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Inertial lock friction hinge

Abstract

One aspect is an inertial lock friction hinge, including a shaft assembly having a shaft assembly recess and a friction assembly having a friction assembly recess. The shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation. The hinge includes a restraining component positioned within the hinge such that when the hinge is in an unlocked condition the restraining component is not engaged with both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are allowed to rotate relative to each. The restraining component is positioned such that when the inertial lock friction hinge is in a locked condition the restraining component is at least partially engaged with both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are locked and prevented from relative rotation by the restraining component.

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Background/Summary

BACKGROUND

(1) Friction hinges are commonly used for many applications and come in many varieties throughout industry. One specific application is in automotive applications for compartment closures. When friction is added within the hinge for center consoles and other compartments, users get a solid feel and can count on the lid staying open until manually moved closed. A friction hinge alone will not keep the bin from opening under certain loading conditions. For this reason, it is known to use a latch or an inertial lock to keep lids closed, particularly in automotive compartment to meet safety standards. Inertial locks are used in situations where there is a desire to not have the user operate a latch each time the compartment is opened. In latch-less compartment designs, an inertial lock is typically used in place of the latch to meet safety standards. These function to prevent the movement of a compartment lid only when exposed to certain impact loads. These inertial locks, however, have drawbacks including cosmetic disadvantages, large package size, need for reset after device engagement, time required to engage and also can require complicated assembly.

(2) Accordingly there is a need for a compact design that provides both frictional torque and an inertial locking function in order to meet cost and cosmetic expectations of these applications. It is also important to provide these features in a design that limits rotation angle of the moving portion of the system due to inertial forces.

SUMMARY

(3) One embodiment is an inertial lock friction hinge system including a first hinged element, a second hinged element, a shaft assembly coupled to the first hinged element, the shaft assembly having a shaft assembly recess, and a friction assembly coupled to the second hinged element, the friction assembly having a friction assembly recess. The shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation. A restraining component is positioned within the inertial lock friction hinge such that when the restraining component is fully contained within one of the friction assembly recess and the shaft assembly recess the shaft assembly and the friction assembly are allowed to rotate relative to each other under friction such that the inertial lock friction hinge system is in an unlocked condition. The restraining component is further positioned such that when the restraining component is at least partially within both of the friction assembly recess and the shaft assembly recess the shaft assembly and the friction assembly are prevented from relative rotation such that the inertial lock friction hinge system is in a locked condition.

(4) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the inertial lock friction hinge system is configured to be in the unlocked condition when gravitational force acts upon the inertial lock friction hinge and configured to be in the locked condition when an external impact force acts upon the inertial lock friction hinge.

(5) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the inertial lock friction hinge system is configured such that gravitational force acting on the inertial lock friction hinge system causes the restraining component to be fully contained within one of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge system is in the unlocked condition.

(6) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the inertial lock friction hinge system is configured such that an external impact force acting on the inertial lock friction hinge system causes the restraining component to be partially contained within each of the friction assembly recess and the shaft assembly recess so that the inertial lock friction

hinge system is in the locked condition.

(7) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the shaft assembly comprises a shaft housing and a shaft and the friction assembly comprises a friction housing containing at least one friction element, and wherein the at least one friction element is configured over the shaft in an interference fit.

(8) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the shaft rotates along a shaft axis and wherein when the inertial lock friction hinge system changes between the locked condition and the unlocked condition the restraining component moves radially relative to the shaft.

(9) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the restraining component is one of a pin and a rectangular block.

(10) One embodiment is the inertial lock friction hinge system of any previous embodiment, wherein the restraining component further comprises a bias mechanism configured to hold the restraining component in one of the friction assembly recess and the shaft assembly recess until an impact force causes a load on the bias mechanism thereby moving the restraining component at least partially into both of the friction assembly recess and the shaft assembly recess.

(11) One embodiment is an inertial lock friction hinge including a shaft assembly having a shaft assembly recess and a friction assembly having a friction assembly recess. The shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation. A restraining component is positioned within the inertial lock friction hinge such that when the inertial lock friction hinge is in an unlocked condition the restraining component is not engaged with both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are allowed to rotate relative to each other under friction. The restraining component is further positioned such that when the inertial lock friction hinge is in a locked condition the restraining component is at least partially engaged with both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are locked and prevented from relative rotation by the restraining component.

(12) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the inertial lock friction hinge is configured to be in the unlocked condition when gravitational force acts upon the inertial lock friction hinge and configured to be in the locked condition when an external impact force act upon the inertial lock friction hinge.

(13) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the inertial lock friction hinge is configured such that an external impact force acting on the inertial lock friction hinge causes the restraining component to be partially engaged with each of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge is in the locked condition.

(14) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the shaft assembly comprises a shaft housing and a shaft and the friction assembly comprises a friction housing containing at least one friction element, and wherein the at least one friction element is configured over the shaft in an interference fit.

(15) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the shaft rotates along a shaft axis and wherein when the inertial lock friction hinge system changes between the locked condition and the unlocked condition the restraining component moves radially relative to the shaft.

(16) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the restraining component transitions radially toward the shaft with application of impact force to the inertial lock friction hinge.

