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(54) Title: A SAFETY BRAKING SYSTEM FOR A HOISTED STRUCTURE

(57) Abstract: A safety braking system (10) for a hoisted structure (4) guided along a guide rail (1) is disclosed. The system (10) includes a brake unit (2) connected to a hoisted structure (4) and configured to slide along the guide rail (1). The system further includes one or more brake shoes (3) accommodated between a brake liner (2a) and the guide rail (1). An actuation mechanism (AM) configured to operate the brake shoes (3) between a first position and a second position. In the second position, the brake shoes (3) frictionally engage the guide rail (1) and the brake unit (2) to exert braking on the hoisted structure (4). The actuation mechanism includes an electromagnet (EM) disposed in one of the brake unit (2) and the one or more brake shoes (3). A permanent magnet (PM) embedded in remaining of the brake unit (2) and each of the brake shoes (3). The electromagnet (EM) when activated repels the permanent magnet (PM) towards the guide rail (1).

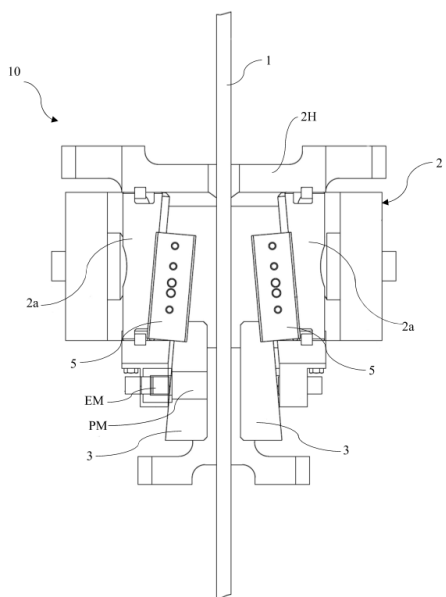


FIG.1

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Robin Koshy Varghese

FORM 2

THE PATENTS ACT 1970
(39 OF 1970)

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The Patent Rules, 2003

Complete Specification

(See Section 10 and Rule 13)

1. TITLE OF THE INVENTION

A SAFETY BRAKING SYSTEM FOR A HOISTED STRUCTURE

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3. PREAMBLE TO THE DESCRIPTION

COMPLETE

The following specification describes the invention and the manner
in which it is to be performed

DESCRIPTION

TECHNICAL FIELD

[001] The present disclosure generally relates to the field elevators. Particularly but not exclusively the present disclosure relates to safety braking systems for elevator cars and counterweights.

BACKGROUND

[002] Typically, in an elevator a car is moved by means of a drive and guided along guide rails to different access levels of a building or site. Traction drives or hydraulic drives serve as the drive to operate the elevators. A traction drive is composed of at least of a motor, a drive pulley and traction mean such as, for example, a cable or belt. Elevators include a safety system to stop an elevator from traveling at excessive speeds in response to an elevator component breaking or otherwise becoming inoperative. Traditionally, elevator safety systems include a speed sensing device referred to as a governor, a governor rope, safeties or clamping mechanisms that are mounted to the elevator car frame for selectively gripping elevator guide rails, and a tension sheave located in an elevator pit. The governor includes a governor sheave located in a machine room which is positioned above the elevator or within an elevator shaft. The governor rope is attached to travel with the elevator car and makes a complete loop around the governor sheave and the tension sheave.

[003] The governor rope is connected to the safeties through mechanical linkages and lift rods. The safeties include brake pads that are mounted for movement with the governor rope and brake housings that are mounted for movement with the elevator car. If the hoist ropes break or other elevator operational components fail, causing the elevator car to travel at an excessive speed, the governor releases a clutch that grips the governor rope. Thus, the rope is stopped from moving while the elevator car continues to move downwardly. The brake pads, which are connected to the rope, remains in position while the brake housings move downwardly with the elevator car. The brake housings are wedge shaped, such that as the brake pads are moved in a direction opposite from the brake housings, the brake pads are forced into frictional contact with the guide rails. Eventually the brake pads become wedged between the guide rails and the brake housing such that there is no relative movement between the elevator car and the guide rails. The governor rope holds the brake pads so that the frictional force between the brake pads and the guide rails remain over a predetermined threshold until the system resets. To reset the safety system, the brake housing (i.e., the elevator car) must be

moved upward while the governor rope is simultaneously released from the clutch. This returns the brake pads to their original positions. One disadvantage with this traditional safety system is that the installation of the sheaves, rope, multiple links and governor is very time consuming. Another disadvantage is the significant number of components that are required to effectively operate the system. The governor sheave assembly, governor rope, and tension sheave assembly are costly and take up a significant amount of space within the hoistway, pit, and machine room. Also, the operation of the governor rope and sheave assemblies generates a significant amount of noise, which is undesirable. Further, high number of components and moving parts increases maintenance costs. These disadvantages have an even greater impact in modern high-speed elevators.

[004] The present disclosure is directed to overcome one or more limitations stated above or any other limitations associated with the prior art. The information disclosed in this background of the disclosure section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

SUMMARY OF THE INVENTION

[005] One or more shortcomings of existing braking system or device have been overcome, and additional advantages are provided through the system as claimed in the present disclosure. Additional features and advantages are realized through the techniques of the present disclosure. Other embodiments and aspects of the disclosure are described in detail herein and are considered a part of the claimed disclosure.

[006] The limitations of the prior arts are addressed to a great extent by a safety braking system for a hoisted structure which can be guided along a guide rail, as disclosed in the present disclosure. The safety braking system includes a brake unit mounted to a hoisted structure and is configured to move along a guide rail to guide the hoisted structure. The system also includes one or more brake shoes accommodated in a space defined between a brake liner of the brake unit and the guide rail. Further, an actuation mechanism is provided in the system which is configured to operate the one or more brake shoes between a first position and a second position. In the second position, the one or more brake shoes frictionally engage the guide rail and the brake unit to exert braking force on the hoisted structure. The actuation mechanism includes an electromagnet disposed in one of the brake unit and each of the one or more brake shoes. Further, the actuation mechanism includes a permanent magnet embedded in remaining of the

brake unit and each of the one or more brake shoes. The electromagnet when activated repels the permanent magnet to operate the one or more brakes to the second position to frictionally engage the guide rail.

[007] In an embodiment of the present disclosure, the system includes a roller arrangement movably mounted on the brake liner of the brake unit. The roller arrangement is provided in a side of the brake liner which is adapted to come in contact with the one or more shoes.

[008] In an embodiment, the system includes a control unit communicatively coupled to the actuation mechanism. The control unit is configured to trigger the actuation mechanism based on the pre-defined parameter. The pre-defined parameter is at least one of freefall condition and over speed condition of the hoisted structure. The control unit receives a signal corresponding to the pre-defined parameter from a detection module associated with the control unit. The control unit receives a signal corresponding to the predefined parameters from a detection module associated with the control unit.

[009] In another non-limiting embodiment of the present disclosure, a method for progressively exerting braking force to a hoisted structure guided along a guide rail is disclosed. The method includes steps of receiving by a control unit, a signal corresponding to pre-defined parameters from a detection module associated with the control unit. In the next step, the control unit triggers an actuation mechanism based on the signal received from the detection module. The actuation mechanism comprises an electromagnet disposed in one of the brake unit and each of the one or more shoes and a permanent magnet embedded in remaining of the brake unit and each of the one or more brake shoes. The electromagnet when activated repels from the permanent magnet and operate the one or more brake shoes accommodated in a space defined between a brake liner of the brake unit and the guide rail from a first position and a second position. In the second position, the one or more brake shoes frictionally engage the guide rail and the brake unit to exert braking force on the hoisted structure.

[0010] It is to be understood that the aspects and embodiments of the disclosure described above may be used in any combination with each other. Several of the aspects and embodiments may be combined to form a further embodiment of the disclosure.

[0011] The foregoing summary is illustrative only and is not intended to be in any way limiting. In addition to the illustrative aspects and features described above, further aspects and features will become apparent by reference to the drawings and the following detailed description.

BRIEF DESCRIPTION OF ACCOMPANYING DRAWINGS

[0012] The novel features and characteristic of the disclosure are set forth in the appended claims. The disclosure itself, however, as well as a mode of use, further objectives and advantages thereof, will best be understood by reference to the following detailed description of an embodiment when read in conjunction with reference to the accompanying drawings wherein like reference numerals represent like elements and in which:

FIG.1 illustrates a schematic view of a safety braking system for a hoisted structure, in accordance with an embodiment of the present disclosure.

FIG.2 illustrates a perspective view of the safety braking mechanism of FIG.1 depicting a roller arrangement, in accordance with an embodiment of the present disclosure.

FIGS.3a and 3b illustrates a sectional front view and front of the safety braking system of FIG.1 in working condition.

FIG.4 illustrates a sectional perspective view of a portion of a safety braking system for a hoisted structure, in accordance with another embodiment of the present disclosure.

FIG.5 illustrates a front view of a portion of the safety braking system of FIG.4.

FIG. 6a and FIG.6b illustrates front view and sectional front view of a brake shoe and a brake liner in assembled position within the safety braking system of FIG. 4.

FIG.7a to FIG.7c illustrate a schematic view of the safety braking system of FIG.4 connected to a hoisted structure in various positions during braking, in accordance with an embodiment of the present disclosure.

FIG.8 illustrate a block diagram of the safety braking system, in accordance with an embodiment of the present disclosure.

