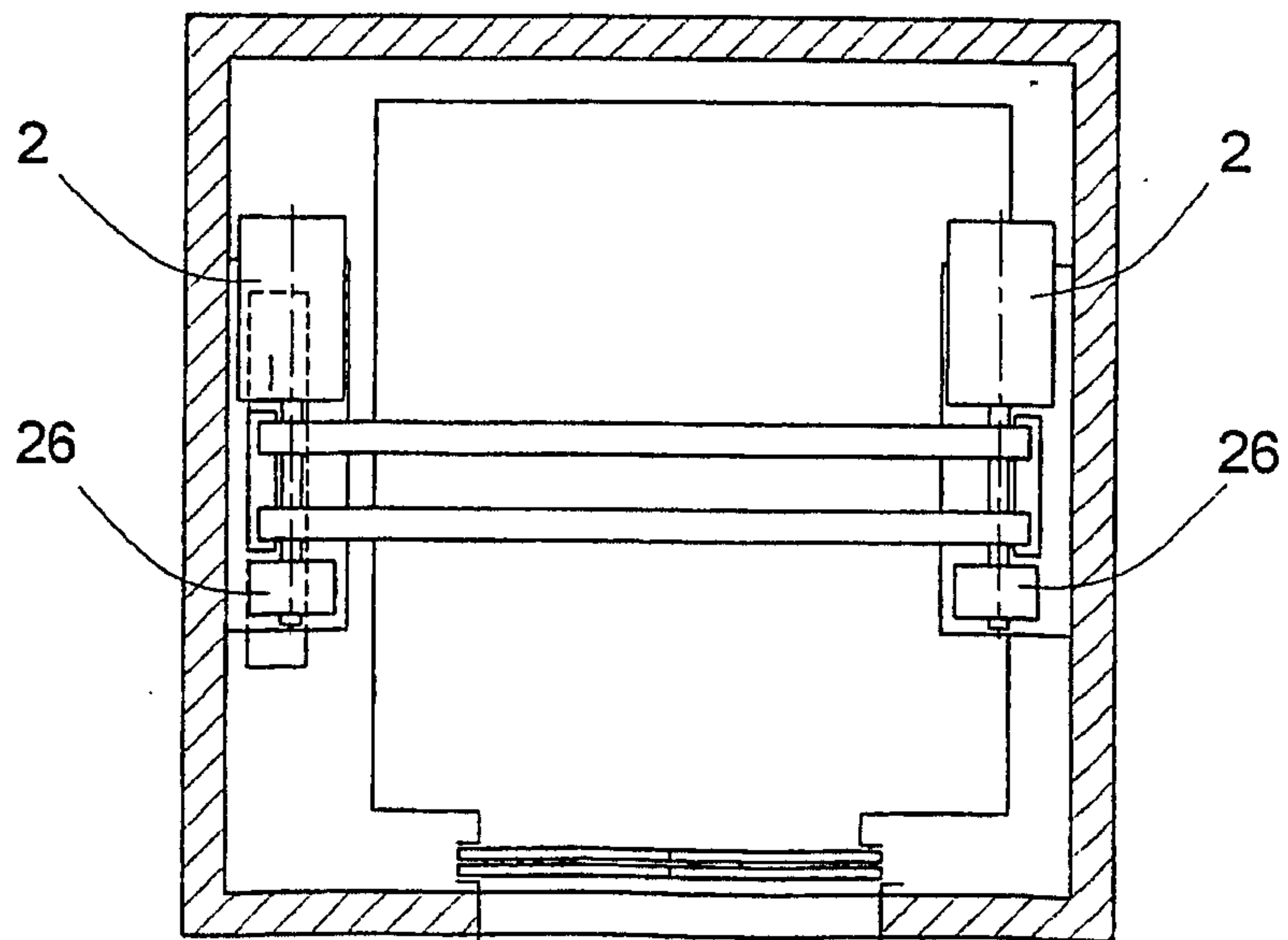


Fig. 10

