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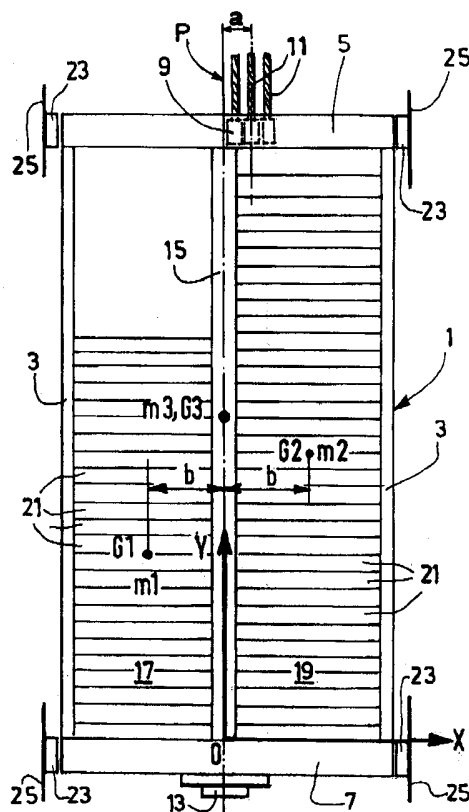
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(54) Title: COUNTERWEIGHT FOR AN ELEVATOR WITH A TRACTION PLANE OFFSET RELATIVE TO THE VERTICAL MID-PLANE, AND WITH A BALANCED GUIDING SYSTEM, AND ELEVATOR EQUIPPED THEREWITH



(57) Abstract: The invention relates to a counterweight for an elevator in which the vertical traction axis of the suspension cables (11) is offset relative to its vertical mid-plane (P), wherein the counterweight is a rectangular peripheral frame (1) with ballast elements and including side guide elements (23) adapted to slide on counterweight, guide rails (25), characterized in that said frame (1) includes at least two separate compartments (17, 19) extending over its height, said compartments being adapted to accommodate each materials or ballast elements (21), up to defined respective total masses, wherein such respective total masses are arranged relative to each other and relative to the suspension axis so that the overall gravity center of the counterweight lies on the counterweight suspension axis.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

**COUNTERWEIGHT FOR AN ELEVATOR WITH A TRACTION PLANE
OFFSET RELATIVE TO THE VERTICAL MID-PLANE AND WITH A
BALANCED GUIDING SYSTEM, AND ELEVATOR EQUIPPED
THEREWITH.**

5 This invention relates to a counterweight for an elevator with a traction plane offset relative to the vertical mid-plane and with a balanced guiding system, and to an elevator equipped therewith.

10 The development of modern elevators without machine rooms is known to reduce the size of the shaft, and the arrangement of the components of the elevator is reduced to the smallest possible volume within this shaft, so that the traction axis of the counterweight may be offset relative to its vertical mid-plane, where its gravity center is located. The counterweight is conventionally made of a rectangular frame with fillers extending across its width, and with a median plan of
15 symmetry. The offset between the vertical traction axis of the counterweight suspension cables and the vertical mid-plane of the counterweight including its gravity center produces an overhang that makes it more difficult to guide and therefore causes a faster wear of the counterweight guiding elements on its guiding rails.

20 This invention aims at correcting this disadvantage and proposes a counterweight for an elevator in which the vertical traction axis of the suspension cables is offset relative to its vertical mid-plane, wherein the counterweight is of the type comprising a rectangular peripheral frame with ballast elements and including side guide elements adapted to
25 slide on counterweight guide rails, characterized in that said frame includes at least two separate compartments extending over its height, said compartments being adapted to accommodate each materials or ballast elements, up to defined respective total masses, wherein such respective total masses are arranged relative to each other and relative
30 to the suspension axis so that the overall gravity center of the counterweight lies on the counterweight suspension axis.

 Said compartments can have a common vertical partition, which is advantageously located in the vertical mid-plane of the counterweight frame.

35 Said compartments can be closed on their front and rear walls to contain a bulk ballast material up to a determined height, such as

sand, steel balls, concrete, etc., but they are advantageously open on their front and rear walls to contain piled-up ballast elements or fillers.