FIG.9a to 9d illustrates a graphical representation generated during simulation of the safety braking system, in accordance with an embodiment of the present disclosure.

FIG.10a and 10d illustrate exemplary schematic view of magnetic field lines between the permanent magnet and the electromagnet, in accordance with an embodiment of the present disclosure.

[0013] The figures depict embodiments of the disclosure for purposes of illustration only. One skilled in the art will readily recognize from the following description that alternative embodiments of the system and methods illustrated herein may be employed without departing from the objective of the disclosure described herein. It should be appreciated by those skilled in the art that any block diagrams herein represent conceptual views of illustrative systems embodying the principles of the present subject matter.

DETAILED DESCRIPTION OF THE DRAWINGS

[0014] The foregoing has broadly outlined the features and technical advantages of the present disclosure in order that the detailed description of the disclosure that follows may be better understood. Additional features and advantages of the disclosure will be described hereinafter which forms the subject of the claims of the disclosure. It should be appreciated by those skilled in the art that, the conception and specific embodiments disclosed may be readily utilized as a basis for modifying other devices, systems, assemblies, and mechanisms for carrying out the same purposes of the present disclosure. It should also be realized by those skilled in the art that, such equivalent constructions do not depart from the scope of the disclosure as set forth in the appended claims. The novel features which are believed to be characteristics of the disclosure, to its system, together with further objects and advantages will be better understood from the following description when considered in connection with the accompanying figures. It is to be expressly understood, however, that each of the figures is provided for the purpose of illustration and description only and is not intended as a definition of the limits of the present disclosure.

[0015] In accordance with various embodiments of the present disclosure, a safety braking system for a hoisted structure guided along a guide rail may be described. The safety braking system includes a brake unit mounted to a hoisted structure and configured to move along a guide rail to guide the hoisted structure. The system further includes one or more brake shoes accommodated in a space defined between a brake liner of the brake unit and the guide rail. The system also includes an actuation mechanism configured to operate the one or more brake shoes from a first position and a second position. In the second position, the one or more brake shoes frictionally engage the guide rail and the brake unit to exert braking force on the hoisted structure. The actuation mechanism includes an electromagnet disposed in one of the brake unit and each of the one or more brake shoes. Further, a permanent magnet may be embedded in remaining of the brake unit and each of the one or more brake shoes. The electromagnet when activated repels from the permanent magnet to operate the one or more brake shoes to the second position to frictionally engage the guide rail. The forthcoming paragraphs will elucidate the configuration of the braking system. Forthcoming embodiments elucidate the braking system and method of braking in detail in conjunction to FIGs 1 to 10b.

[0016] In an embodiment, the safety braking system of the configuration described above requires lesser number of mechanical components as compared to the conventional systems.

Also, the system eliminates need of installation of the sheaves, rope, multiple links and governor. Thereby reducing cost of installation and system significantly.

[0017] While the embodiments in the disclosure are subject to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the figures and will be described below. It should be understood, however, that it is not intended to limit the disclosure to the particular forms disclosed, but on the contrary, the disclosure is to cover all modifications, equivalents, and alternative falling within the scope of the disclosure.

[0018] It is to be noted that a person skilled in the art would be motivated from the present disclosure and modify construction of a safety braking system for a hoisted structure guided along a guide rail. However, such modifications should be construed within the scope of the disclosure. Accordingly, the drawings show only those specific details that are pertinent to understand the embodiments of the present disclosure, so as not to obscure the disclosure with details that will be readily apparent to those of ordinary skill in the art having benefit of the description herein.

[0019] The terms “comprises”, “comprising”, or any other variations thereof used in the disclosure, are intended to cover a non-exclusive inclusion, such that a system and method that comprises a list of components does not include only those components but may include other components not expressly listed or inherent to such system, method, or assembly, or device. In other words, one or more elements in a system or device preceded by “comprises... a” does not, without more constraints, preclude the existence of other elements or additional elements in the system or device.

[0020] The following paragraphs describe the present disclosure with reference to FIG(s) 1 to 10b. In the figures, the same element or elements which have similar functions are indicated by the same reference signs. With general reference to the drawings, a safety braking system for a hoisted structure (4) in accordance with the teachings of a preferred embodiment of the present disclosure is illustrated and generally identified at reference numeral 10. The safety braking system (10) may be employed in the hoisted structures (4) such as an elevator car or counterweights used in the elevator assembly. It will be understood that the teachings of the present disclosure are not limited to any particular hoisted structure. Further, in the corresponding drawings neither the complete elevator system nor the elevator is depicted to promote better understanding of the instant invention.

[0021] The following detailed description is merely exemplary in nature and is not intended to limit application and uses. Furthermore, there is no intention to be bound by any theory presented in the preceding background or summary or the following detailed description. It is to

be understood that the disclosure may assume various alternative orientations and step sequences, except where expressly specified to the contrary. It is also to be understood that the specific devices or components illustrated in the attached drawings and described in the following specification are simply exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions or other physical characteristics relating to the embodiments that may be disclosed are not to be considered as limiting, unless the claims expressly state otherwise. Hereinafter, preferred embodiments of the present disclosure will be described referring to the accompanying drawings. While some specific terms of “upper,” “lower,” “below,” “above,” “right,” “left,” “rear” or “front” and other terms containing these specific terms and directed to a specific direction will be used, the purpose of usage of these terms or words is merely to facilitate understanding of the present invention referring to the drawings. Accordingly, it should be noted that the meanings of these terms or words should not improperly limit the technical scope of the present invention.

[0022] Also, it is to be understood that the phraseology and terminology used herein is for description and should not be regarded as limiting. Unless specified or limited otherwise, the terms “mounted,” “connected,” “supported,” and “coupled” and variations thereof are used broadly and encompass both direct and indirect mountings, connections, supports, and couplings. Further, “connected” and “coupled” are not restricted to physical or mechanical connections or couplings. It is to be understood that this disclosure is not limited to the specific devices, methods, applications, conditions, or parameters described and/or shown herein and that the terminology used herein is to describe particular embodiments by way of example and is not intended to be limiting of the claimed invention. Hereinafter in the following description, various embodiments will be described. For purposes of explanation, specific configurations and details are outlined to provide a thorough understanding of the embodiments. However, it will also be apparent to one skilled in the art that the embodiments may be practiced without the specific details. Furthermore, well-known features may be omitted or simplified in order not to obscure the embodiment being described.

[0023] Referring to FIGs 1 to 8 in conjunction, which illustrate the safety braking system (10) [hereinafter referred to as system (10)] and various components associated with the system (10). The system (10) of the present disclosure may be designed to be employed in the hoisted structures (4) such as but not limiting to elevator cars, counterweights, and the like. Also, application of the system (10) elucidated going forward should not be construed as a limitation of the present disclosure. The system (10) may be supported for movement with the hoisted

structure (4) for selectively engaging a blade portion of guide rail (1) guiding the hoisted structure (4) to prevent undesired movement of the hoisted structure (4) in a variety of situations. In an embodiment, the variety of situations [also referred to as pre-defined parameters in the present disclosure] include at least one of freefall condition or overspeed condition of the hoisted structure. The safety braking system (10) of the present disclosure ensures effective braking for the hoisted structures (4) relative to the guide rails (1) when the hoisted structure (4) is encountering undesirable movements. FIG.1 and FIG.2 schematically illustrates an embodiment of the system (10) which may be mountable at an appropriate portion of the hoisted structure (4) to function effectively during undesired movement. Said appropriate position on the hoisted structure (4) may include a car outer frame member but not limiting to the same. Hereinafter, features of the braking system (10) along with working may be elucidated.

[0024] The safety braking system (10) among other components may include a brake unit (2). The brake unit (2) [refer FIGs 1 and 4] of the present disclosure may be connected to the hoisted structure (4) at appropriate portions. In an embodiment, the system (10) may be mounted on either ends of the hoisted structure (4) on at least one of bottom portion, top portion, and the like. Further, the brake unit (2) may be configured to move along the guide rail (1) respective to the movement of the hoisted structure (4) to guide the hoisted structure (4). In some embodiments, the brake unit (2) may be structured to partially encompass the guide rail (1) [as shown in FIGs 1 and 2]. In an embodiment, the brake unit (2) may include a housing (2H) defining an opening. The opening of the housing (2H) may be configured to accommodate a brake liner (2a) [best shown in FIG.3a, 5, 6a and 6b]. In an embodiment, the brake liner (2a) may be adjustably connectable within the housing (2H) of the brake unit (2). The brake liner (2a) may be connected to the housing (2H) by mechanical joining members but not limiting to the same. In some embodiments, the brake liner (2a) may be defined with a key on at least one of a top major surface and a bottom major surface. The key defined on the brake liner (2a) may be accommodated within a corresponding keyway defined in the housing (2H), thereby arresting the movement of the brake liner (2a) within the housing (2H). In an embodiment, shape of the brake liner (2a) may resemble a wedge-shaped profile and may be positioned invertedly within the housing (2H). In an embodiment, the brake liner (2a) may be defined with an elongated slot (2b) [best shown in FIG.3b]. The elongated slot (2b) may be defined along an inclined surface of brake liner (2a) having the wedge-shaped profile.