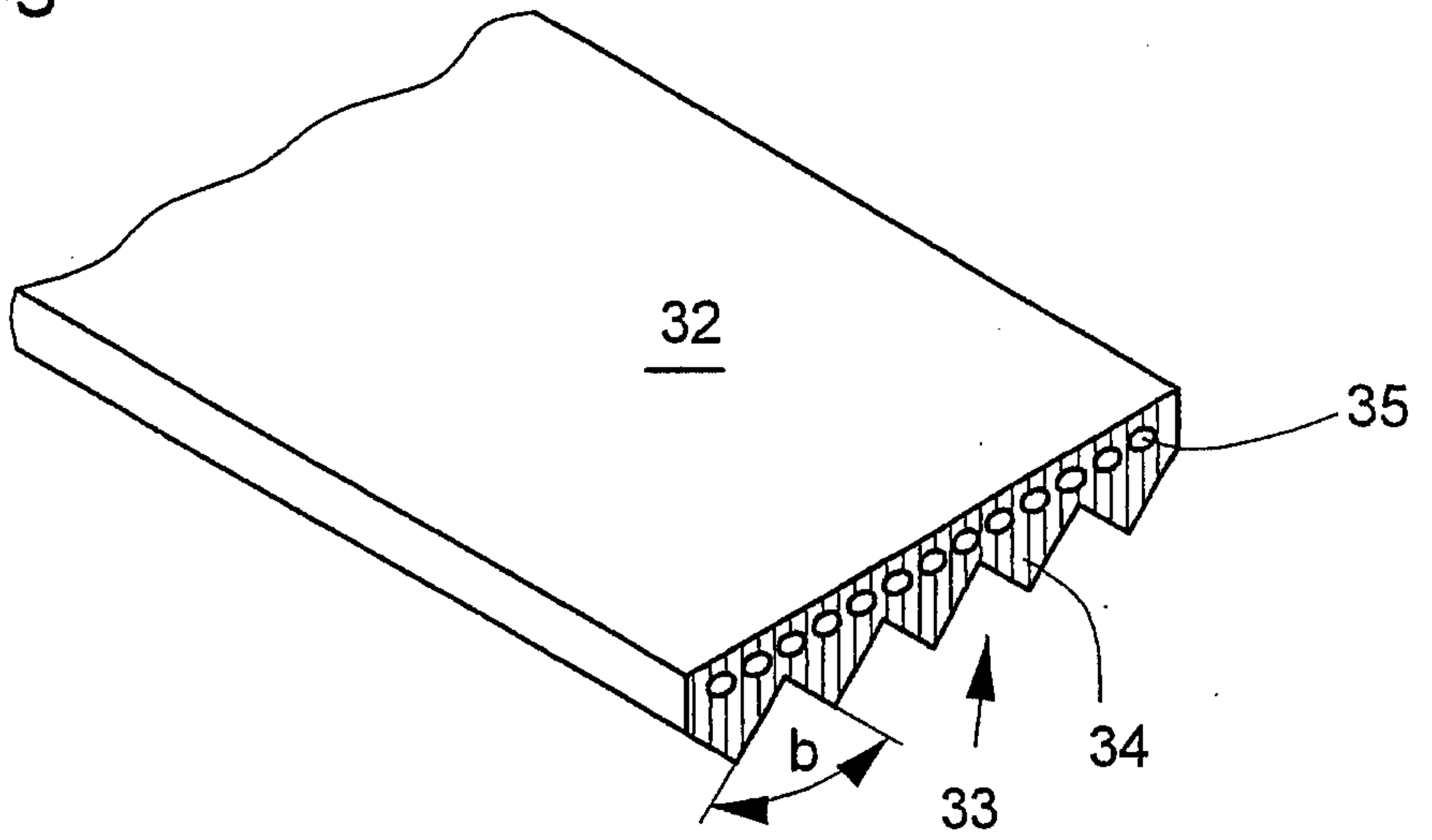


Fig. 11