(17) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the restraining component is one of a pin, a rectangular block

and a pawl.
(18) One embodiment is an inertial lock friction hinge including a shaft assembly having a shaft assembly recess and a friction assembly having a friction assembly recess. The shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation. A restraining component is positioned within the inertial lock friction hinge such that when the inertial lock friction hinge is in an unlocked condition the restraining component is fully contained within one of the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are allowed to rotate relative to each other under friction. The restraining component is further positioned such that when the inertial lock friction hinge is in a locked condition the restraining component is at least partially contained within both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are locked and prevented from relative rotation by the restraining component.
(19) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the inertial lock friction hinge system is configured to either change from the locked condition to the unlocked condition or change from the unlocked condition to the locked condition when an external impact force acts upon the inertial lock friction hinge.
(20) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the external impact force on the inertial lock friction hinge system either causes the restraining component to be fully contained within one of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge system is in the unlocked condition or causes the restraining component to be partially contained within each of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge system is in the locked condition.
(21) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the shaft assembly comprises a shaft housing and a shaft and the friction assembly comprises a friction housing containing at least one friction element, and wherein the at least one friction element is configured over the shaft in an interference fit.
(22) One embodiment is the inertial lock friction hinge system or the inertial lock friction hinge of any previous embodiment, wherein the shaft rotates along a shaft axis and wherein when the inertial lock friction hinge system changes between the locked condition and the unlocked condition the restraining component moves radially relative to the shaft.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The accompanying drawings are included to provide a further understanding of embodiments and are incorporated in and constitute a part of this specification. The drawings illustrate embodiments and together with the description serve to explain principles of embodiments. Other embodiments and many of the intended advantages of embodiments will be readily appreciated as they become better understood by reference to the following detailed description. The elements of the drawings are not necessarily to scale relative to each other. Like reference numerals designate corresponding similar parts.
(2) FIG. **1** illustrates a perspective view of a hinged system incorporating an inertial lock friction hinge in accordance with one embodiment.
(3) FIG. **2** illustrates an exploded view of the hinged system of FIG. **1** incorporating an inertial lock friction hinge in accordance with one embodiment.
(4) FIG. **3** illustrates a perspective view of an inertial lock friction hinge in accordance with one embodiment.
(5) FIG. **4** illustrates an exploded view of the inertial lock friction hinge in FIG. **3** in accordance

with one embodiment.
(6) FIGS. **5-7** illustrate cross-sectional views of the inertial lock friction hinge in FIGS. **3-4** in accordance with one embodiment.
(7) FIG. **8** illustrates an exploded view of an inertial lock friction hinge in accordance with one embodiment.
(8) FIGS. **9-10** illustrate cross-sectional views of the inertial lock friction hinge in FIG. **8** in accordance with one embodiment.
(9) FIG. **11** illustrates a perspective view of a hinged system incorporating an inertial lock friction hinge in accordance with one embodiment.
(10) FIG. **12** illustrates a partially exploded view of the hinged system of FIG. **11** incorporating an inertial lock friction hinge in accordance with one embodiment.
(11) FIG. **13** illustrates a perspective view of a three-part inertial lock friction hinge in accordance with one embodiment.
(12) FIG. **14** illustrates an exploded view of the three-part inertial lock friction hinge of FIG. **13** in accordance with one embodiment.
(13) FIGS. **15-17** illustrate cross-sectional views of the inertial lock friction hinge in FIGS. **13-14** in accordance with one embodiment.
(14) FIG. **18** illustrates a perspective view of an inertial lock friction hinge in accordance with one embodiment.
(15) FIG. **19** illustrates an exploded view of the inertial lock friction hinge in FIG. **18** in accordance with one embodiment.
(16) FIGS. **20-23** illustrate cross-sectional views of the inertial lock friction hinge in FIGS. **18-19** in accordance with one embodiment.
(17) FIG. **24** illustrates a perspective view of an inertial lock friction hinge in accordance with one embodiment.
(18) FIG. **25** illustrates an exploded view of the inertial lock friction hinge in FIG. **24** in accordance with one embodiment.
(19) FIGS. **26-28** illustrate cross-sectional views of the inertial lock friction hinge in FIGS. **24-25** in accordance with one embodiment.

DETAILED DESCRIPTION

(20) In the following Detailed Description, reference is made to the accompanying drawings, which form a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. In this regard, directional terminology, such as “top,” “bottom,” “front,” “back,” “leading,” “trailing,” etc., is used with reference to the orientation of the Figure(s) being described. Because components of embodiments can be positioned in a number of different orientations, the directional terminology is used for purposes of illustration and is in no way limiting. It is to be understood that other embodiments may be utilized and structural or logical changes may be made without departing from the scope of the invention. The following detailed description, therefore, is not to be taken in a limiting sense, and the scope of the invention is defined by the appended claims.
(21) It is to be understood that the features of the various exemplary embodiments described herein may be combined with each other, unless specifically noted otherwise.
(22) FIG. **1** illustrates a hinged system **10** incorporating an inertial lock friction hinge **16** in accordance with one embodiment. FIG. **2** further illustrates an exploded view of hinged system **10**, illustrating further components not visible in FIG. **1**. In one embodiment, hinged system **10** includes a base **14** and a top **12**. In one embodiment, base **14** includes openings **18** and top **12** includes openings **19**, which are respectively configured to house or contain portions of inertial lock friction hinge **16**. In this way, top **12** is frictionally hinged relative to base **14** with inertial lock friction hinge **16**. In the illustrated embodiment, two inertial lock friction hinges **16** are illustrated, but in some embodiments one may be used, while in others more than two are used.