[0025] In an embodiment, the brake liner (2a) may be defined with an extension arm (A) that may extend downwardly from a bottom portion of the brake liner (2a). The extension arm (A)

may be configured to accommodate a portion of the actuation mechanism (AM). In an embodiment, the actuation mechanism (AM) may include among other components at least one of electromagnet (EM) or a permanent magnet (PM). According to embodiments of the present disclosure, the extension arm (A) may be configured to accommodate the electromagnet (EM). The extension arm (A) may be adapted to accommodate the permanent magnet (PM) without deviating from the scope of the present disclosure. In an embodiment, the electromagnet (EM) may be secured to the bottom portion of the brake liner (2a) without need of an extension arm (A). In another embodiment of the present disclosure, the elongated slot (2b) defined in the brake liner (2a) may be configured to accommodate a portion of an actuation mechanism (AM). That is the elongated slot (2b) may accommodate at least one of the electromagnet (EM) and the permanent magnet (PM). According to the present disclosure, the elongated slot (2b) defined in the brake liner (2a) may be configured to accommodate the electromagnet (EM). The electromagnet (EM) may be embedded in a portion within the elongated slot (2b). Without deviating from the scope of the present disclosure, the elongated slot (2b) may be adapted to receive the permanent magnet (PM).

[0026] The system (10) further includes one or more brake shoes (3) [refer FIGs 3a/b, 6a/b] configure to work in tandem with the brake unit (2) and the guide rail (1) when the hoisted structure (4) encounter undesirable movement. The one or more brake shoes (3) may be positioned in a space defined between the guide rail (1) and the brake unit (2), in particular between the brake liner (2a) and the guide rail (1) [as shown in FIG.1 and 4]. An exemplary representation of one of the one or more brake shoes (3) is depicted in FIG.3a/3b and FIG.6a/6b in the corresponding figures. The one or more brake shoes (3) may be structured to engage with the blade portion of the guide rails (1). In an embodiment, the one or more brake shoes (3) may be structured to magnetically engage with the guide rail (1). In another embodiment, a surface of the one or more braking shoes (3) engaging with the guide rail (1) may be provided with a frictional material or defined with frictional surface. In an embodiment, shape of each of the one or more brake shoes (3) may correspond to shape of the brake liner (2a). The brake liner (2a) and the one or more brake shoes (3) is defined with complementing wedge-shaped profile [as shown in FIG(s).3a and 3b]. Said one or more brake shoes (3) may be defined with a slot. In an embodiment, the slot may be defined at a substantially central portion of each of the one or more brake shoes (3). In some embodiments, the slot may be defined relative to position of the electromagnet (EM) embedded in the brake liner (2a). In an embodiment, the slot may be defined up to a pre-defined depth on at least one of an inclined surface of the one or more brake shoes (3) and the end opposite to the inclined surface. In some embodiments, the slot may be

defined all through from the inclined surface to the end opposite to the inclined surface on the one or more brake shoes (3). The slot may be designed to accommodate remaining components associated with the actuation system (AM) which includes the permanent magnet (PM). In another embodiment, the permanent magnets (PM) may be individually embedded on the inclined surface and the frictional surface of the one or more brake shoes (3). The permanent magnet (PM) may be secured to the slot by mechanical joining process but not limiting to the same. In another embodiment, the slot defined in the one or more brake shoes (3) may be configured to accommodate the electromagnet (EM) without deviating from the scope of the present disclosure. The electromagnet (EM) may be secured to the one or more brake shoes (3) by joining methods similar to that of the permanent magnet (PM). The position of the permanent magnet (PM) or the electromagnet (EM) should not be construed as a limitation of the present disclosure. In case, the electromagnet (EM) may be provided in the brake liner (2a), the permanent magnet (PM) may be provided in the one or more brake shoes (3). In another case, the electromagnet (EM) may be provided in the one or more brake shoes (3) and the permanent magnet (PM) may be provided in the brake liner (2a). According to the present disclosure and as described in earlier paragraphs, the electromagnet (EM) may be provided in the vicinity of the brake liner (2a) and the permanent magnet (PM) may be embedded in the one or more brake shoes (3). In a preferred embodiment, the permanent magnet (PM) may be embedded within the one or more brake shoes (3) considering the centre of gravity (COG) of the one or more brake shoes. In an embodiment, the permanent magnet (PM) may be a rare earth magnet including a sintered neodymium magnet of grade-42 but not limiting to the same. In another embodiment, the one or more brake shoes (3) may be defined with a guide stem that may be accommodated within the elongated slot (2b) of the brake liner (2a). The guide stem may engage the one or more brake shoes (3) to the brake liner (2a) and enable sliding movement of the at least one of the brake liner (2a) and the one or more brake shoes (3) relative to each other during operational condition.

[0027] In an embodiment, the system (10) includes a roller arrangement (5) movably mounted on the brake liner (2a) of the brake unit (2) and configured to come in contact with the one or more brake shoes (3). The roller arrangement (5) may include housing configured to accommodate a plurality of rollers. The housing may include a couple of side plates spaced apart from each other and a plurality of rollers provided between the side plates along the length of the housing. A guide arrangement may be defined on the brake liner (2a) and may be configured to guide the roller arrangement (5) to traverse along the brake liner (2a) when the corresponding

brake shoe of the one or more brake shoes (3) is operated to the second position. In an embodiment, the guide arrangement may be a slot defined in the brake liner (2a) and a corresponding protrusion on the housing [i.e., either side plates] of the roller arrangement (5). In another embodiment, the guide arrangement may be a protrusion defined on the brake liner (2a) and a slot defined on the housing [i.e., either side plates] on the roller arrangement (5).

[0028] The system (10) further includes a control unit (CU) [as shown in FIG.8] communicatively coupled to the actuation mechanism (AM) [as shown in FIG.8] and a detection module (DM) associated with the hoisted structure (4). The control unit (CU) may be configured to trigger the actuation mechanism (AM) based on a signals received from the detection module (DM). The signal received from the detection module (DM) [as shown in FIG.8] may correspond to the pre-defined parameters. The pre-defined parameters are at least one of freefall condition and over speed condition of the hoisted structure (4). In an embodiment, the detection module (DM) may be a speed sensor configured to determine speed at which the hoisted structure (4) is traversing in the hoistway. The detection module (DM) sends the signal to the control unit (CU) which then triggers the actuation mechanism (AM) to operate the one or more brake shoes (3) between a first position and the second position. Triggering the actuation mechanism (AM) energises the electromagnet (EM) embedded in the brake unit (2). Once the electromagnet (EM) is energised, the electromagnet (EM) may repel from the permanent magnet (PM) embedded in the one or more brake shoes (3), thereby moving the one or more brake shoes (3) to second position from the first position. In the second position, the one or more brake shoes (3) may magnetically and frictionally engage the guide rail (1) and the brake unit (2) to exert braking force on the hoisted structure (4). Thus, progressively halting the hoisted structure (4) in the event of undesirable movement.

[0029] Referring now to FIG(s) 3a, 3c, and 7a to 7c in conjunction which depict exemplary schematic representations of the hoisted structure (4) with safety braking system (10) according to the present disclosure. FIGs. 3a and 7a depicts the hoisted structure (4) moving within the hoistway during normal operating conditions. It may be observed that the one or more brake shoes (3) of the system (10) is in the first position during the normal operating conditions. Now considering that the hoisted structure (4) [in this case the elevator car] experience undesirable movement i.e., either freefall condition or over speed condition, the detection module (DM) associated with the hoisted structure (4) sends a signal to the control unit (CU). Upon receiving the signal corresponding to the condition of the hoisted structure (4) from the detection module (DM), the control unit (CU) may trigger the actuation mechanism (AM) associated with the system (10). The actuation mechanism (AM) includes the electromagnet (EM) disposed in one

of the brake unit (2) and each of the one or more brake shoes (3) and the permanent magnet (PM) embedded in the remaining of the brake unit (2) and each of the one or more brake shoes (3). According to the present disclosure, the electromagnet (EM) is disposed in the vicinity of the brake liner (2a) and the permanent magnet (PM) is disposed in the one or more brake shoes. As described the actuation mechanism (AM) is triggered by the control unit (CU) based on the signal received from the detection module (DM). Upon triggering the actuation mechanism (AM), the electromagnet (EM) may be activated. Activating the electromagnet (EM) energises the electromagnet (EM) associated with brake liner (2a) which then pushes permanent magnet (PM) associated with each of the one or more brake shoes (3) towards the guide rail (1). Pushing the permanent magnet (PM) towards the guide rail (1) moves the one or more brake shoes (3) to the second position from the first position [as shown in FIG.7b]. In case the electromagnet (EM) is provided in the one or brake shoes (3) and the permanent magnet (PM) is provided in the brake liner (2a). Upon activation of the electromagnet (EM) it may repel from the permanent magnet (PM) towards the guide rail (1) moving the one or more brake shoes (3) to second position. Once the one or more brake shoes (3) is in second position, the inclined surface of the brake liner (2a) may transverse along co-operating inclined surface of corresponding brake shoe of the one or more brake shoes (3) up to a pre-defined distance. Due to the complementing wedge-shaped profile of the brake liner (2a) and corresponding brake shoe, the one or more brake shoes (3) frictionally engage both the guide rail (1) and the brake liner (2a) [as shown in FIG.3b and FIG.7c] to progressively halt/slow down the hoisted structure (4). As shown in FIGs 3b and 7c, the hoisted structure (4) comes to halt once the one or more brake shoes (3) are engaged with the guide rail (1) and the brake liner (2a).

