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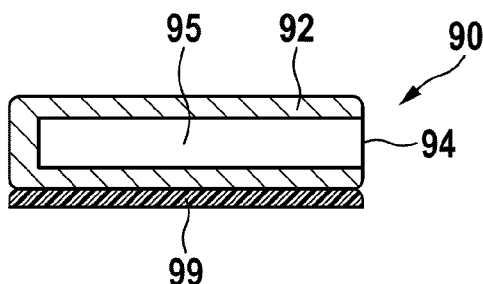
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(54) Title: BALANCING WEIGHTS WITH FERROMAGNETIC INLAY

**Fig. 1**



(57) Abstract: A balancing weight (90) for balancing a wheel of a vehicle has a body (92) of non-ferromagnetic material providing a major portion of the balancing weight's mass and a ferromagnetic inlay (95) for holding the balancing weight (90) by magnetic force. The ferromagnetic inlay (95) provides a minor portion of the balancing weight's mass. A weight applicator (80) has a magnet (82) for interacting with the ferromagnetic inlay (95) of the balancing weight (90) and holding the balancing weight (90).



## Balancing Weights with Ferromagnetic Inlay

### Field of the invention

The invention relates to balancing weights, which can be handled by an auto-  
5 mated handling system, and which may be attached to the rim of a wheel of a  
vehicle for balancing the wheel. The invention also relates to a balancing weight  
applicator, which can be part of an automated handling system, for handling the  
balancing weights. The invention furthermore relates to a method for automated  
handling of balancing weights.

### 10 Description of the related art

Clip-on balancing weights as disclosed in the US patent 4,728,154 have a body of  
a metal providing mass and a clip to hold the balancing weight to the rim of a  
wheel.

US patent 7,478,659 B2 discloses a sticker weight pressurizer for wheels. The  
15 pressurizer has two pressure blocks for pressing balancing weights to a rim of a  
wheel. The balancing weights are applied manually by an operator in a first step,  
and are firmly pressed to the rim by the pressurizer in a second step.

US patent 8,182,639 B2 discloses a weight applicator for a wheel. The weight  
applicator has an outer arcuate surface for holding the balancing weight to be  
20 attached to the wheel by means of an adhesive. For this purpose, balancing  
weights having adhesives on opposing sides are required.

A dispensing device for balancing weights and a method for dispensing balancing  
weights is disclosed in WO 2013/034399 A1. Herein, plastic balancing weight  
tapes with integrated steel balls are disclosed.

US 5,134,766 discloses an automatic weight application machine holding the balancing weights by a ferromagnetic clip.

WO 2010/143322 A1 discloses a balancing weight.

### **Summary of the invention**

5 The problem to be solved by the invention is to improve balancing weights and applicators for balancing weights for a simplified handling of balancing weights during application to a rim. Furthermore, it is desired, if the balancing weights can be applied precisely to a predetermined position. A further objective is to reduce costs in handling of balancing weights by an applicator and to provide an  
10 improved method of handling balancing weights.

Solutions of the problem are described in the independent claims. The dependent claims relate to further improvements of the invention.

Tests have shown, on that the magnetic force which can be established to a balancing weight as known from prior art is not sufficient to hold the balancing  
15 weight at a modern handling device. Due to very short cycle times, high movement speeds and high accelerations are required. Accordingly a precise location of the balancing weights compared to the handling device and high holding forces are required.

In a first embodiment, a balancing weight comprises a balancing weight body  
20 having an inlay of ferromagnetic material, which preferably is shaped as an elongated member. The ferromagnetic inlay has a contact surface located at one side of the balancing weight body. This contact surface allows establishing a magnetic circuit with an external magnet, having a comparatively small air gap. The term air gap means herein a gap of non-magnetic material, or any material having a  
25 low magnetic permeability like air, imposing a comparatively high magnetic resistance. Due to be accessible contact surface, a high magnetic flux density can

easily be established. Although it is preferred to have only one contact surface, there may be two or more contact surfaces, preferably at opposing sides of the balancing weight. One contact surface has shown to be sufficient. It is the best choice, as it has only a low impact on the design and the mechanical stability of  
5 the balancing weight.

It is preferred, that the balancing weights are coated to provide a corrosion protection and/or to cover the ferromagnetic inlays. As the thickness of two pitted coatings is in the range of some micrometers, this would not or only rarely affect the magnetic flux.

10 In another embodiment, a balancing weight has a body with at least one ferromagnetic inlay. The balancing weight may have a body comprising at least one of titanium, chromium, Nickel, molybdenum, tin, zinc, tungsten, aluminum. The body may also be a polymer, plastic or composite material containing mass particles of at least one of these materials. The purpose of the body is to provide a  
15 significant amount of the total mass of the balancing weight. Therefore, the body (excluding the inlay) provides the major portion of the total mass of the balancing weight, while the inlay provides the minor portion of the total mass of the balancing weight. The mass of the inlay is less than the mass of the body. The ferromagnetic inlay provides ferromagnetic properties and may interact with  
20 another ferromagnetic material or magnet in an application head. The inlay comprises at least one ferromagnetic material. Such a ferromagnetic material may be a metal based on iron, or any iron alloy, composition or compound. Preferably, the inlay has a mass of less than 50%, most preferably less than 20% of the total mass of the balancing weight. It is further preferred, if the mass of the  
25 inlay is less than 10%, most preferably less than 5% of the total mass of the balancing weight.