(23) In one embodiment, hinged system **10** is a console, such as a console located between front seats in an automobile. Friction torque within inertial lock friction hinge **16** holds top **12** closed on base **14**. In this way, hinged system **10** does not require a separate latch to hold top **12** closed. A user can open top **12** by simply applying a force greater than the friction torque within inertial lock friction hinge **16**. This allows for simple one-hand operation, and friction at the hinge location allows for efficient packaging when space is consumed at the back corner of the compartment.
(24) Furthermore, inertial lock friction hinge **16** holds lid **12** completely closed and locked in place in a situation where an inertial force within inertial lock friction hinge **16** is exceeded, such as when the automobile within which hinged system **10** is mounted experiences an external dynamic force, such as an impact that normally would cause the lid to open. This ensures that lid **12** is prevented from significantly rotating away from base **14** such that any contents therein cannot project out into the automobile in case of impact or collision. Inertial lock friction hinge **16** may also be similarly implemented in applications other than automobiles.
(25) In one embodiment, when hinge system **10** is oriented as illustrated in FIGS. **1** and **2**, a gravitational force F.sub.G acts down in the direction of arrow F.sub.G. In this orientation, a gravitational force acting upon inertial lock friction hinge **16** maintains inertial lock friction hinge **16** in an unlocked condition. In this way, a user can open and close lid **12** relative to base **14** by overcoming the frictional torque or force of inertial lock friction hinge **16**. When hinge system **10** is subjected to a dynamic or impact force, however, the inertial force caused by the impact with a component that is in the same direction as gravitational force F.sub.G overcomes the gravitational force F.sub.G such that inertial lock friction hinge **16** is in a locked condition. In this way, the lid **12** cannot be opened or moved relative to base **14** regardless of the force applied to lid **12**.
(26) FIGS. **3-7** illustrate inertial lock friction hinge **16** in accordance with one embodiment. In one embodiment, inertial lock friction hinge **16** includes shaft assembly **30**, friction assembly **40** and restraining component **50**. In one embodiment, a first hinged element **12** is coupled to friction assembly **40** and second hinged element **14** is coupled to shaft assembly **30**. As first hinged element **12** and friction assembly **40** are rotated relative to second hinged element **14** and shaft assembly **30**, friction torque due to inertial lock friction hinge **16** is produced, as will be explained further below. In one embodiment, for example when added to a console or other compartment, a user experiences a solid feel and can count on the hinged element **12**, such as a lid, staying open until manually moved closed and staying closed until manually moved open. This allows for simple one-hand operation. Also, inertial lock friction hinge **16** allows the elimination of latch and catch components.
(27) In one embodiment, shaft assembly **30** includes shaft housing **32** and shaft **34**. In one embodiment, shaft housing **32** further includes shaft housing opening **33** and shaft assembly recess **54**. In one embodiment, friction assembly **40** includes a plurality of friction elements **44** and friction housing **42**. In one embodiment, friction housing **42** includes friction assembly recess **52**.
(28) In one embodiment, when inertial lock friction hinge **16** is assembled, shaft **34** is firmly attached within shaft housing opening **33**. In one embodiment, shaft **34** has a knurled end that is forced into shaft housing opening **33** such that they are fixed together. Shaft **34** is configured to rotate about its axis X, and shaft **34** and shaft housing **32** rotate together by virtue of being fixed together.
(29) Friction elements **44** are placed over shaft **34** in an interference fit and are also contained within friction housing **42**. In one embodiment, grease is placed between the friction elements **44** and shaft **34**. In one embodiment, friction housing **42** has a friction housing opening **43** with a profile that matches a portion of the outer profile of friction elements **44**, such that friction elements **44** are prevented from relative rotation with friction housing **42**. Accordingly, when shaft housing **32** rotates relative to friction housing **42**, shaft **34** rotates within friction elements **44**. Because of the interference fit between shaft **34** friction elements **44**, their relative rotation produces friction torque within inertial lock friction hinge **16**. The amount of friction torque within