[0030] In an embodiment of the disclosure, the control unit (CU) may be a centralized control unit, or a dedicated control unit associated with the system (10). The control unit may be comprised of a processing unit. The processing unit may comprise at least one data processor for executing program components for executing user- or system-generated requests. The processing unit may be a specialized processing unit such as integrated system (bus) controllers, memory management control units, floating point units, graphics processing units, digital signal processing units, etc. The processing unit may include a microprocessor, such as AMD Athlon, Duron or Opteron, ARM's application, embedded or secure processors, IBM PowerPC, Intel's Core, Itanium, Xeon, Celeron or other line of processors, etc. The processing unit may be implemented using a mainframe, distributed processor, multi-core, parallel, grid, or other architectures. Some embodiments may utilize embedded technologies like application-specific integrated circuits (ASICs), digital signal processors (DSPs), Field Programmable Gate Arrays

(FPGAs), etc. In some embodiments, the processing unit may be disposed in communication with one or more memory devices (e.g., RAM, ROM etc.) via a storage interface. The storage interface may connect to memory devices including, without limitation, memory drives, removable disc drives, etc., employing connection protocols such as serial advanced technology attachment (SATA), integrated drive electronics (IDE), IEEE-1394, universal serial bus (USB), fiber channel, small computing system interface (SCSI), etc. The memory drives may further include a drum, magnetic disc drive, magneto-optical drive, optical drive, redundant array of independent discs (RAID), solid-state memory devices, solid-state drives, etc. It is to be understood that a person of ordinary skill in the art may develop a system and a method of similar configuration without deviating from the scope of the present disclosure. Such modifications and variations may be made without departing from the scope of the present disclosure. Therefore, it is intended that the present disclosure covers such modifications and variations provided they come within the ambit of the appended claims and their equivalents.

EXEMPLARY EXPERIMENTAL ANALYSIS

[0031] Following paragraphs may illustrate exemplary experimental simulation results of the safety braking system (10) for the hoisted structure (4) according to the present disclosure. In the corresponding figures, FIG.9a to 10b illustrates results of the system (10) FIG.10a illustrates a schematic view of the permanent magnet (PM) and the electromagnet (EM) attracted to each other in the first position. The magnetic field lines illustrate that the two magnets (PM and EM) are attracted to each other. Similarly, FIG.10b illustrates magnetic field lines of the permanent magnet (PM) repelling from the magnetic field lines of the electromagnet (EM) when the electromagnet (EM) is activated. Further, referring to FIG.9a which illustrates a graphical representation indicating current wave form [i.e, current vs time], as shown in the graph, at 3 milliseconds (ms) a peak current of 20A is generated to move the repel the magnets (EM or PM) from each other. Referring to FIG.9b which illustrates movement of magnet (EM or PM) relative to each other. The force depicted i.e., 120N indicates the force of permanent magnet (PM) on electromagnet (EM) core. As shown in FIG.9b, at 3ms [i.e., when the current is at peak], the electromagnet (EM) repels the permanent magnet (PM) and travels towards the guiderail (1). At 22ms the travel of the electromagnet (EM) is complete [i.e., the electromagnet (EM) is attached to the guiderail] [as shown in FIG.9c]. The force imparted at 22ms on the guide rail (1) is depicted in FIG.9b. Once the electromagnet (EM) displaces to second position,

the force becomes constant. FIG.9d illustrates the change in magnetic force of the electromagnet (EM) from first position to the second position. The above exemplary embodiment is elucidated considering that the electromagnet (EM) is embedded in the extension arm (A) of the brake liner (2a) and the same should not be considered as a limitation of the present disclosure. The above-described forces are exemplary and are illustrated for particular dimensions of components of the system (10) and are subjected to vary based on the change in dimensions of the components of the system (10).

ADVANTAGES OF THE INVENTION

[0032] The safety braking system for a hoisted structure guided along a guide rail in accordance with the present disclosure requires lesser number of mechanical components when compared to the conventional systems. The safety braking system in accordance with the present disclosure significantly reduces activation time compared to conventional braking systems. Also, the cost of manufacturing is significantly lesser as the number of components involve in manufacturing the safety braking system is also less.

WE CLAIM:

1. A safety braking system (10) for a hoisted structure (4) guided along a guide rail (1), the system (10) comprising:
a brake unit (2) mounted to a hoisted structure (4) and configured to move along a guide rail (1) to guide the hoisted structure (4);
one or more brake shoes (3) accommodated in a space defined between a brake liner (2a) of the brake unit (2) and the guide rail (1); and
an actuation mechanism (AM) to operate the one or more brake shoes (3) from a first position and a second position, wherein in the second position, the one or more brake shoes (3) frictionally engage the guide rail (1) and the brake unit (2) to exert braking force on the hoisted structure (4), the actuation mechanism (AM) comprising:
 - an electromagnet (EM) disposed in one of the brake unit (2) and each of the one or more brake shoes (3);
 - a permanent magnet (PM) embedded in remaining of the brake unit (2) and each of the one or more brake shoes (3),wherein, electromagnet (EM) when activated repels the permanent magnet (PM) to operate the one or more brake shoes (3) to the second position to frictionally engage the guide rail (1).
2. The system (10) as claimed in claim 1, wherein the brake liner (2a) comprises an extension arm (A) extending downwardly, and the electromagnet (EM) is disposed in the extension arm.
3. The system (10) as claimed in claim 1, wherein the electromagnet (EM) is disposed in the brake liner (2a) and the permanent magnet (PM) is embedded in each of the one or more brake shoes (3).
4. The system (10) as claimed in claim 1, wherein the brake liner (2a) and the one or more brake shoes (3) is defined with complementing wedge-shaped profile.
5. The system (10) as claimed in claim 1 and 4, wherein the brake liner (2a) is defined with an elongated slot (2b) to accommodate and guide a guide stem extending from a corresponding brake shoe of the one or more brake shoes (3).

6. The system (10) as claimed in claim 4, wherein an inclined surface of the brake liner (2a) traverse along co-operating inclined surface of the corresponding brake shoe of the one or more brake shoes (3), when the one or more brake shoes (3) are operated to the second position.

7. The system (10) as claimed in claim 1 comprises a roller arrangement (5) movably mounted on the brake liner (2a) of the brake unit (2), the roller arrangement (5) is provided in a side of the brake liner (2a) which is adapted to come in contact with the one or more brake shoes (3), wherein brake liner (2a) is defined with a guide arrangement to guide the roller arrangement (5) to traverse along the brake liner (2a) when the corresponding brake shoe of the one or more brake shoes (3) is operated to the second position.

8. The system (10) as claimed in claim 1 comprises a control unit (CU) communicatively coupled to the actuation mechanism (AM), the control unit (CU) is configured to trigger the actuation mechanism (AM) based on the pre-defined parameter, wherein the pre-defined parameter is at least one of freefall condition and over speed condition of the hoisted structure (4), the control unit (CU) receives a signal corresponding to the predefined parameter from a detection module (DM) associated with the control unit (CU).

9. A method for progressively exerting braking force to a hoisted structure (4) guided along a guide rail (1), the method comprising:

receiving, by a control unit (CU), a signal corresponding to pre-defined parameter from a detection module (DM) associated with the control unit (CU):

triggering, by the control unit (CU), an actuation mechanism (AM) based on the signal received from the detection module (DM),

wherein, the actuation mechanism (AM) comprises an electromagnet (EM) disposed in one of the brake unit (2) and each of the one or more brake shoes (3) and a permanent magnet (PM) embedded in remaining of the brake unit (2) and each of the one or more brake shoes (3),

wherein, the electromagnet (EM) when activated repels the permanent magnet (PM) and operate the one or more brake shoes (3) accommodated in a space defined between a brake liner (2a) of the brake unit (2) and the guide rail (1) from a first position and a second position, wherein in the second position, the one or more brake shoes (3) frictionally engage the guide rail (1) and the brake unit (2) to exert braking force on the hoisted structure (4).

10. The method as claimed in claim 9, wherein triggering the actuation mechanism (AM) activates an electromagnet (EM) disposed in one of the brake unit (2) and each of the one or

more brake shoes (3) to push a permanent magnet (PM) embedded in remaining of the brake unit (2) and each of the one or more brake shoes (3).

Dated this 19th day of April 2022

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ABSTRACT

A SAFETY BRAKING SYSTEM FOR A HOISTED STRUCTURE

A safety braking system (10) for a hoisted structure (4) guided along a guide rail (1) is disclosed. The system (10) includes a brake unit (2) connected to a hoisted structure (4) and configured to slide along the guide rail (1). The system further includes one or more brake shoes (3) accommodated between a brake liner (2a) and the guide rail (1). An actuation mechanism (AM) configured to operate the brake shoes (3) between a first position and a second position. In the second position, the brake shoes (3) frictionally engage the guide rail (1) and the brake unit (2) to exert braking on the hoisted structure (4). The actuation mechanism includes an electromagnet (EM) disposed in one of the brake unit (2) and the one or more brake shoes (3). A permanent magnet (PM) embedded in remaining of the brake unit (2) and each of the brake shoes (3). The electromagnet (EM) when activated repels the permanent magnet (PM) towards the guide rail (1).