Some kinds of balancing weights have metal clips for holding the balancing weights to the rim of a wheel. Often, this clip is made of iron or steel, providing ferromagnetic properties. Using this clip for holding the balancing weight does not provide a high reproducibility. Instead, there is, according to the invention, a  
5 ferromagnetic inlay within the balancing weight, which is separated from the clip. This ferromagnetic inlay should have no mechanic and magnetic connection to the clip. Instead, it should be located at a position, at which the magnetic flux is not destructed or deflected by the clip. Most preferably, the ferromagnetic inlay is for the only purpose of holding the balancing weight during delivery to a  
10 rim.

Although it is preferred that the ferromagnetic inlay is a soft magnetic material, it may also be a permanent magnetic material. It may comprise beyond iron at least one of the following materials: samarium, cobalt, nickel. The ferromagnetic inlay preferably is completely embedded within a body of the balancing weight.  
15 In an alternative embodiment, the ferromagnetic inlay may be inserted through or into a cutout in the body of the balancing weight. The cutout may be a punched, drilled, or molded hole in the balancing weight. In a further embodiment, there may be a diamagnetic material like a plastic, or a gas like air or nitrogen close to the ferromagnetic inlay for controlling the magnetic flux through  
20 the ferromagnetic inlay. The ferromagnetic inlay may be held within the balancing weight by means of an adhesive, a glue, a plastic material, by form fit or by press fit or a combination thereof. It is preferred, if the ferromagnetic inlay is a short piece of a cylinder or rod. In an alternative embodiment, the ferromagnetic inlay may be an elongated piece of a cylinder or rod.

25 There may be one or a plurality of ferromagnetic inlays within the body of a balancing weight. Preferably, a ferromagnetic inlay is in the center section of a balancing weight. In an alternative embodiment, at least two ferromagnetic inlays are at the outer ends and sections of a balancing weight. In chained balancing

weights, not every balancing weight has a ferromagnetic inlay. Instead, every second or fourth, or any other number of balancing weights may have a ferromagnetic inlay.

According to a further embodiment, a weight applicator head has a magnet for holding a balancing weight with a ferromagnetic inlay. The applicator head may have a permanent magnet or an electrical magnet (electromagnet). It may have a coil through which a current may flow to generate a magnetic field for holding the ferromagnetic inlay of a balancing weight and therefore the balancing weight.

According to another embodiment, a method for handling balancing weights comprises the steps of moving an applicator head close to a balancing weight, holding the balancing weight by magnetic force to the applicator head, moving the applicator head together with the balancing weight to the rim, and releasing the balancing weight from the applicator head.

In a further embodiment, a method for handling balancing weights comprises the further steps of enabling an electrical magnet within the applicator head after the application head has been moved close to a balancing weight and disabling the electrical magnet within the applicator head after the balancing weight has been moved to the rim. Enabling of the electrical magnet may be done by switching on a current through the coil of the electrical magnet. A disabling of the electric magnet may be done by switching of the current.

### **Description of Drawings**

In the following, the invention will be described by way of example, without limitation of the general inventive concept, on examples of embodiment with reference to the drawings.

Fig. 1 shows a first embodiment of a balancing weight in a sectional view.

Fig. 2 shows the balancing weight in a sectional view from the top.

Fig. 3 shows the chain of balancing weights in a side view.

5 Fig. 4 shows another embodiment of a clip-on balancing weight.

Fig. 5 shows a further embodiment of a clip-on balancing weight.

Fig. 6 shows a further embodiment of a clip-on balancing weight without clip.

Fig. 7 shows a sectional view of a balancing weight with ferromagnetic inlay.

Fig. 8 shows a balancing weight with embedded ferromagnetic inlay.

10 Fig. 9 shows a balancing weight with a cutout at the bottom side, holding a ferromagnetic inlay.

Fig. 10 shows a chain of adhesive balancing weights.

Fig. 11 shows a single adhesive balancing weight.

Fig. 12 shows a side view of another embodiment of a balancing weight.

15 Fig. 13 shows an embodiment of a balancing weight with a modified cutout.

Fig. 14 shows an embodiment of a balancing weight with a further modified cutout.

Fig. 15 shows a balancing weight with an elongated ferromagnetic inlay in a top view.

Fig. 16 shows a balancing weight with an elongated ferromagnetic inlay in a side view.

Fig. 17 shows an adhesive balancing weight with an integrated magnet.

Fig. 18 shows an applicator head holding a balancing weight.

5 Fig. 18 shows an applicator head with an electrical magnet, holding a balancing weight.

Fig. 20 shows a further embodiment of an applicator head holding a balancing weight.