inertial lock friction hinge **16** can be readily adjusted up or down by respectively adding or subtracting the number of friction elements **44**.
(30) In at least one position of relative orientation of shaft housing **32** and friction housing **42**, friction assembly recess **52** and shaft assembly recess **54** are aligned, for example, as illustrated in FIG. **5**. In one embodiment, restraining component is located fully within shaft assembly recess **54**, also as illustrated in FIG. **5**. In this position, inertial lock friction hinge **16** is in an unlocked condition, such that shaft assembly **30**, including shaft housing **32**, and friction assembly **40**, including friction housing **42**, can be rotated relative to each other by applying a force greater than the friction torque of inertial lock friction hinge **16**.
(31) FIG. **6** illustrates how shaft housing **32** is rotated (counterclockwise as illustrated in the figure) relative to friction housing **42** as restraining component **50** remains fully within shaft assembly recess **54**. During this rotation, of shaft housing **32** restraining component **50** is held in shaft assembly recess **54** by the outer diameter of friction housing **42**. Accordingly, any acceleration and deceleration occurring during this orientation will not move restraining component **50**. Only when friction assembly recess **52** and shaft assembly recess **54** are aligned will restraining component **50** move by gravity and/or the impact forces that cause engagement.
(32) In one embodiment, subjecting inertial lock friction hinge **16** to an outside impact or dynamic force causes inertial lock friction hinge **16** to change from an unlocked condition to a locked condition. For example, when inertial lock friction hinge **16** is subjected to impact force F.sub.1, as illustrated in FIG. **7**, this causes restraining component **50** to shift partially out of shaft assembly recess **54** and at least partially into friction assembly recess **52** due to its inertial force, sometimes referred to as frictional force. Once this occurs, shaft housing **32** and friction housing **42** are prevented from significant relative rotation by restraining component **50**. When restraining component **50** is oriented partially within shaft assembly recess **54** and partially within friction assembly recess **52**, inertial lock friction hinge **16** is in a locked condition. When inertial lock friction hinge **16** is installed in a console, the cover **12** is then locked closed against base **14** and will retain any contents within base **14**.
(33) In one embodiment, when inertial lock friction hinge **16** is installed in hinge system **10**, inertial lock friction hinge **16** is oriented such that gravitational force F.sub.G acts down causing restraining component **50** to remain within shaft assembly recess **54** (as illustrated in FIG. **5**). When hinge system is subjected to a dynamic or impact force F.sub.1 in the same direction as the gravitational force F.sub.G, inertia of the blocker **50** causes it to want to stay in position relative to ground, while the rest of hinge **16** accelerates down according to the impact. In an application where hinge system **10** is mounted in an automobile, shaft assembly **30**, friction assembly **40**, first hinged element **12**, and second hinged element **14** are all fixed to the automobile and will all accelerate with the impact force F.sub.1 on the automobile. Since restraining component **50** is not fixed and free to move within shaft assembly recess **54** and friction assembly recess **52**, however, its inertial force will cause it to move up (relative to how it is illustrated in FIG. **7**), or radially toward shaft axis X.
(34) In one embodiment, when dynamic or impact force F.sub.1 dissipate, gravitational force F.sub.G will cause restraining component **50** to move radially away from shaft axis X and return within shaft assembly recess **54** (FIG. **5**) so that inertial lock friction hinge **16** is again in the unlocked condition and the cover **12** is then movable relative to base **14**. In one embodiment, the amount of impact force F.sub.1 required to move restraining component **50** out of shaft assembly recess **54** into the locked position is about 2× the gravitational force F.sub.G holding it there, and applied in the same direction as gravitational force F.sub.G.
(35) In the embodiment illustrated in FIGS. **3-7**, restraining component **50** is configured as a pin or generally cylindrical in shape. The corresponding shapes of friction assembly recess **52** and shaft assembly recess **54** are then configured to accommodate the shape of restraining component **50**. Other configurations for restraining component **50** are possible, as will be illustrated.

(36) Hinge system **10** with inertial lock friction hinge **16** includes an inertial locking mechanism directly within the components of a friction hinge mechanism. With both these mechanisms combined, the assembly of system **10** is simplified because both functions are combined into one system, thereby eliminating extra pieces of the known separate systems. Positioning the inertial locking features, including restraining component **50**, near the axis X of rotation for shaft **34**, in addition to providing friction at the axis, creates the advantage of allowing the inertial lock additional time to engage. Inertial lock friction hinge **16** has the challenge of dealing with high stresses due to directing the energy of the cover **12** to the pivot area. However, the structure of inertial lock friction hinge **16** and cover **12** can accommodate without much added mass. Several variations for creating a friction hinge, including friction disks and other friction torque technology, can be used in order to provide the same function.
(37) In addition, because of both the friction torque and inertial effect of inertial lock friction hinge **16**, neither a separate latch mechanism nor separate inertial lock mechanism, which are associated with prior systems, are needed. For example, with inertial lock friction hinge **16** installed in hinge system **10**, no latch is needed to keep top **12** closed against base **14**. As illustrated in FIGS. **1-2**, when inertial lock friction hinge **16** is installed toward the back of hinged system **10**, no latch is required at the front of hinged system **10**, as would be required in some prior systems to ensure top **12** remains closed. This frees up valuable space, especially in applications where space is needed for other mechanisms.
(38) Inertial lock friction hinge **16** illustrated in FIGS. **1-7** provides symmetrical function in either rotational direction. In applications that require multiple hinges due to high inertial forces or frictional requirements, one design could be used for all hinges. Other inertial lock designs can require a left and right pair. Inertial lock friction hinge **16** illustrated in FIGS. **1-7** can be used with either the shaft assembly or the friction assembly **40** attached to the rotating system component (top **12** in FIG. **1**).
(39) FIGS. **8-10** illustrate an exploded view and sectional views of inertial lock friction hinge **116**. In one embodiment, inertial lock friction hinge **116** further includes spring **158** coupled to restraining component **150**. In one embodiment, spring **158** is configured in a relaxed state to hold restraining component **150** within shaft assembly recess **154**. In this position, inertial lock friction hinge **116** is in the unlocked condition, such that shaft housing **132** and friction housing **142** can be rotated relative to each other by applying a force greater than the friction torque of inertial lock friction hinge **116**.
(40) FIG. **10** illustrates inertial lock friction hinge **116** after it has been subjected to an impact force F.sub.1 that is large enough to apply a tension load to spring **158**, moving it from its relaxed state to a stretched state, thereby allowing restraining component **150** to move out of shaft assembly recess **154**. In this way, restraining component **150** extends at least partially into friction assembly recess **152** so that inertial lock friction hinge **116** is in the locked condition, and shaft housing **132** and friction housing **142** are prevented from relative rotation. Accordingly, inertial lock friction hinge **116** can be designed to provide an adjustable amount tension load due to spring **158** so that the amount of impact force F.sub.1 required to transition inertial lock friction hinge **116** from unlocked to locked condition is customizable for any particular application.
(41) The orientation of spring **158** can also be adjusted. For example, spring **158**, can be configured to hold restraining component **150** within friction assembly recess **152** so that inertial lock friction hinge **116** is in the unlocked condition. Once an impact force F.sub.1 is applied sufficient to provide enough tension load to spring **158**, restraining component **150** will extend at least partially into shaft assembly recess **154** so that inertial lock friction hinge **116** is in the locked condition, and shaft housing **132** and friction housing **142** are prevented from relative rotation. Other bias mechanisms can also be used for stored energy that need to be overcome with the inertial force to transition inertial lock friction hinge **116** form the unlocked to locked condition. For example, a compression spring, leaf springs, magnets, fluid pressure and similar bias mechanism can be used