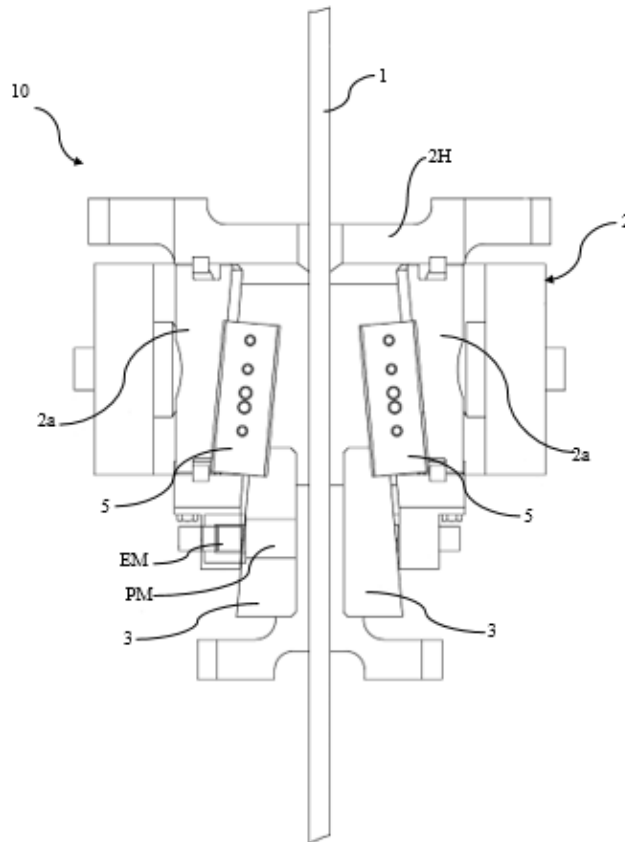


FIG.1

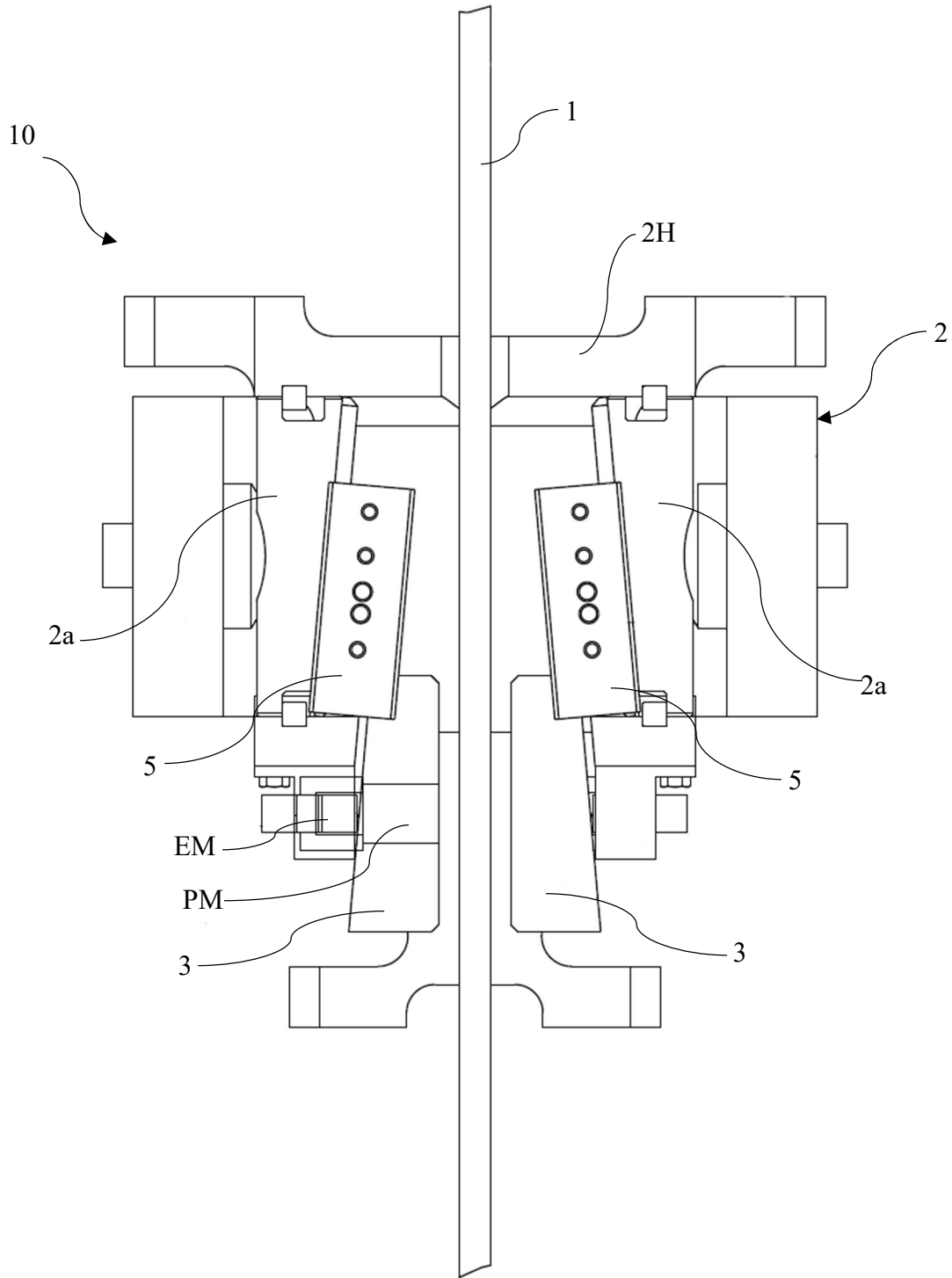


FIG.1

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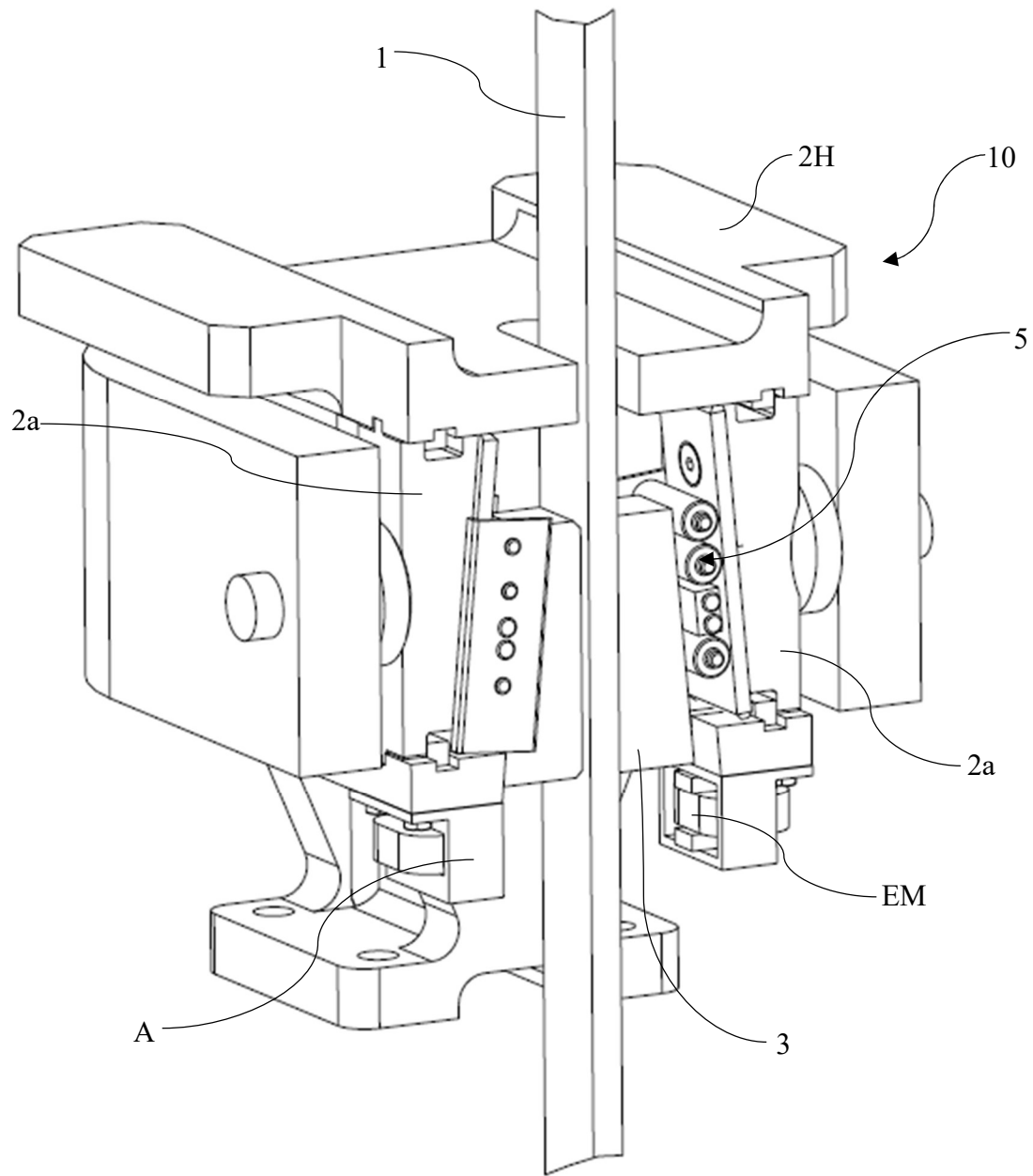