10 Fig. 21 shows a further embodiment of an applicator head with an electrical magnet, holding a balancing weight

In figure 1, a first embodiment of the balancing weight is shown in a sectional view from one side. The balancing weight has a bottom side with is designed to contact a rim of a wheel to be balanced. In this embodiment, the contact side  
15 has an adhesive tape 99 attached. In the case of a clip on balancing weight, there would be no adhesive tape. Opposing it to the contact side is a top side, which may bear a marking. In the case of an approximately rectangular balancing weight, there are four other sides. The balancing weight body 92 has an inlay 95 of ferromagnetic material, which preferably is shaped as an elongated member.  
20 Most preferably, the inlay is approximately parallel to the contact side. The ferromagnetic inlay 95 has a contact surface 94 located at one side of the balancing weight body. This contact surface allows establishing a magnetic circuit with an external magnet, having a comparatively small air gap.

25 In figure 2, the previous embodiment is shown in the further sectional view from the top.



In figure 3, a plurality of balancing weights, forming a chain or belt is shown. The balancing weights are attached to a common adhesive tape 99. Before assembly, a required number of balancing weights may be cut or separated from the belt, maintaining its adhesive tape section. Here, the ferromagnetic inlays 95 can still  
5 be seen. It is preferred, that the balancing weights are coated to provide a corrosion protection and/or to cover the ferromagnetic inlays. As the thickness of two pitted coatings is in the range of some micrometers, this would not or only rarely affect the magnetic flux.

In Fig. 4, an embodiment of a clip-on balancing weight is shown. The balancing  
10 weight 10 has a body comprising a center section 13, a first side wing 11 and a second side wing 12. A clip 16 for attaching the balancing weight to the rim of a wheel is attached to the center section 13 of the balancing weight. Preferably, the clip 16 is embedded into the center section 13. For holding the balancing weight by an applicator, a first ferromagnetic inlay 14 and a second ferromagnet-  
15 ic inlay 15 are provided. Preferably, these ferromagnetic inlays comprise a ferromagnetic material, like iron, steel or even a plastic with embedded ferromagnetic particles. The ferromagnetic inlays shown herein may be oriented towards the top surface, as shown in the figure, which improves the magnetic force to a magnetic weight applicator. Alternatively, the ferromagnetic inlays may also be  
20 covered by the weight material, or any other cover material, like a dye, a protective film, or any other coating. By using two or more ferromagnetic inlays, the position of the balancing weight with respect to an applicator head may be precisely defined. There may be an additional means for mechanically guiding the stabilizing the balancing weight.

25 In Fig. 5, a further embodiment of a clip-on balancing weight 10 is shown. Here, only a first ferromagnetic inlay 14 is provided, preferably at the center of the balancing weight. To avoid unwanted effects, the ferromagnetic inlay must be

separated, preferably magnetically separated by the clip 16, if the clip has ferromagnetic properties. If a plastic clip is used, such as separation is not necessary.

In Fig. 6, a clip-on balancing weight 20 without clip is shown. The balancing weight shown herein is similar to the previously shown balancing weights. The main difference is that there is no clip provided. During the mounting process of the balancing weight to the rim, a separate clip is pushed over the balancing weight and the rim, to secure the balancing weight to the rim. For holding the clip, a recess 21, preferably at the center of the balancing weight is provided. Again, a first ferromagnetic inlay 14 and a second ferromagnetic inlay 15 are provided. Although it is preferable to have a symmetrical arrangement with two ferromagnetic inlays, a single ferromagnetic inlay would work.

In Fig. 7, a sectional view of a balancing weight 20 according to any one of the previous embodiments is shown. There may be a first cutout 25 at the top of the balancing weight in which a second ferromagnetic inlay 15 is held. The cutout 25 may be manufactured during molding of the balancing weight 20, it may be punched into the balancing weight, or it may be drilled or manufactured by any other suitable way into the balancing weight 20. It may have chamfered or rounded edges to simplify insertion of the ferromagnetic inlay 15. There may be a similar cutout for a first ferromagnetic inlay and/or any further ferromagnetic inlays.

In Fig. 8, a further balancing weight 30 is shown with embedded ferromagnetic inlay 15. This ferromagnetic inlay may be molded into the body of the balancing weight.

In Fig. 9, a balancing weight 40 with a cutout 45 at the bottom side is shown. In this cutout, a ferromagnetic inlay is held. The cutout may be manufactured as described before, and the balancing weight may be covered as described before.

In Fig. 10, a chain 50 of self-adhesive balancing weights is shown. The balancing weights 51, 52, and 53 are preferably chained together, for example by a common self-adhesive tape under the balancing weights or by a metallic connection between the balancing weights. There may be a long chain of balancing weights from which pieces of required length may be cut off. Each of these balancing weights preferably has a ferromagnetic inlay 54, 55, and 56. There may also be segments of chained balancing weights, for example comprising of a piece of three balancing weights 51, 52, 53, which are fixedly connected to each other. In such a case, it is preferred to use ferromagnetic inlays only in one or two of the balancing weights. For example, a single magnetic inlay may be used at the center balancing weight 52 of three adjacent balancing weights, or any other number of adjacent balancing weights. In an alternative embodiment, two ferromagnetic inlays may be used at the outmost balancing weights of a chain of balancing weights. These may be the balancing weights 51 and 53 in this embodiment.

15 In Fig. 11, a single adhesive balancing weight 60 is shown. At its center, there is a ferromagnetic inlay 65. There may also be any other number of ferromagnetic inlays in this balancing weight.