Said partition between the compartments can be made of a stiff middle profile post attached to the peripheral counterweight frame, so as to form two compartments having the same size and adapted to accommodate fillers of the same width and to stiffen the counterweight frame structure, with a corresponding possibility to design lighter frame posts.

In addition, aligning the bearing axis and the gravity center of the counterweight ensures a perfectly free guiding of the counterweight on its guides, without any side friction to maintain the counterweight off axis and therefore without uncomfortable vibration as the elevator car moves. In addition, the number of counterweight guiding elements can be reduced, as well as their cross-section and that of the corresponding guides, and the counterweight frame is no longer submitted to a parallelogram deformation.

The invention logically relates also to an elevator equipped with a counterweight as described above.

The invention is illustrated hereafter by an exemplary embodiment, with reference to the appended drawings in which:

Figure 1 is a schematic elevation view of a counterweight according to the embodiment of the invention, and

Figure 2 is a schematic elevation view of a counterweight according to the exemplary embodiment with an optimized filler load.

Referring to Figure 1, the exemplary counterweight has a classic stiff peripheral frame 1 made of two metallic side posts 3 with a U-shaped internal cross-section and of an upper 5 and a lower 7 cross-members connecting said side posts. The upper cross-member 5 bears the sheave unit 9 for the counterweight hanging cables 11 in its mid-longitudinal plane, and the suspension axis is indicated by the upper vertical chain dotted line.

The lower cross-element 7 bears a classic bottom shock-absorbing pad 13.

A metallic post with an H-shaped cross-section 15 connects the lower cross-member 7 to the upper cross-member 5 in the mid-plane P of the peripheral frame. This post 15 divides the peripheral frame 1 into left 17 and right 19 vertical longitudinal compartments. These

compartments contain identical fillers 21 piled up on each other and held at their ends shaped as rectangular noses in the U-shaped recess of the lateral post 13 and the H of the middle post 15 respectively, within some clearance.

5 Four guiding slides 23 are attached by pairs to the opposite upper and lower side ends of the peripheral frame, respectively. The slides 23 move on counterweight guide rails 25.

As can be seen on the drawing, the counterweight suspension axis is offset by a distance a from the mid-plane P and, in order to avoid any off-axis suspension stress by the counterweight on its guides 25 through the slides 23, the overall gravity center of the counterweight must be aligned with the cable suspension axis.

The detail of the filling method to align the counterweight axis containing its gravity center, referred to hereinafter as "Cwt axis", with the traction axis is illustrated above.

The principle is to put more weight in the right filling row to compensate for said offset a .

The following part details, for information, the method to calculate these specific masses m_1 and m_2 of the rows. The present data are given with reference to Figure 1.

G_1 = Gravity center of the fillers in the left row

G_2 = Gravity center of the fillers in the right row

G_3 = Gravity center of the Cwt frame (sheave not included)

25 m_1 = Fillers in the left row total mass

m_2 = Fillers in the right row total mass

m_3 = Cwt frame weight (without sheave)

m_{sheave} = sheave mass

a = offset

30

To have the traction axis aligned with the gravity center of the complete counterweight, it is necessary to have the following, with reference to the coordinates axis XY as represented:

35 $m_1 X_{G_1} + m_2 X_{G_2} + m_3 X_{G_3} = (m_1 + m_2 + m_3) a$
(by definition of the gravity center)

Since:

$$\left| \begin{array}{l} X_{G1} = -b \\ X_{G2} = +b \\ X_{G3} = 0 \end{array} \right. \text{ it comes:}$$

$$\begin{aligned} 5 \quad m_1 X_{G1} + m_2 X_{G2} &= (m_1 + m_2 + m_3) \cdot a \\ \text{or} \quad b \quad (m_2 - m_1) &= (m_1 + m_2 + m_3) \cdot a \\ \text{or} \quad m_1 (a + b) + m_2 (a - b) + m_3 \cdot a &= 0 \end{aligned}$$

$$\text{And we know that} \quad m_1 + m_2 + m_3 + m_{\text{sheave}} = m_{\text{Cwt}}$$