FIG.2

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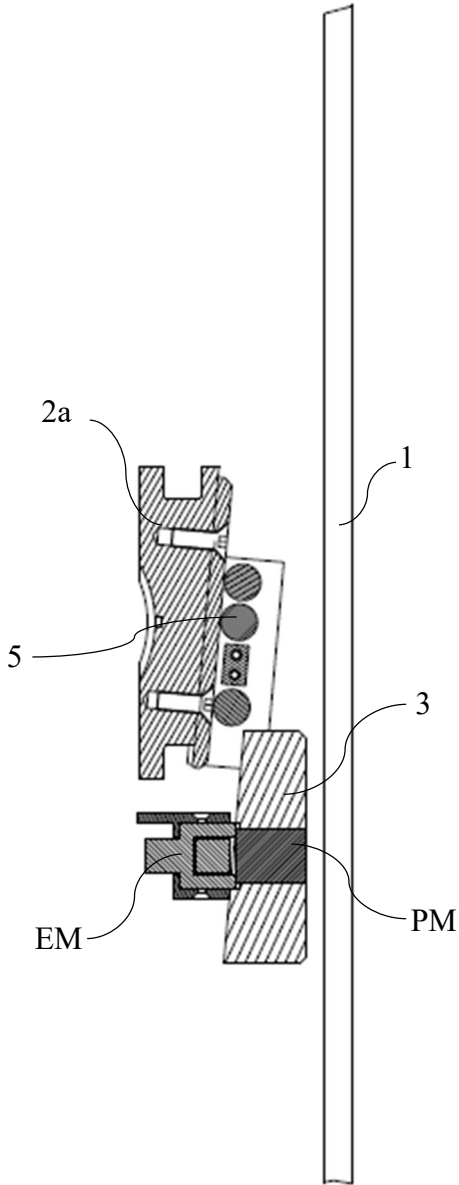


FIG.3a

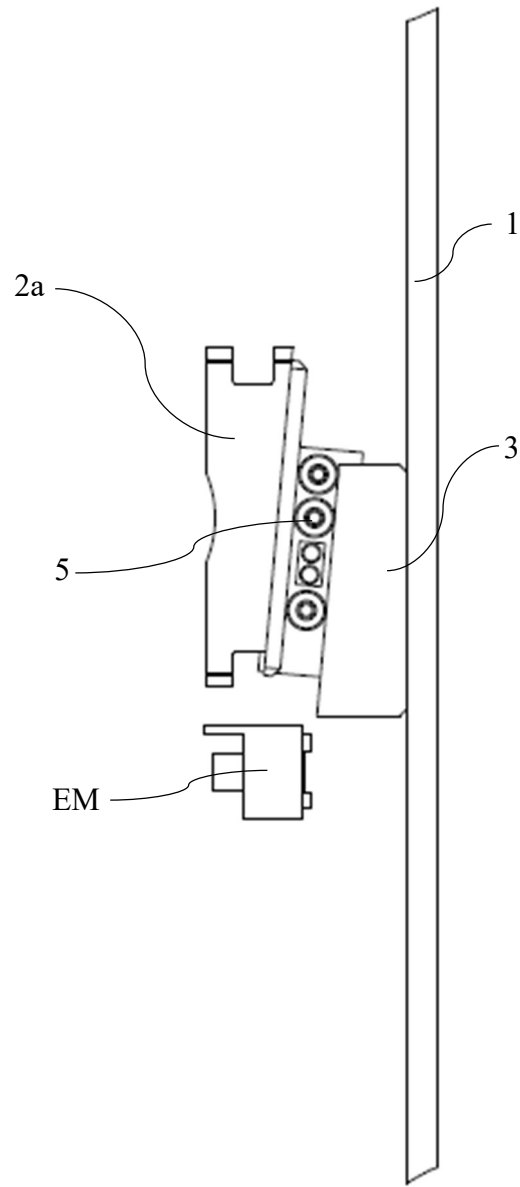


FIG.3b

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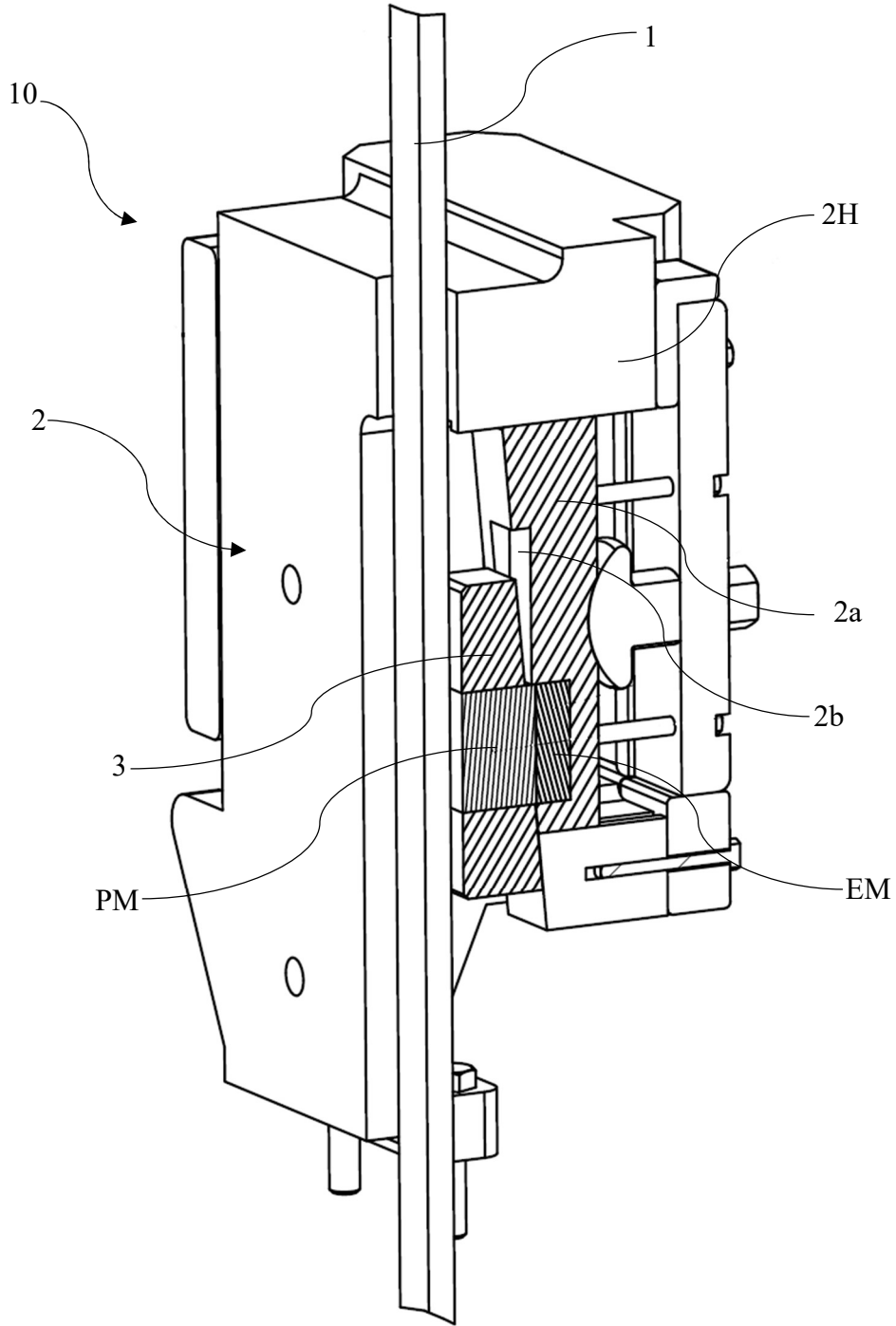


FIG.4

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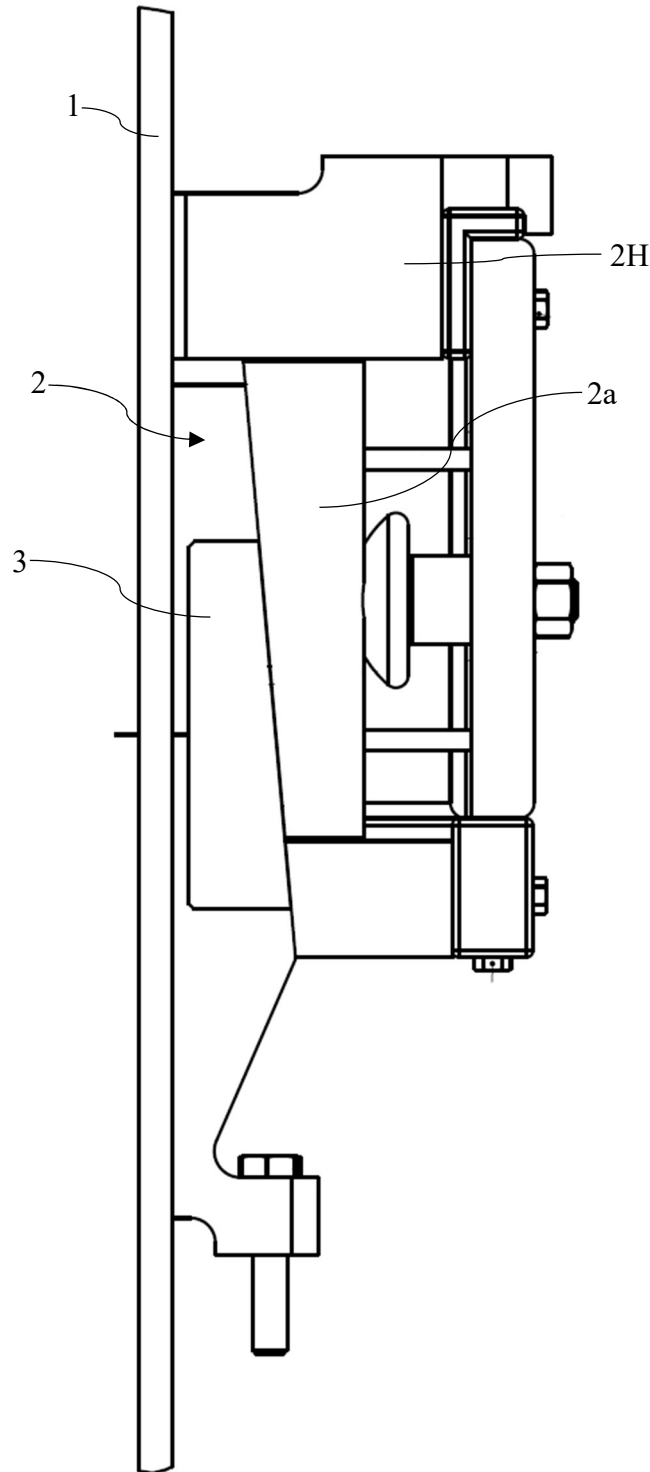