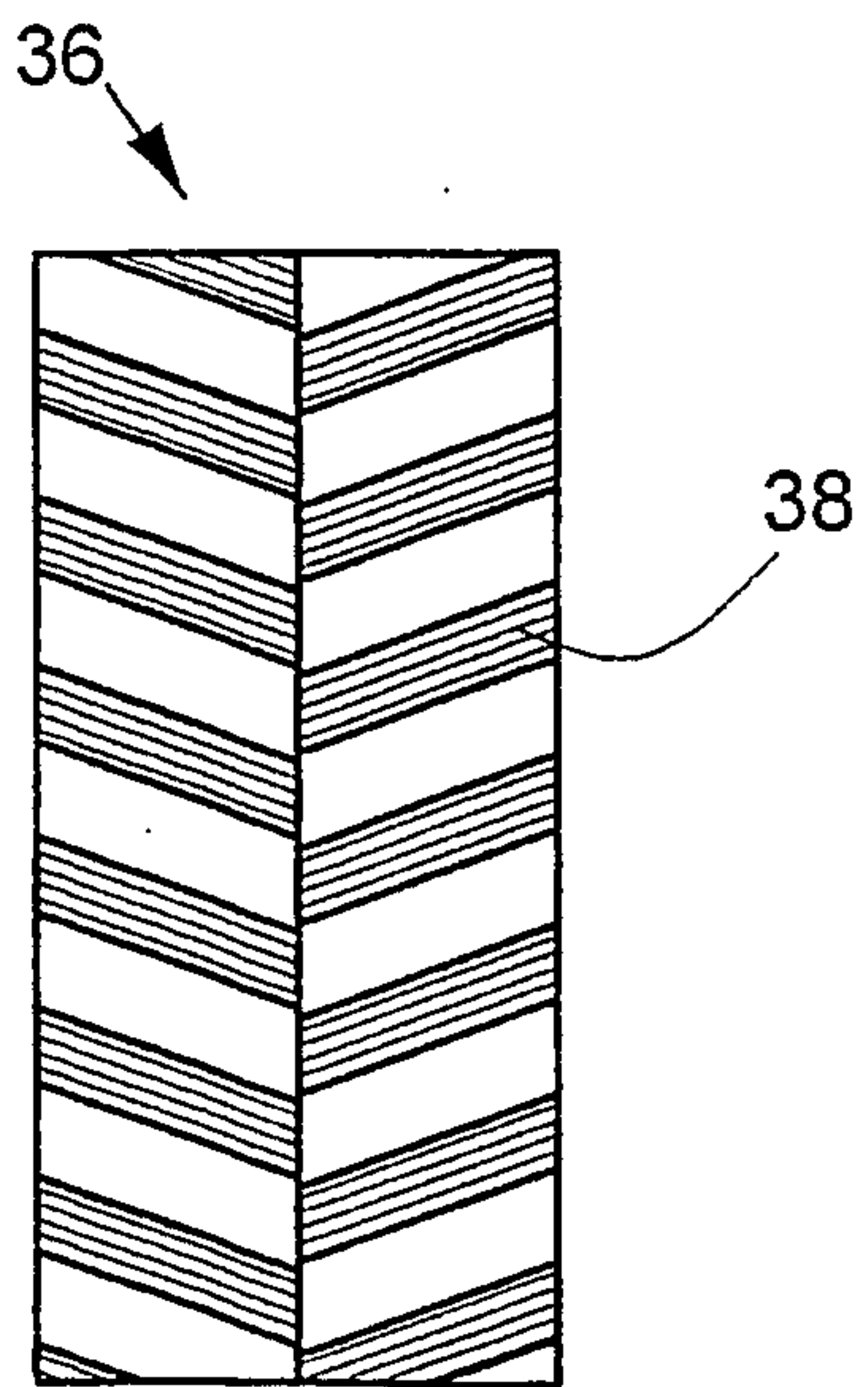