10

$$\text{So the equation system is :} \quad \left\{ \begin{array}{l} m_1 (a + b) + m_2 (a - b) + m_3 \cdot a = 0 \\ m_1 + m_2 + m_3 + m_{\text{sheave}} = m_{\text{Cwt}} \end{array} \right.$$

The unknowns in system are m_1 and m_2

15

After resolution, it comes:

$$\begin{aligned} m_2 &= \frac{m_{\text{Cwt}}(a + b) - m_{\text{sheave}}(a + b) - m_3 \cdot b}{2b} \\ m_1 &= m_{\text{Cwt}} - m_{\text{sheave}} - m_3 - m_2 \end{aligned}$$

20

Thus, if in the left filling row the total mass of the fillers is m_1 as calculated above and if in the right filling row, the total mass of the fillers is m_2 as calculated above, then the traction axis will be aligned with the gravity center of the complete counterweight.

Once the weight in each filling row is defined (m_1 and m_2), it is possible to define a combination of concrete and steel fillers to fill the counterweight up to the top of each row as the density of concrete fillers can be 2 or 4 and the density of steel fillers is 7.85.

This can be easily done via a classic filling program. This kind of program defines the number of concrete and steel fillers which have to be installed to achieve a given weight at a given height.

30

Figure 2 shows such a filling optimization of the counterweight, the gravity center of same being in line with the traction axis (in the sheave middle).

The steel fillers are represented at the lower level and the concrete fillers (dotted) at the upper level.

35

The theoretic calculation of the number of steel and concrete fillers for the counterweight shall now be described for the right-side compartment.

Considering that:

5 ℓ_1 = density of steel

ℓ_2 = density of concrete

S = area of a filler (there are two rows of fillers across the width of the counterweight)

10 f = stacking factor (twisting of steel fillers according to their thickness)

h_1 = height of the steel fillers including stacking factor

h_2 = height of the concrete fillers

H = maximum possible filling height

15 P_{tot} fillers = total weight of the steel and concrete fillers
= $P_{\text{theory CWT}} - P_{\text{steel frame CWT}}$

n_1 = number of steel fillers

n_2 = number of concrete fillers

e_1 = nominal thickness of a steel filler (no stacking factor)

e_2 = nominal thickness of a concrete filler

20 The starting assumption is that filling is optimized so that:

$$H = h_1 + h_2$$

$$\text{We have: } h_1 = n_1 \cdot (e_1 \cdot f) \text{ or } n_1 e_1 = \frac{h_1}{f} \text{ and } h_2 = n_2 \cdot e_2;$$

$$\text{hence } H = n_1 \cdot e_1 \cdot f + n_2 \cdot e_2$$

25 It should be noted that n_1 and n_2 do not have to be integers to meet this condition; they will be rounded later.

Now the total weight of steel fillers is:

$$P_{\text{tot steel fillers}} = 2S n_1 e_1 \ell_1 = 2S \frac{h_1 \ell_1}{f}$$

The total weight of concrete fillers is: $P_{\text{tot concrete fillers}} = 2S h_2 \ell_2$

The total weight of the fillers is:

30
$$P_{\text{tot fillers}} = 2S \left(\frac{h_1 \ell_1}{f} + h_2 \ell_2 \right)$$

$$\text{Now } h_2 = H - h_1, \text{ therefore } P_{\text{tot fillers}} = 2S \left[\frac{h_1 \ell_1}{f} + (H - h_1) \ell_2 \right]$$

$$\text{and hence } h_1 = \frac{P_{\text{tot fillers}} - 2SH \ell_2}{2S \left(\frac{\ell_1}{f} - \ell_2 \right)}$$

Now $h_1 = n_1 \cdot e_1 \cdot f$, therefore $n_1 = \frac{P_{tot} fillers - 2SH\ell_2}{2Se_1(\ell_1 - \ell_2 f)}$
 (to be rounded up)

$H - h_1 = h_2 = n_2 \cdot e_2$, therefore $n_2 = \frac{H - h_1}{e_2}$

5

Hence
$$n_2 = \frac{1}{e_2} \left(H - \frac{P_{tot} fillers - 2SH\ell_2}{2Se_2 \left(\frac{\ell_1}{f} - \ell_2 \right)} \right)$$

Note: the condition $n_1 \cdot e_1 + n_2 \cdot e_2 \leq H$ should be verified (with n_1 and n_2 , the numbers of steel and concrete fillers, being respectively rounded).