to hold restraining component **150** in a locked or unlocked position so that the bias mechanism must be overcome in order to change from locked to unlocked or from unlocked to locked.
(42) Also, the orientation of inertial lock friction hinge **116**, and thus of spring **158** and restraining component **150**, can be adjusted so that spring **158** and restraining component **150** are aligned with an anticipated impact force F.sub.1 so that application of the force will cause transition between locked and unlocked conditions.
(43) FIG. **11-12** illustrate an implementation of inertial lock friction hinge **116** within a hinge system **100**. In this system, inertial lock friction hinge **116** hinges a moveable door **112** relative to a base **114**. In one embodiment, movable door **112** is a glove box in an automobile. Similar to hinge system **10** in FIGS. **1-2**, hinge system **100** is oriented with a gravitational force F.sub.G acting down in the direction of arrow F.sub.G. In this orientation, stored energy within spring **158** of inertial lock friction hinge **116** maintains inertial lock friction hinge **116** in an unlocked condition, regardless of gravitational force F.sub.G. In this way, a user can open and close door **112** relative to base **114** simply by overcoming the frictional force or torque of inertial lock friction hinge **116**.
(44) In one embodiment, the orientation of inertial lock friction hinge **116** illustrated in FIG. **10** is used in hinge system **100**. Accordingly, when an impact force F.sub.1 is applied as shown in FIG. **12** to hinge system **100**, restraining component **150** moves out of shaft assembly recess **154** and at least partially into friction assembly recess **152** so that inertial lock friction hinge **116** is in the locked condition, and shaft housing **132** and friction housing **142** are prevented from relative rotation. In this way, the door **112** cannot be opened relative to base **114** regardless of the force applied to door **112** during the impact event.
(45) In such an orientation of inertial lock friction hinge **116**, spring **158** may also be used to ensure restraining component **150** remains in shaft assembly recess **154** when inertial lock friction hinge **116** is in the unlocked condition. Because gravitational force F.sub.G is in a direction that perpendicular the orientation of friction assembly recess **152** and shaft assembly recess **154** in hinge system **100** of FIG. **12**, gravitational force F.sub.G will not help ensure that restraining component **150** remains in shaft assembly recess **154**. Spring **158** can be added for this purpose in one embodiment.
(46) Hinge system **100** of FIGS. **11** and **12** may be required by some safety standards within automobiles in order to prevent objects from escaping bin and becoming flying projectiles. Various other hinged systems may readily implement one or more inertial lock friction hinges **116** to take advantage of its favorable performance characteristics. For example, inertial lock friction hinges **16** or **116** could be used in a hospital cart to prevent contents from flying out of the cart in case it tips over.
(47) FIGS. **13-17** illustrate inertial lock friction hinge **216** in accordance with one embodiment. In one embodiment, inertial lock friction hinge **216** includes shaft assembly **230**, friction assembly **240** and restraining component **250**. In one embodiment, inertial lock friction hinge **216** includes only these three main components. As described previously, a first hinged element, such as top **12**, base **14**, door **112** or base **114**, is coupled to friction assembly **240** and second hinged element, such as top **12**, base **14**, door **112** or base **114**, is coupled to shaft assembly **230**, and the relative movement of restraining component **250** between them causes inertial lock friction hinge **216** to transition between locked and unlocked condition.
(48) In one embodiment, shaft assembly **230** is configured as a single component and friction assembly **240** is configured as a single integrated component. Such a configuration greatly lowers part count, assembly expenses and overall cost. In one embodiment, the three components shaft assembly **230**, friction assembly **240** and restraining component **250**, are each made using an injection molding process, particularly when they are a plastic material. In another embodiment, each are made using a metal injection molding (MIM) process. Other processes and combinations thereof may also be used to construct shaft assembly **230**, friction assembly **240** and restraining component **250** each as single components.