FIG.5

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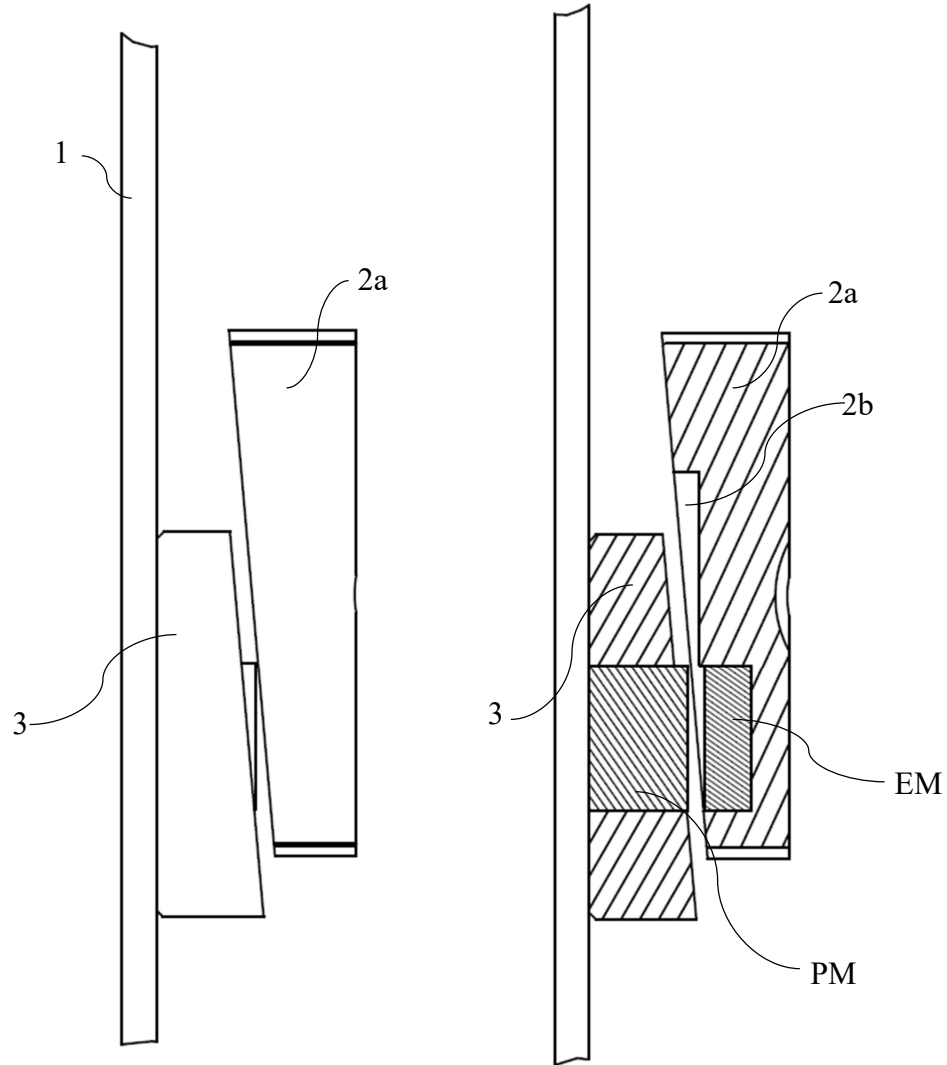


FIG.6a

FIG.6b

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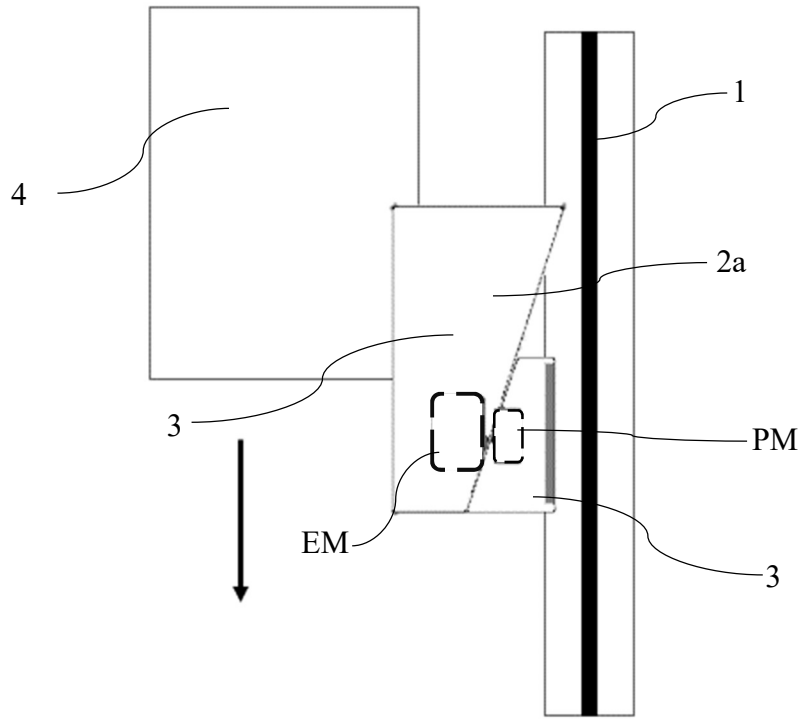


FIG.7a

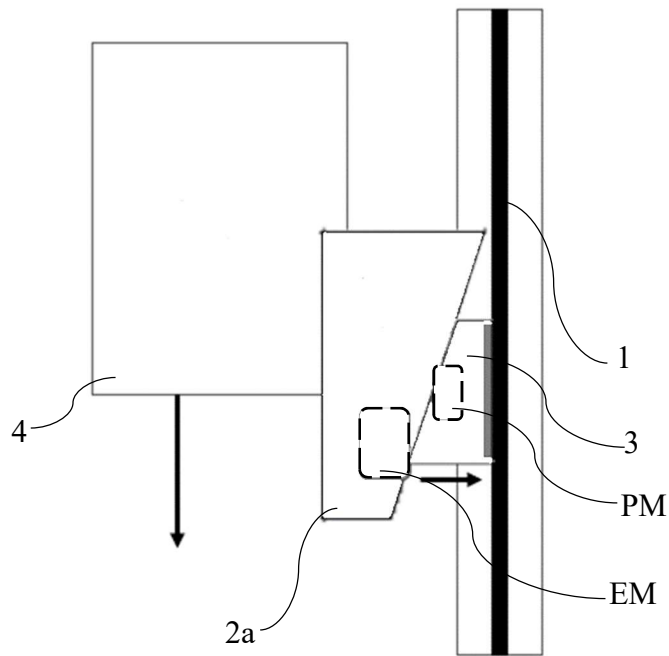


FIG.7b

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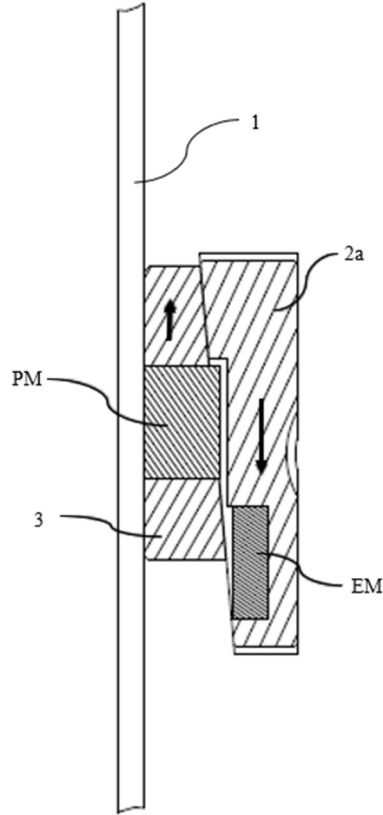