10

The calculation is the same as before for the filling of the left-side compartment.

Of course, implementation variants can be introduced within the scope of the appended claims.

15

For example, each of the counterweights may have front and rear walls, optionally removable, as above, to contain a bulk ballast material such as sand, steel balls or concrete, which may be arranged at a determined height according to the offset between the cable suspension axis and the mid-plane of the counterweight.

20

CLAIMS

1. Counterweight for an elevator in which the vertical traction axis of the suspension cables (11) is offset relative to its vertical mid-plane (P), wherein the counterweight is a rectangular peripheral frame (1) with ballast elements and including side guide elements (23) adapted to slide on counterweight guide rails (25), characterized in that said frame (1) includes at least two separate compartments (17, 19) extending over its height, said compartments being adapted to accommodate each materials or ballast elements (21), up to defined respective total masses, wherein such respective total masses are arranged relative to each other and relative to the suspension axis so that the overall gravity center of the counterweight lies on the counterweight suspension axis.

2. Elevator counterweight as per claim 1, characterized in that said compartments (17, 19) have a common vertical partition (15).

3. Elevator counterweight as per claim 2, characterized in that said common partition (15) of the compartments lies in the vertical mid-plane (P) of the counterweight frame (1).

4. Elevator counterweight as per any one of the preceding claims, characterized in that said compartments (17, 19) can be closed on their front and rear walls to contain a bulk ballast material up to a determined height, such as sand, steel balls, concrete, etc.

5. Elevator counterweight as per any one of claims 1-3, characterized in that said compartments (17, 19) are open on their front and rear walls to contain piled-up ballast elements or fillers (21).

6. Elevator counterweight as per any one of claims 3 and 5, characterized in that said compartment partition is made of a stiff middle profile post (15) attached to the peripheral counterweight frame (1), so as to form two compartments (17, 19) having the same size and adapted to accommodate fillers (21) of the same width and to stiffen the counterweight frame (1) structure, with a corresponding possibility to design lighter frame posts.