In Fig. 12, a further embodiment of a balancing weight 60 is shown. Here, the ferromagnetic inlay is positioned at the bottom side of the balancing weight, which is close to the rim. To hold the balancing weight 60 to the rim, a self-adhesive tape 69 may be provided. The ferromagnetic inlay 65 is placed within a cutout 64. Between the ferromagnetic inlay and the body of the balancing weight 60, there may be gap 66. In the most preferred embodiment, the ferromagnetic inlay is held within the cutout by the adhesive tape 69. In another embodiment, there is filler, like a glue or cement, within the gap 66 to further hold the ferromagnetic inlay within the body of the balancing weight 60. It is further preferred, if the gap contains at least a ferrimagnetic material. Such a ferrimagnetic material may be air, plastic, or a similar material. Having at least a small

amount of ferrimagnetic material in series with the ferromagnetic inlay would give a well-determined magnetic flow, and therefore may avoid excessive holding forces between the balancing weights and an applicator head. This may prevent sticking of the balancing weight to an applicator head.

5 In Fig. 13, a further adhesive balancing weight 60 with a modified cutout 64 is shown. Here, the cutout preferably has a conical shape, into which the ferromagnetic inlay, which preferably also has an adapted conical shape, is pressed. This results in a form fit between the ferromagnetic inlay and the body of the adhesive balancing weight. In addition, here may be a gap 66. Preferably, the  
10 thickness of the gap is between 3mm and 0.1 mm. Most preferably, the thickness is between 0.5mm and 0.1 mm.

In Fig. 14, a further adhesive balancing weight 60 with a modified cutout 64 in inverted conical shape is shown. It preferably is held by press fit.

In Fig. 15, a self-adhesive balancing weight 70 with an elongated ferromagnetic  
15 inlay 75 is shown in a top view.

In Fig. 16, a self-adhesive balancing weight 70 with is shown. This balancing weight contains an elongated ferromagnetic inlay 75. This inlay may have the shape of a cylindrical rod. The ferromagnetic inlay may be mounted from the top side or from the bottom side, similar to the embodiments shown before. Most  
20 preferably, it is embedded into the body of the balancing weight. Preferably, there is an adhesive tape 79 to hold the balancing weight to the rim.

In Fig. 17, a balancing weight 71 with an integrated magnet 76 is shown. The magnet may be mounted from the top side or from the bottom side, similar to the embodiments shown before. Most preferably, it is embedded into the body  
25 of the balancing weight. The letters N and S denote the North Pole and the south pole of the magnet. These may be exchanged in their direction.

In Fig. 18, an applicator head 80 is shown, holding a balancing weight 91. The applicator head has a body 81 holding a magnet 82. Herein, a permanent magnet is shown. Instead, a magnetic coil may be used. The magnetic field generated by the magnet 82 in the applicator head generates a magnetic flux 83 penetrating the elongated ferromagnetic inlay 95 in balancing weight 91. The magnetic flux is guided by an armature 84. By this magnetic flux, the ferromagnetic inlay 75 and therefore the balancing weight 91 is held to the applicator head 80. There may be further mechanical fixing means 89 for mechanically holding the balancing weight in a predetermined position with respect to the applicator head, so that the balancing weight may not rotate or tilt when being held by the applicator head. Dependent of or together with the fixing means 89, the orientation of the balancing weight with respect to the applicator head may be determined by the direction of the magnetic flux. The magnetic flux shown in this embodiment would try to force the elongated ferromagnetic inlay parallel to the magnet 82. Therefore, there would always be a clearly determined orientation of the balancing weight.

In Fig. 19, an applicator head 80 having an electrical magnet is shown. The electrical magnet preferably has a coil 86 comprising of a plurality of windings. Preferably, the windings are held by a coil form 85. For better flux control, it is preferred to have an armature 84 within the coil. Preferably, the armature is extended to the sides of the balancing weight, like in the previous figure. In this case, the previous permanent magnet is replaced by a coil with an inner armature part. The magnetic flux 83 is similar to the magnetic flux generated by a permanent magnet, as shown in the previous figure. The magnetic force may be controlled by controlling a current flowing through the coil. Accordingly, the magnetic force may be increased or decreased. For example for picking up the balancing weight, a comparatively high magnetic force may be used; during transport, the magnetic force may be reduced; after the balancing weight has

been applied to the rim, for releasing the balancing weight from the applicator head, the magnetic force may be set to zero.

In Fig. 20, a further embodiment of an applicator head 80 is shown for holding a balancing weight 60, as previously disclosed. If there is only a small and not elongated ferromagnetic inlay, it is preferred to change the orientation of the magnet 82 towards the ferromagnetic inlay as shown. The magnetic flux 83 differs in its orientation accordingly, compared to the previous embodiments. If there is a plurality of ferromagnetic inlays, a plurality of magnets may be used.

In Fig. 21, an embodiment of an applicator head 80 with an electrical magnet is shown for holding a balancing weight 60. The electrical magnet may have a winding 86 held by a coil form 85 and being centered by an armature 84. The magnetic flux 83 is similar to the magnetic flux of the previous embodiment.

In Fig. 22, a preferred embodiment of an applicator head 80 with an electrical magnet is shown for holding a balancing weight 90. The electrical magnet may have at least one winding 86 held by a coil form 85 and being centered by an armature 84. The magnetic flux 83 goes from the armature into the ferromagnetic inlay and leaves the ferromagnetic inlay by contact surface 94 into the Armature 84.