(49) In one embodiment, shaft assembly **230** has a shaft housing portion **232**, a shaft portion **234** and a shaft assembly recess **254**. In one embodiment, friction assembly **240** includes a friction portion **244**, friction housing portion **242**, and friction assembly recess **252**. Inertial lock friction hinge **216** of FIGS. **13-17** operates similarly to that described above for FIGS. **1-10**, except that shaft assembly **230** and friction assembly **240** are each configured as a single component.
(50) In one embodiment, when inertial lock friction hinge **216** is assembled, shaft portion **234** of shaft assembly **230** extends into friction portion **244** of friction assembly **240** with an interference fit. In one embodiment, grease is also added between them. As illustrated, for example in FIGS. **13-14**, friction portion **244** is spaced at least partially from friction housing portion **242** such that friction portion **244** can flex slightly as shaft portion **234** is forced into friction portion **244**. Accordingly, when shaft assembly **230** and friction assembly **240** are rotated relative to each other, shaft portion **232** rotates within friction portion **244** producing friction torque within inertial lock friction hinge **216**.
(51) In at least one position of relative orientation of shaft assembly **230** and friction assembly **240**, friction assembly recess **252** and shaft assembly recess **254** are aligned, for example, as illustrated in FIG. **15**. In one embodiment, restraining component **250** is located fully within shaft assembly recess **254**, as illustrated in FIGS. **15** and **16**. In this position, inertial lock friction hinge **216** is in an unlocked condition, such that shaft assembly **230** and friction assembly **240** can be rotated relative to each other by applying a force greater than the friction torque of inertial lock friction hinge **216**. FIG. **16** illustrates how friction assembly **240** is rotated (counterclockwise as illustrated in the figure) relative to shaft assembly **230** as restraining component **250** remains fully within shaft assembly recess **254**.
(52) In one embodiment, subjecting inertial lock friction hinge **216** to an impact force F.sub.1 causes inertial lock friction hinge **216** to change from an unlocked condition to a locked condition. For example, when inertial lock friction hinge **216** is subjected impact force F.sub.1, as illustrated in FIG. **17**, the inertial force on restraining component **250** causes it to shift partially out of shaft assembly recess **254** and at least partially into friction assembly recess **252**. Once this occurs, shaft assembly **230** and friction assembly **240** are prevented from significant relative rotation by restraining component **250**. When restraining component **250** is oriented partially within shaft assembly recess **254** and partially within friction assembly recess **252**, inertial lock friction hinge **216** is in a locked condition.
(53) In the embodiment illustrated in FIGS. **13-17**, restraining component **250** is configured as a rectangular blocker. The corresponding shapes of friction assembly recess **252** and shaft assembly recess **254** are then configured to accommodate the shape of restraining component **250**. In one embodiment, the surfaces of shaft assembly recess **254** and of friction assembly recess **252**, and/or the surfaces of restraining component **250** can be designed with slight angles, which may provide improved engagement in some embodiments.
(54) FIGS. **18-23** illustrate inertial lock friction hinge **316** in accordance with one embodiment. In one embodiment, inertial lock friction hinge **316** includes shaft assembly **330**, friction assembly **340** and restraining component **350**. Inertial lock friction hinge **316** operates similarly to inertial lock friction hinges **16**, **116** and **216** previously described.
(55) In one embodiment, shaft assembly **330** includes shaft housing **332** and shaft **334**. In one embodiment, shaft housing **332** further includes shaft assembly recess **354**. In one embodiment, friction assembly **340** includes a plurality of friction elements **344** and friction housing **342**. In one embodiment, friction housing **342** includes friction assembly recess **352**.
(56) In one embodiment, when inertial lock friction hinge **316** is assembled, shaft **334** is firmly attached within an opening in shaft housing **332** such that they are fixed together. As such, shaft **334** and shaft housing **332** rotate together. Friction elements **344** are placed over shaft **334** and are also contained within friction housing **342**, along with optional grease. In one embodiment, friction elements **344** include fixed plate members **344***a*, friction disc members **344***b*, Belleville disc spring

344*c* and retaining ring **344***d*. In one embodiment, fixed plate members **344***a* are clocked to housing **342**, friction disc members **344***b* are clocked to shaft **334**, and retaining ring **344***d* is press fit to shaft **334** with a compressive force that holds all the members together axially. Belleville disc spring **344***c* provides a compressive force against friction disc members **344***b*. Accordingly, when shaft housing **332** rotates relative to friction housing **342**, the compression force between fixed plate members **344***a* and friction disc members **344***b* during their relative rotation produces friction torque within inertial lock friction hinge **316**. The amount of friction torque within inertial lock friction hinge **316** can be readily adjusted up or down by adjusting the compression of Belleville disc spring **344***c* or by adding or subtracting the number of fixed plate members **344***a* and friction disc members **344***b*. Other means of creating friction torque with relative rotation of shaft housing **332** and friction housing **342** are also possible.

(57) Also similar to inertial lock friction hinges **16**, **116** and **216** above, in at least one position of relative orientation of shaft housing **332** and friction housing **342** for inertial lock friction hinge **316**, friction assembly recess **352** and shaft assembly recess **354** are aligned, for example, as illustrated in FIG. **22**. In one embodiment, restraining component **350** is located fully within shaft assembly recess **354**, also as illustrated in FIG. **22**. In this position, inertial lock friction hinge **316** is in an unlocked condition, such that shaft assembly **330**, including shaft housing **332**, and friction assembly **340**, including friction housing **342**, can be rotated relative to each other by applying a force greater than the friction torque of inertial lock friction hinge **316**. FIG. **23** illustrates how shaft housing **332** is rotated (counterclockwise as illustrated in the figure) relative to friction housing **342** as restraining component **350** remains fully within shaft assembly recess **354**.