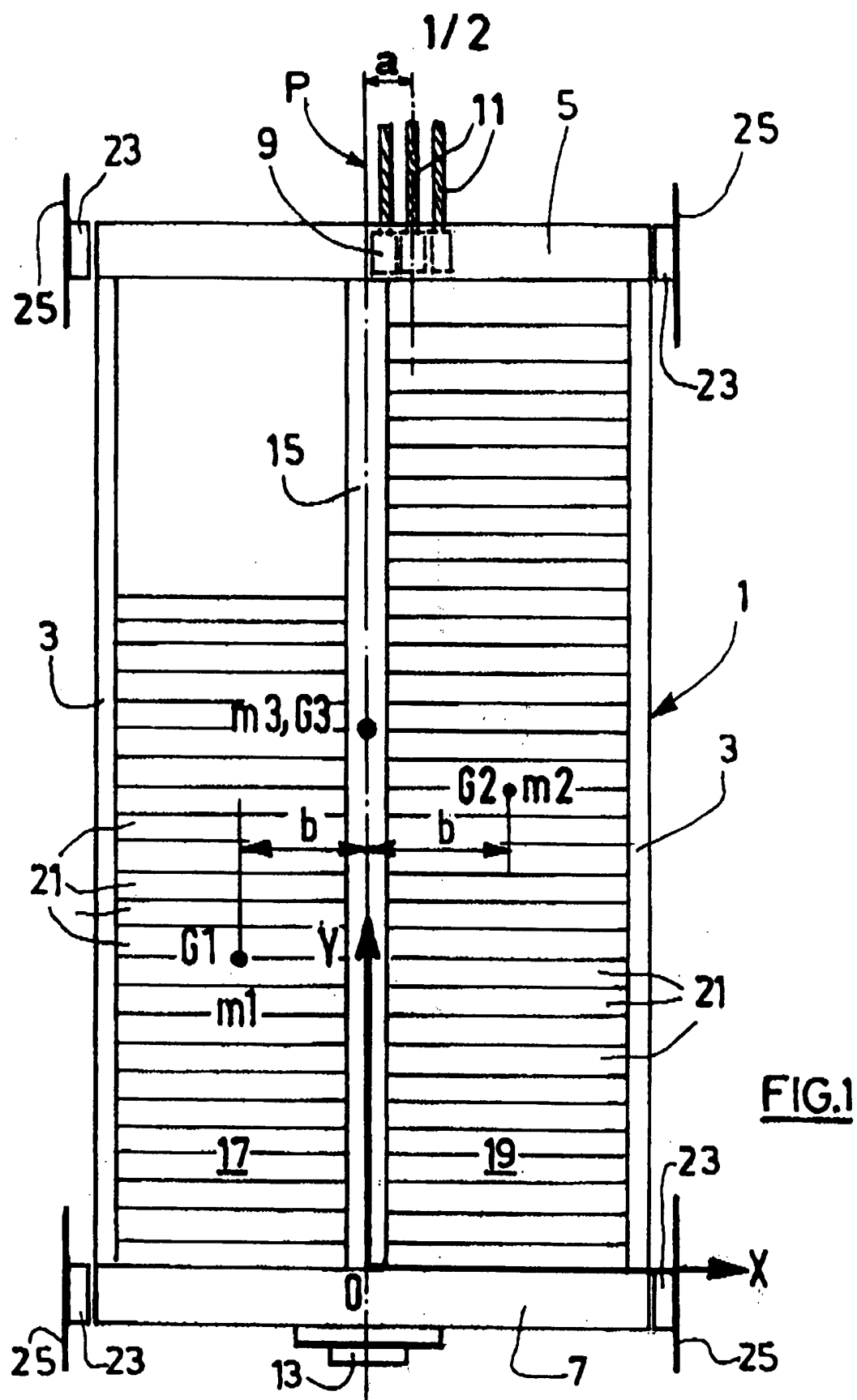
7. Elevator counterweight as per claim 6, characterized in that it includes a metallic post with an H-shaped cross-section (15) that connects the lower cross-member (7) to the upper cross-member (5) in the mid-plane (P) of the peripheral frame (1), wherein this post (15) divides the peripheral frame (1) into left (17) and right (19) vertical

longitudinal compartments containing identical fillers (21) piled up on each other and held at their ends shaped as rectangular noses in the U-shaped recess of the lateral post (13) and the H of the middle post (15) respectively, within some clearance.