**List of reference numerals**

10	clip-on balancing weight
11	first side wing
12	second side wing
13	center section
14	first ferromagnetic inlay
15	second ferromagnetic inlay
16	clip
20	clip-on balancing weight
21	recess
25	cutout
30	clip-on balancing weight
40	clip-on balancing weight
40	cutout
50	chain of adhesive balancing weights
51, 52, 53	adhesive balancing weights
54, 55, 56	ferromagnetic inlay
60	adhesive balancing weight
64	cutout
65	ferromagnetic inlay
66	gap
69	adhesive tape
70	adhesive balancing weight
71	adhesive balancing weight
75	elongated ferromagnetic inlay
76	magnet
79	adhesive tape

## Claims

1. Balancing weight having a body (92) of non-ferromagnetic material and a ferromagnetic inlay (95) for holding the balancing weight by magnetic force,  
characterized in, that  
the ferromagnetic inlay (95) provides at least one contact surface (94) at at least one side of the balancing weight body.
2. Balancing weight according to claim 1,  
characterized in, that  
the ferromagnetic inlay (95) provides one contact surface (94) at one side of the balancing weight body.
3. Balancing weight according to any one of the preceding claims,  
characterized in, that  
the ferromagnetic inlay (95) is parallel to an attachment side of the balancing weight body.
4. Balancing weight according to any one of the previous claims,  
characterized in, that  
the body is providing an major portion of the balancing weight's mass and  
the ferromagnetic inlay is providing a minor portion of the balancing weight's mass.
5. Balancing weight according to any one of the previous claims,  
characterized in, that  
the balancing weight has a metal clip for attaching the balancing weight to a rim, and that the ferromagnetic inlay is located separately from the clip.



6. Balancing weight according to any one of the previous claims, characterized in, that  
the ferromagnetic inlay is held within a cutout in the body of the balancing weight.
7. Balancing weight according to any one of the previous claims, characterized in, that  
the ferromagnetic inlay is embedded within the balancing weight.
8. Balancing weight according to claim 6, characterized in, that  
the cutout is sealed by a sealing material, like a plastic, an epoxy or a dye.
9. Balancing weight according to any one of the previous claims, characterized in. that  
the ferromagnetic inlay is a cylindrical-shaped rod.
10. Weight applicator for applying a balancing weight according to at least one of the previous claims to a wheel, characterized in, that  
the weight applicator has at least one magnet for interacting with the ferromagnetic inlay of the balancing weight.
11. Weight applicator according to claim 10, characterized in, that  
the magnet is a permanent magnet or an electrical magnet.

12. Method for handling balancing weights according to any one of the previous claims, comprising the steps of  
moving an applicator head close to a balancing weight,  
holding the balancing weight by magnetic force to the applicator head,  
moving the applicator head together with the balancing weight to the rim,  
and  
releasing the balancing weight from the applicator head.
13. Method for handling balancing weights according to claim 12,  
comprising the further steps of:  
enabling an electrical magnet within the applicator head after the application head has been moved close to a balancing weight and  
disabling the electrical magnet within the applicator head after the balancing weight has been moved to the rim.