(58) In one embodiment, subjecting inertial lock friction hinge **316** to an outside impact force F.sub.1 causes inertial lock friction hinge **316** to change from an unlocked condition to a locked condition. For example, when inertial lock friction hinge **316** is subjected to an impact force F.sub.1 this causes restraining component **350** to shift partially out of shaft assembly recess **354** due to its inertial force and at least partially into friction assembly recess **352**, as illustrated in FIG. **21**. Once this occurs, shaft housing **332** and friction housing **342** are prevented from significant relative rotation by the engagement by each of restraining component **350**. When restraining component **350** is oriented partially within shaft assembly recess **354** and partially within friction assembly recess **352**, inertial lock friction hinge **316** is in a locked condition.

(59) When inertial lock friction hinge **316** is installed in a console, such as in FIG. **1**, the cover **12** is then locked closed against base **14** and will retain any contents within base **14**. When inertial lock friction hinge **316** is installed in a glove compartment, such as in FIG. **11**, the door **112** is then locked closed against base **114** and will retain any contents therein. In one embodiment, when inertial lock friction hinge **316** is installed in a glove compartment, depending on orientation, it may also include a spring, such as spring **158** in FIG. **10**, coupled to restraining component **350**.

(60) As illustrated in FIG. **19**, restraining component **350** is a generally rectangular block, while restraining component **50** in FIG. **4** is pin or cylindrically shaped and restraining component **250** in FIG. **14** is yet another rectangular shape. Accordingly, many different shapes can be used for a restraining component, with shaft and friction assembly recesses shaped in a complementary form to accommodate the restraining component. The various types of restraining components, friction elements and bias mechanisms in the embodiments can be variously combined within an inertial lock friction hinge.

(61) FIGS. **24-28** illustrate inertial lock friction hinge **416** in accordance with one embodiment. In one embodiment, inertial lock friction hinge **416** includes shaft assembly **430**, friction assembly **440**, and restraining component **450**. In one embodiment, shaft assembly **430** includes shaft housing **432**, shaft **434**, and shaft housing recess **454**. In one embodiment, friction assembly **440** includes a plurality of friction elements **444**, friction housing **442**, and friction housing recess **452**. Inertial lock friction hinge **416** operates similarly to inertial lock friction hinges **16**, **116**, **216** and **316** previously described.

(62) In one embodiment, when inertial lock friction hinge **416** is assembled, shaft **434** is firmly attached within an opening in shaft housing **432** such that they are fixed together and shaft **434** and shaft housing **432** rotate together. Friction elements **444** are placed over shaft **434** in an interference fit and are also contained within friction housing **442**, such that friction elements **444** are prevented from relative rotation with friction housing **442**. Accordingly, when shaft housing **432** rotates relative to friction housing **442**, shaft **434** rotates within friction elements **444** producing friction torque within inertial lock friction hinge **416**.
(63) In one embodiment, restraining component **450** is a configured as pawl blocker. When inertial lock friction hinge **416** is in an unlocked condition, restraining component **450** or pawl rests on a pivot axis **456** (see, FIG. **27**) and does not engage friction housing recess **452** or shaft housing recess **454**. As shown in FIGS. **26** and **28**, restraining component **450** rotates with shaft housing **432** and gravitational forces hold restraining component **450** in a disengaged position from friction housing recess **452**. When restraining component **450** is a pawl as illustrated, its geometry is such that its center of gravity CG (see, FIG. **27**) is off pivot axis **456** and in a location that holds it in a disengaged state under normal gravitational forces. Like the previously described embodiments, friction torque from the friction portion of the embodiment is all that resists movement between shaft housing **432** and friction housing **442** during normal operation.
(64) When an outside impact force F.sub.1 in the same direction of normal gravitational force exceed those set during the design, restraining component **450** rotates into a position engaging shaft housing recess **454**, thereby preventing relative rotation between shaft housing **432** and friction housing **442** and placing inertial lock friction hinge **416** in this locked condition. Friction housing recess **452** and shaft housing recess **454** as well as the pawl features of restraining component **450** are designed with locking angles to prevent disengagement under load during the locked condition. When inertial forces dissipate, the pawl returns to a disengaged position due to gravitational forces such that inertial lock friction hinge **416** returns to the unlocked condition.
(65) Although specific embodiments have been illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternate and/or equivalent implementations may be substituted for the specific embodiments shown and described without departing from the scope of the present invention. This application is intended to cover any adaptations or variations of the specific embodiments discussed herein. Therefore, it is intended that this invention be limited only by the claims and the equivalents thereof.

Claims

1. An inertial lock friction hinge system comprising: a first hinged element; a second hinged element; a shaft assembly coupled to the first hinged element, the shaft assembly having a shaft assembly recess and a shaft; a friction assembly coupled to the second hinged element, the friction assembly having a friction assembly recess; wherein the shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation about the shaft; a restraining component positioned within the inertial lock friction hinge system such that when the restraining component is fully contained within one of the friction assembly recess and the shaft assembly recess the shaft assembly and the friction assembly are allowed to rotate relative to each other under friction such that the inertial lock friction hinge system is in an unlocked condition, and the restraining component positioned such that when the restraining component is at least partially within both of the friction assembly recess and the shaft assembly recess the shaft assembly and the friction assembly are prevented from relative rotation such that the inertial lock friction hinge system is in a locked condition, wherein the restraining component moves radially relative to the shaft.
2. The inertial lock friction hinge system of claim 1, wherein the inertial lock friction hinge system is configured to be in the unlocked condition when gravitational force acts upon the inertial lock friction hinge system and configured to be in the locked condition when an external impact force

acts upon the inertial lock friction hinge system.