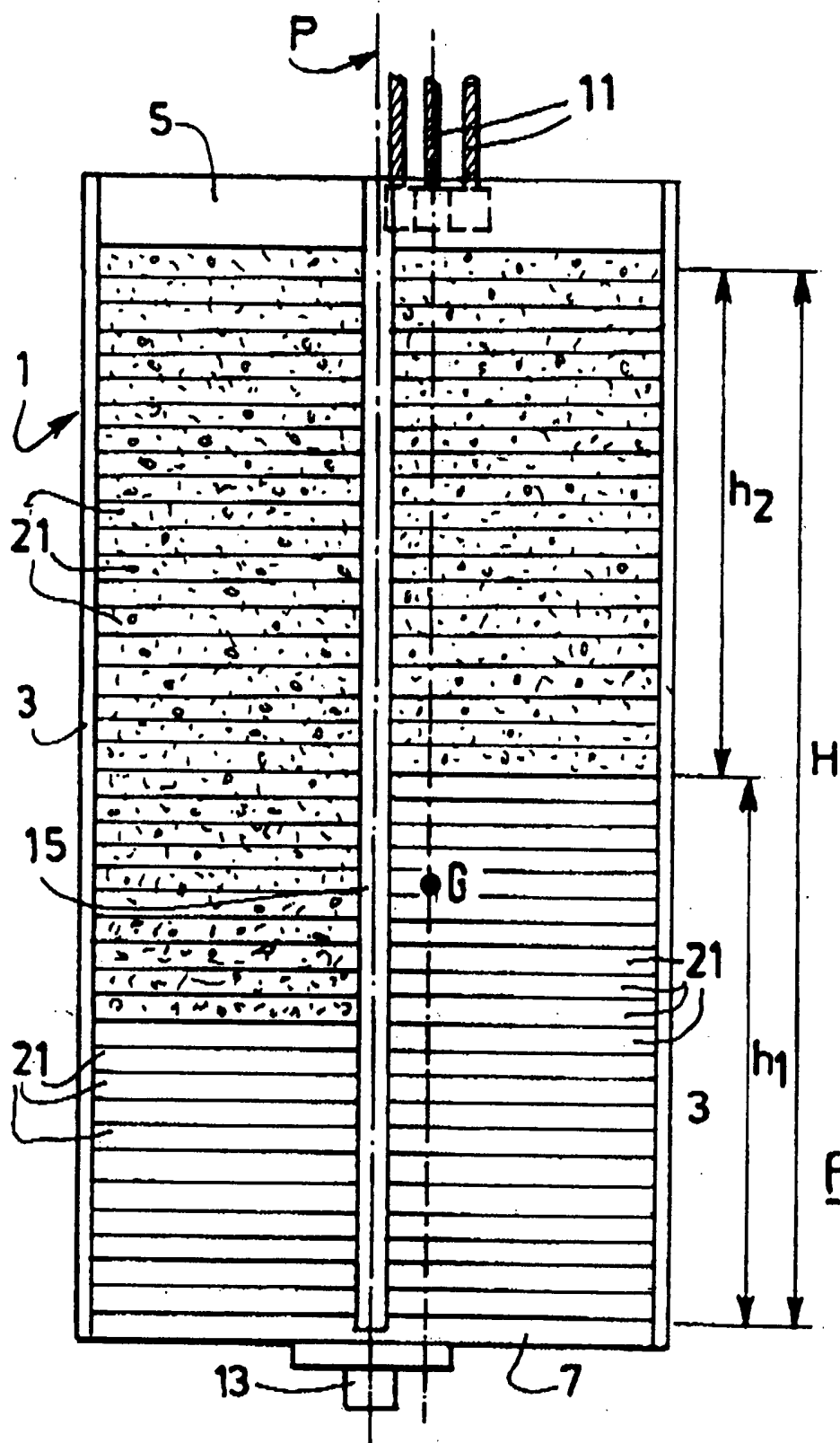
5 8. Elevator counterweight as per any one of the preceding claims, characterized in that, with the counterweight suspension axis being offset by a distance a from the mid-plane (P), in order to avoid any off-axis suspension stress by the counterweight on its guides (25) through the slides (23), the overall gravity center of the counterweight is
10 aligned with the cable suspension axis, which means that the respective masses m_1 and m_2 of the compartments (17 and 19) must be calculated according to the offset of their center of gravity G1 and G2 from the mid-plane and to the mass of the counterweight without ballast elements.

15 9. Elevator counterweight as per claim 7 or 8, characterized in that each compartment (17, 19) is filled over its height with an optimized combination of concrete and steel fillers (21) according to the respective number of each determined for each of the compartments (17, 19).

20 10. Elevator characterized in that it includes a counterweight as per any one of the preceding claims.



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INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B66B17/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B66B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 385 255 A (OTIS ELEVATOR COMPANY) 5 September 1990 (1990-09-05)	1, 5, 10
A	column 2, lines 15-39 -----	2-4, 6-9
Y	DE 298 24 796 U1 (WITTUR AG) 29 August 2002 (2002-08-29)	1-3, 5-7, 10
A	figures 14-16 -----	4, 8, 9
Y	AT 389 862 B (OTIS ELEVATOR COMPANY) 12 February 1990 (1990-02-12)	1-3, 5-7, 10
A	the whole document -----	4, 8, 9
Y	US 2004/094371 A1 (AUGUGLIARO DARIO) 20 May 2004 (2004-05-20)	1, 2, 5, 10
A	paragraph '0030! - paragraph '0033! -----	3, 4, 6-9



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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