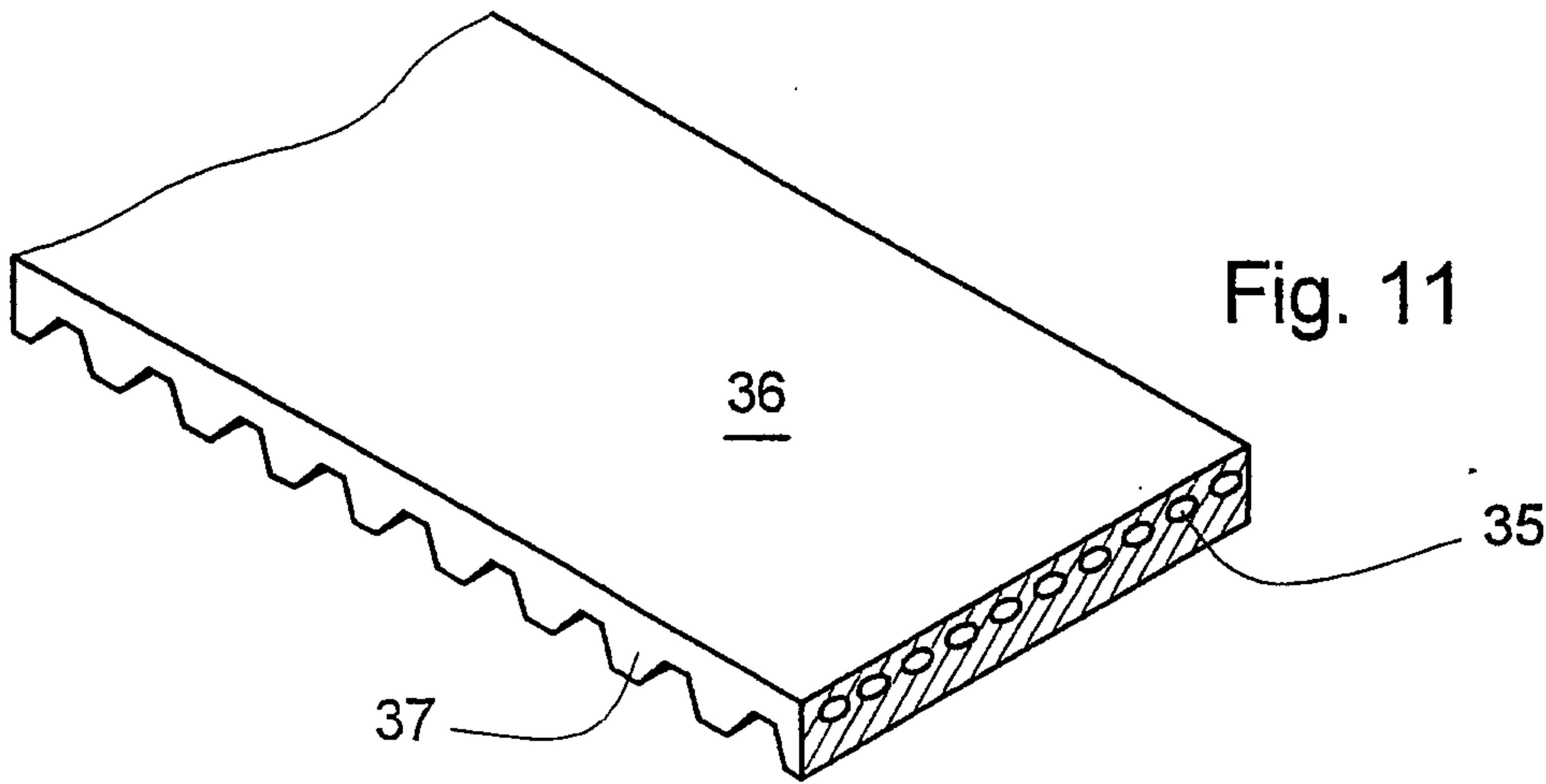


Fig. 12