Fig. 1

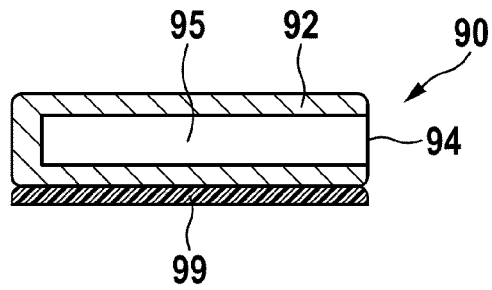


Fig. 2

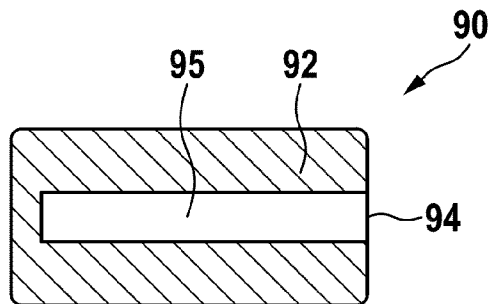


Fig. 3

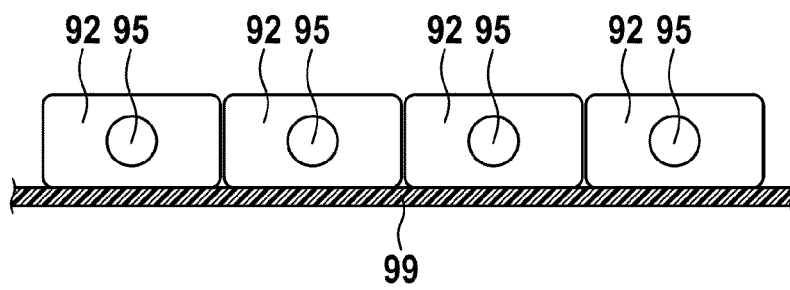


Fig. 4

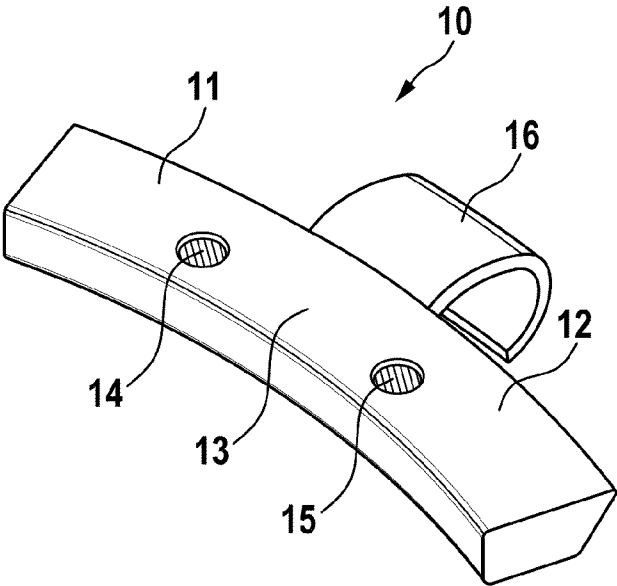


Fig. 5

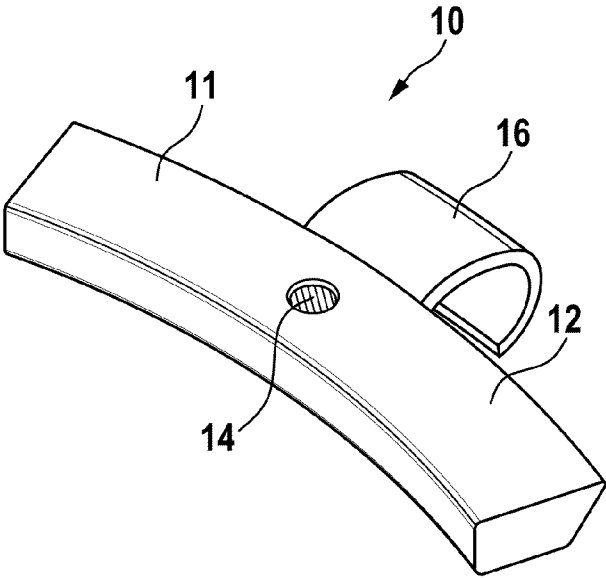


Fig. 6

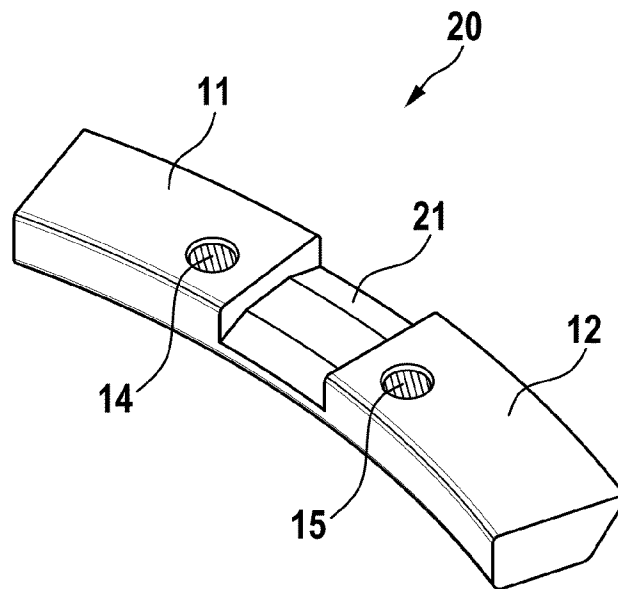


Fig. 7

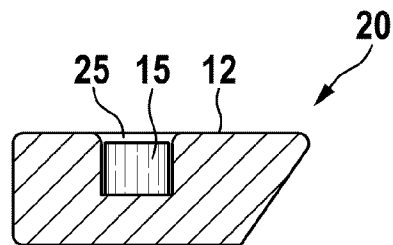


Fig. 8

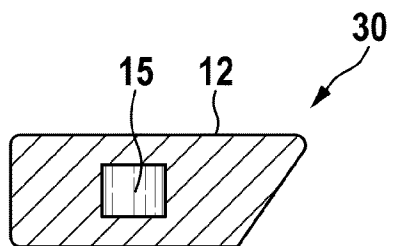


Fig. 9

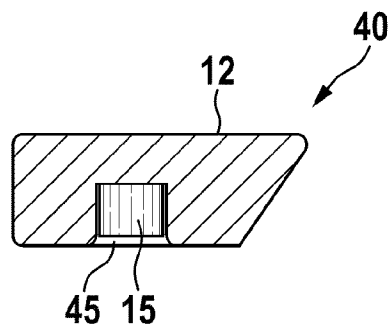


Fig. 10

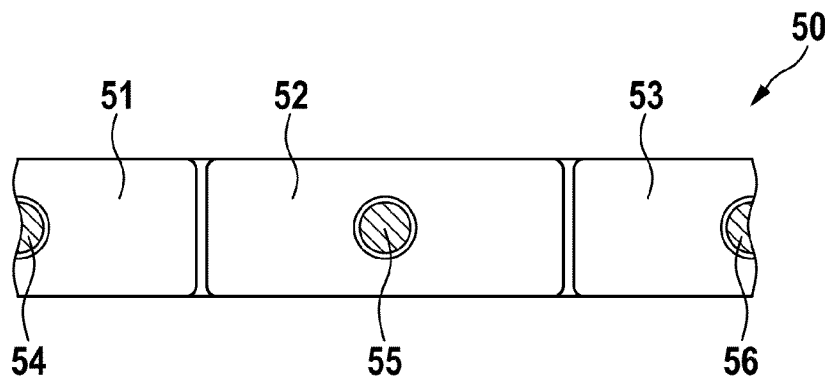


Fig. 11

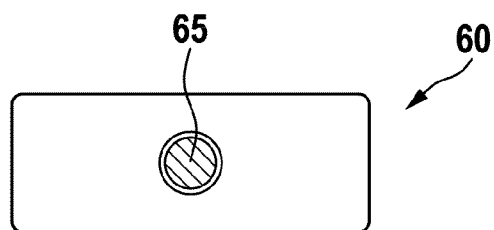


Fig. 12

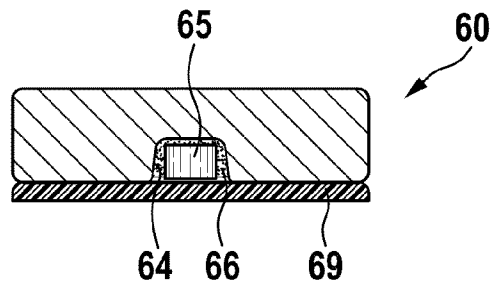


Fig. 13

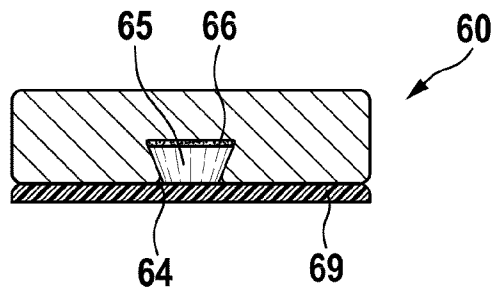


Fig. 14

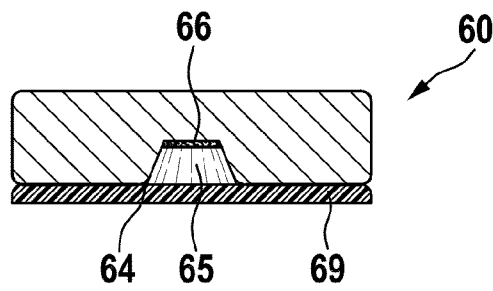


Fig. 15

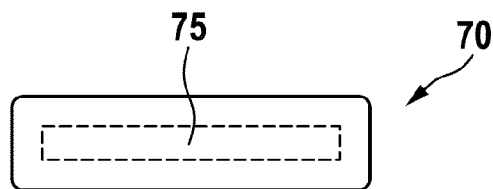


Fig. 16

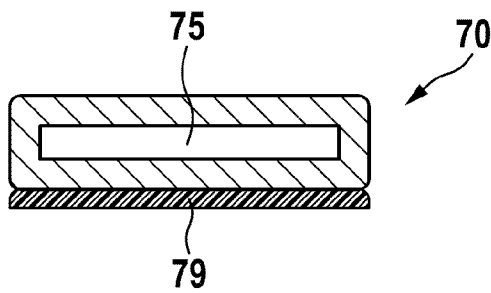


Fig. 17

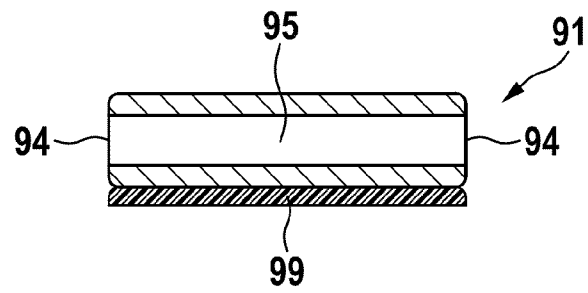