FIG.7c

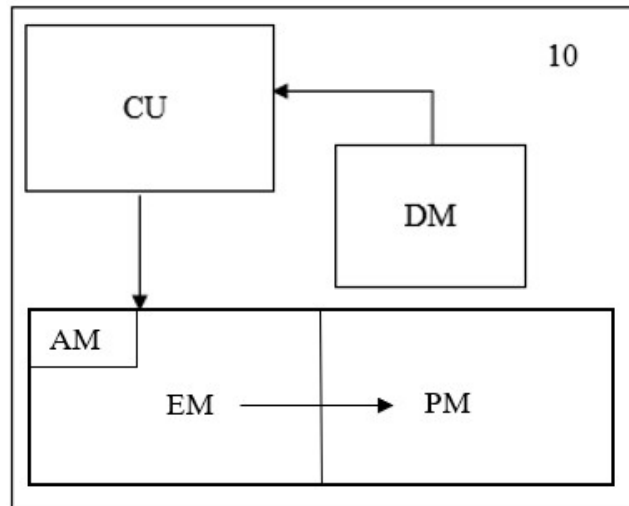


FIG.8

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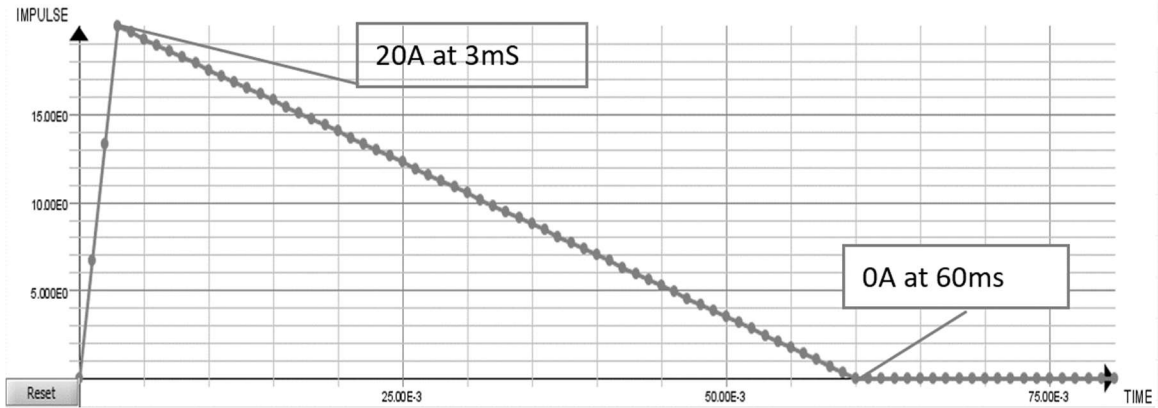


FIG.9a

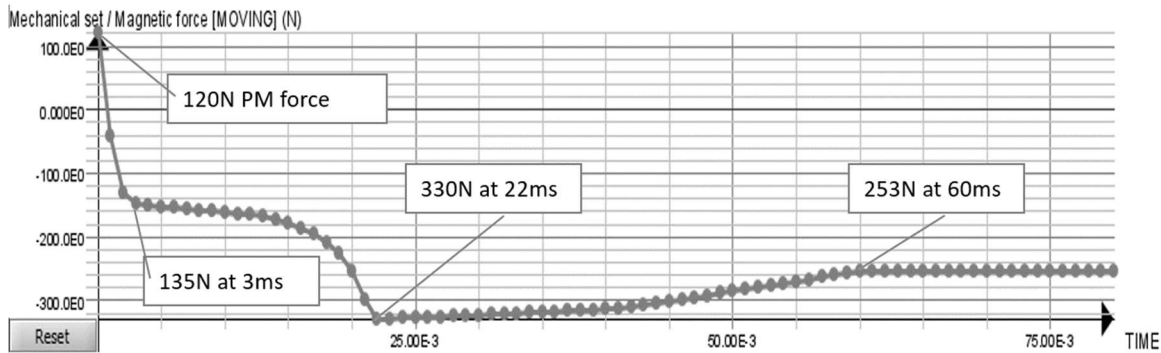


FIG.9b

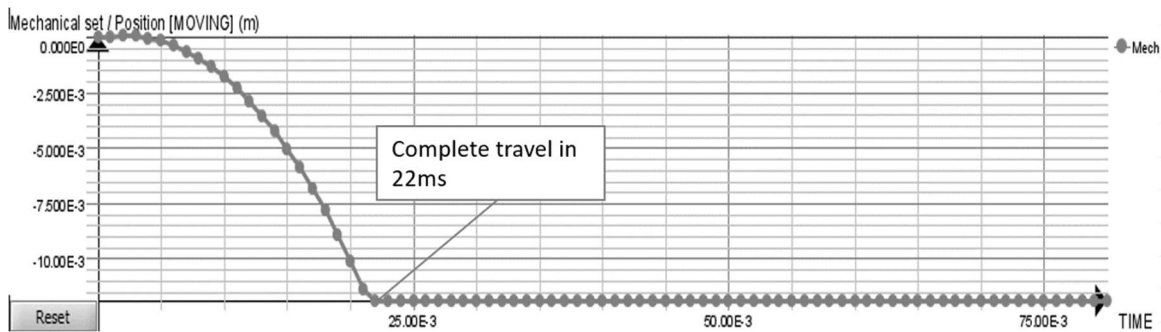


FIG.9c

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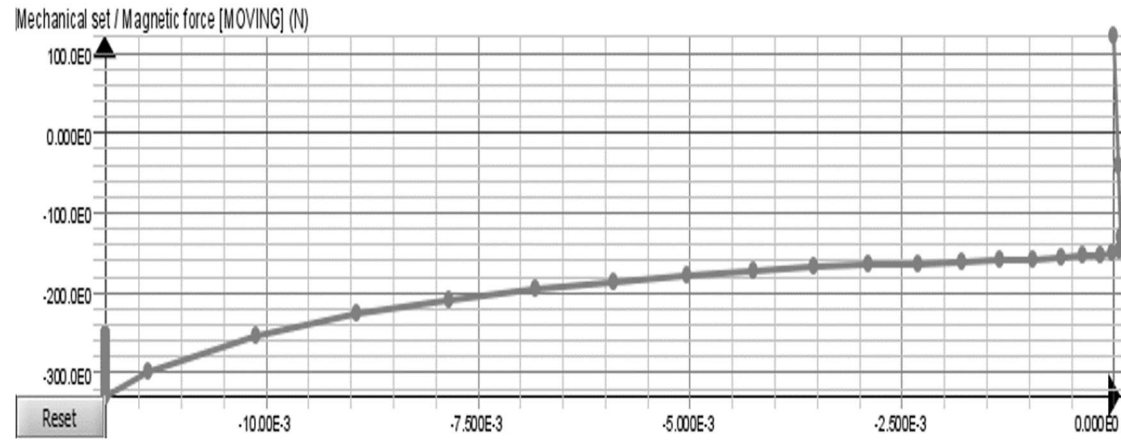
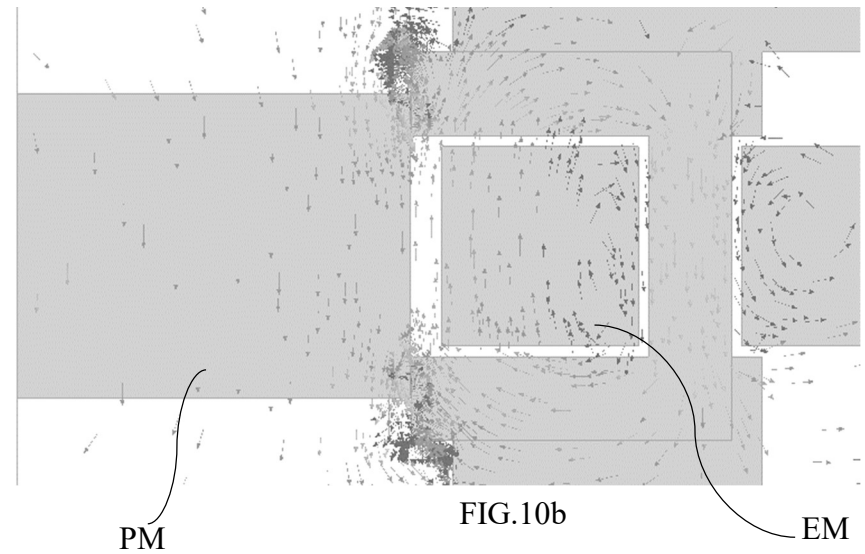
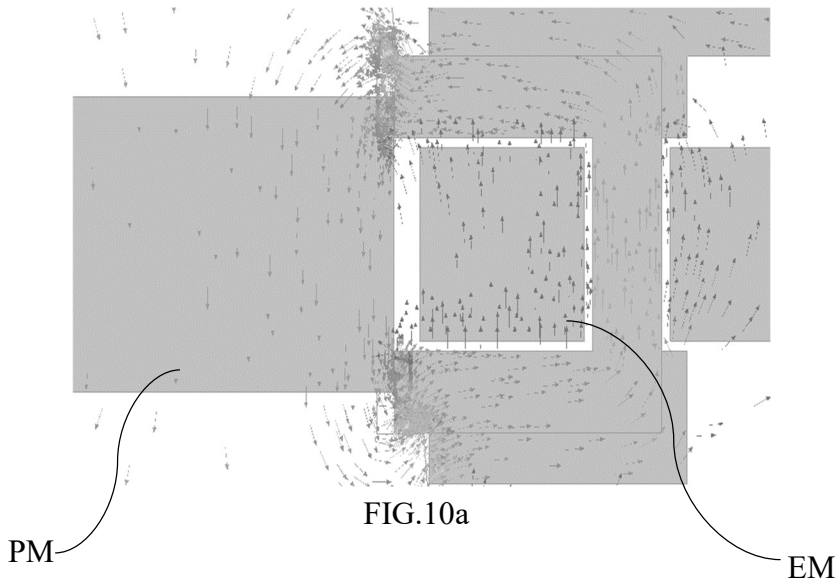


FIG.9d



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