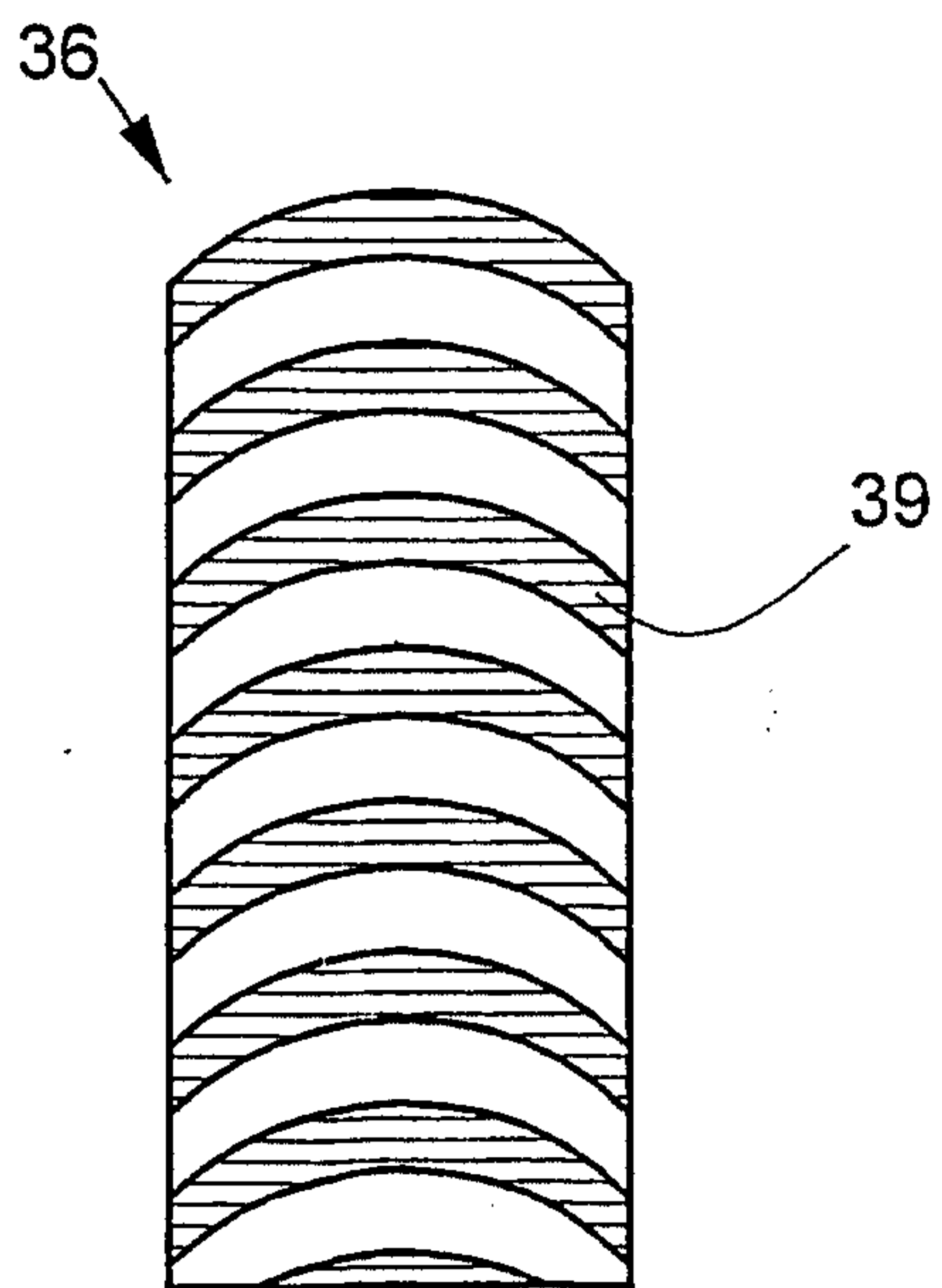


Fig. 13