Fig. 18

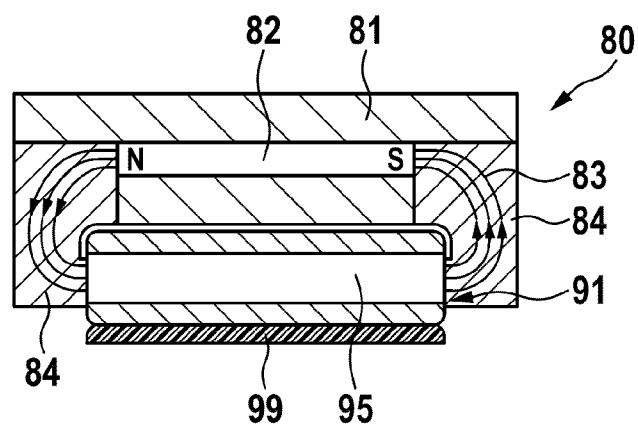


Fig. 19

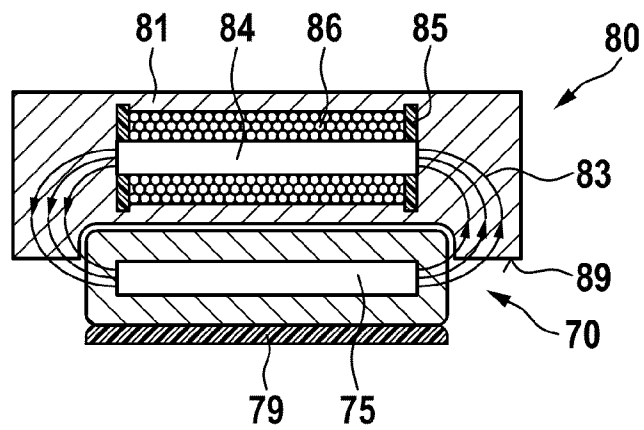




Fig. 20

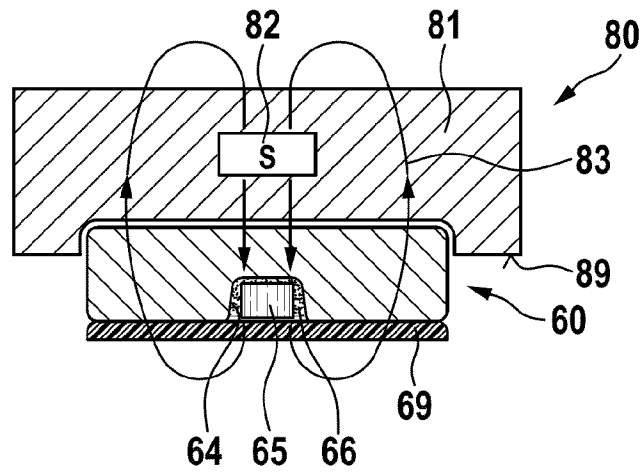


Fig. 21

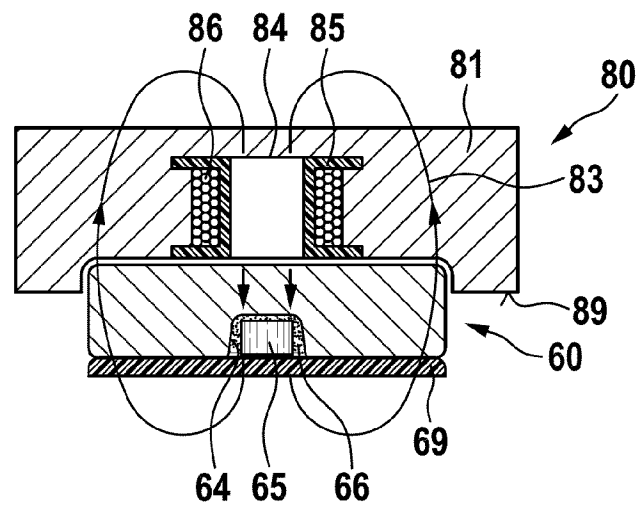
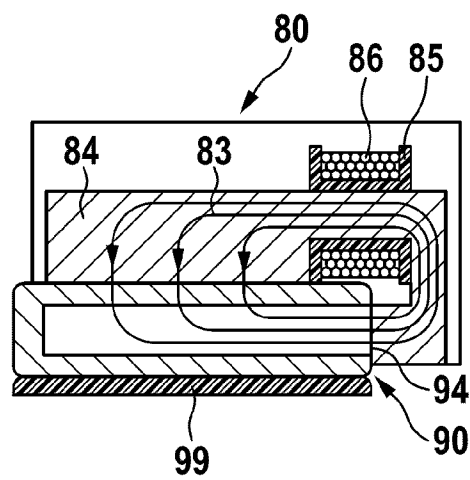


Fig. 22



## INTERNATIONAL SEARCH REPORT

International application No

PCT/EP2014/057330

A. CLASSIFICATION OF SUBJECT MATTER  
 INV. F16F15/32 G01M1/32  
 ADD.

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)  
 F16F G01M

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 practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2013/034399 A1 (WEGMANN AUTOMOTIVE GMBH & CO KG [DE]; BODE FELIX [DE]) 14 March 2013 (2013-03-14) the whole document	1-13
X	WO 2004/018899 A1 (MERITOR DO BRASIL LTDA [BR]; FRANCISCHETTI EVANDRO LUIS [BR]; GOSSER N) 4 March 2004 (2004-03-04) abstract; figures	1-3,5
A		4,6-13
X	DE 10 2010 008657 A1 (FISCHER ERIKA [DE]) 25 August 2011 (2011-08-25) abstract; figures	1,2
A		7,10,12
X	WO 2010/143322 A1 (TRD CO LTD [JP]; ASO KENICHI [JP]) 16 December 2010 (2010-12-16) abstract; figures	10-13
A		1



Further documents are listed in the continuation of Box C.



See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 August 2014

Date of mailing of the international search report

26/09/2014

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Kramer, Pieter Jan

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/EP2014/057330

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013034399	A1	14-03-2013	NONE
WO 2004018899	A1	04-03-2004	AU 2003236743 A1 11-03-2004 BR 0203372 A 18-05-2004 US 2006158018 A1 20-07-2006 WO 2004018899 A1 04-03-2004
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WO 2010143322	A1	16-12-2010	NONE