3. The inertial lock friction hinge system of claim 1, wherein the inertial lock friction hinge system is configured such that gravitational force acting on the inertial lock friction hinge system causes the restraining component to be fully contained within one of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge system is in the unlocked condition.

4. The inertial lock friction hinge system of claim 1, wherein the inertial lock friction hinge system is configured such that an external impact force acting on the inertial lock friction hinge system causes the restraining component to be partially contained within each of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge system is in the locked condition.

5. The inertial lock friction hinge system of claim 1, wherein the shaft assembly comprises a shaft housing and the shaft and the friction assembly comprises a friction housing containing at least one friction element, and wherein the at least one friction element is configured over the shaft in an interference fit.

6. The inertial lock friction hinge system of claim 5, wherein the shaft rotates along a shaft axis and wherein when the inertial lock friction hinge system changes between the locked condition and the unlocked condition the restraining component moves radially relative to the shaft.

7. The inertial lock friction hinge system of claim 1, wherein the restraining component is one of a pin and a rectangular block.

8. The inertial lock friction hinge system of claim 1, wherein the restraining component further comprises a bias mechanism configured to hold the restraining component in one of the friction assembly recess and the shaft assembly recess until an impact force causes a load on the bias mechanism thereby moving the restraining component at least partially into both of the friction assembly recess and the shaft assembly recess.

9. An inertial lock friction hinge comprising: a shaft assembly having a shaft assembly recess and a shaft; a friction assembly having a friction assembly recess; wherein the shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation about the shaft; a restraining component positioned within the inertial lock friction hinge such that when the inertial lock friction hinge is in an unlocked condition the restraining component is not engaged with both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are allowed to rotate relative to each other under friction, and the restraining component positioned such that when the inertial lock friction hinge is in a locked condition the restraining component is at least partially engaged with both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are locked and prevented from relative rotation by the restraining component, wherein the restraining component moves radially relative to the shaft.

10. The inertial lock friction hinge of claim 9, wherein the inertial lock friction hinge is configured to be in the unlocked condition when gravitational force acts upon the inertial lock friction hinge and configured to be in the locked condition when an external impact force act upon the inertial lock friction hinge.

11. The inertial lock friction hinge of claim 9, wherein the inertial lock friction hinge is configured such that an external impact force acting on the inertial lock friction hinge causes the restraining component to be partially engaged with each of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge is in the locked condition.

12. The inertial lock friction hinge of claim 9, wherein the shaft assembly comprises a shaft housing and the shaft and the friction assembly comprises a friction housing containing at least one friction element, and wherein the at least one friction element is configured over the shaft in an interference fit.

13. The inertial lock friction hinge of claim 12, wherein the shaft rotates along a shaft axis and wherein when the inertial lock friction hinge changes between the locked condition and the unlocked condition the restraining component moves radially relative to the shaft.

14. The inertial lock friction hinge of claim 13, wherein the restraining component transitions radially toward the shaft with application of impact force to the inertial lock friction hinge.
15. The inertial lock friction hinge of claim 9, wherein the restraining component is one of a pin, a rectangular block and a pawl.
16. An inertial lock friction hinge comprising: a shaft assembly having a shaft assembly recess and a shaft; a friction assembly having a friction assembly recess; wherein the shaft assembly and the friction assembly are rotatably coupled for relative frictional rotation about the shaft; a restraining component positioned within the inertial lock friction hinge such that when the inertial lock friction hinge is in an unlocked condition the restraining component is fully contained within one of the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are allowed to rotate relative to each other under friction, and the restraining component positioned such that when the inertial lock friction hinge is in a locked condition the restraining component is at least partially contained within both the friction assembly recess and the shaft assembly recess so that the shaft assembly and the friction assembly are locked and prevented from relative rotation by the restraining component, wherein the restraining component moves radially relative to the shaft.
17. The inertial lock friction hinge of claim 16, wherein the inertial lock friction hinge is configured to either change from the locked condition to the unlocked condition or change from the unlocked condition to the locked condition when an external impact force acts upon the inertial lock friction hinge.
18. The inertial lock friction hinge of claim 17, wherein the external impact force on the inertial lock friction hinge either causes the restraining component to be fully contained within one of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge is in the unlocked condition or causes the restraining component to be partially contained within each of the friction assembly recess and the shaft assembly recess so that the inertial lock friction hinge is in the locked condition.
19. The inertial lock friction hinge of claim 16, wherein the shaft assembly comprises a shaft housing and the shaft and the friction assembly comprises a friction housing containing at least one friction element, wherein the at least one friction element is configured over the shaft in an interference fit, and wherein the shaft rotates along a shaft axis and wherein when the inertial lock friction hinge changes between the locked condition and the unlocked condition the restraining component moves radially relative to the shaft.
20. The inertial lock friction hinge of claim 16, wherein the shaft assembly, the friction assembly, and the restraining component are each single integrated components.