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DOOR HINGE WITH INTEGRATED DOOR CHECK

Abstract

A door hinge with integrated door check is disclosed herein. The door hinge includes a first and second bracket connected by a hinge pin and rotatable relative to first bracket about an axis, and a door check plate. The hinge pin includes a plurality of bearings distributed about the axis. The door check plate has a bearing engagement surface axially opposed to the bearings, defining a plurality of curved paths, where the number of curved paths equals number of bearings, each curved path has a path length and an elevation profile of variable elevation that is substantially identical for all curved paths. A resiliently compressible bias is positioned in contact with the door check plate to axially bias the bearing engagement surface against the bearings so each bearing travels along the elevation profile of a respective curved path when the second bracket rotates relative to the first bracket.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION [0001] This application is a continuation of U.S. application Ser. No. 17/078,167 filed Oct. 23, 2020, which claims priority from the U.S. Provisional Patent Application No. 62/942,879 filed Dec. 3, 2019, and the entire contents of the U.S. application Ser. No. 17/078,167 and U.S. Provisional Patent Application No. 62/942,879 are hereby incorporated herein in their entirety.

FIELD
[0002] This application relates to the field of door hinges having an integrated door check.
INTRODUCTION
[0003] Vehicles, such as for example cars, vans, trucks, and recreational vehicles, commonly include a door check mechanism (also referred to simply as a ‘door check’). A door check may provide one or more open retention positions at which a door is substantially inhibited from moving (i.e. absent a deliberate application of force by a user). The door check may also control the force required to open and close the door to inhibit the door slamming shut or opening too rapidly.

Description

DRAWINGS
[0004] FIG. **1** is a partial perspective view of a vehicle with a prior art rotational connection between a vehicle body and vehicle door;
[0005] FIG. **2** is a cross-sectional view of a prior art door check;
[0006] FIG. **3** is a perspective view of a prior art hinge;
[0007] FIG. **4** is a perspective view of a hinge, in accordance with an embodiment;
[0008] FIG. **5** is a partial perspective view of a vehicle with a rotational connection, in accordance with an embodiment;
[0009] FIG. **6** is a partial exploded view of the hinge of FIG. **4**;
[0010] FIG. **7** is a side elevation view of a hinge pin, in accordance with an embodiment;
[0011] FIG. **8** is a bottom perspective view of the hinge pin of FIG. **7**;
[0012] FIG. **9** is a bottom plan view of the hinge pin of FIG. **7**;
[0013] FIG. **10** is a top perspective view of a check plate, in accordance with an embodiment;
[0014] FIG. **11** is a side elevation view of the check plate of FIG. **10**;
[0015] FIG. **12** is a partial side elevation view of the hinge of FIG. **4**, in a first position;
[0016] FIG. **13** is a cross-sectional view taken along line **13-13** in FIG. **12**;
[0017] FIG. **14** is a partial side elevation view of the hinge of FIG. **4**, in a second position;
[0018] FIG. **15** is a cross-sectional view taken along line **15-15** in FIG. **14**;
[0019] FIG. **16** is a top plan view of a check plate in accordance with an embodiment;
[0020] FIGS. **17-19** are cross-sectional views taken along line A-A in FIG. **16**, in accordance with various embodiments;
[0021] FIG. **20** is a side elevation view of a hinge pin, in accordance with an embodiment;
[0022] FIG. **21** is a bottom perspective view of the hinge pin of FIG. **20**;
[0023] FIG. **22** is a bottom plan view of the hinge pin of FIG. **20**;
[0024] FIG. **23** is a perspective view of a check plate in accordance with another embodiment;

[0025] FIG. **24** is a top plan view of the check plate of FIG. **23**;
[0026] FIG. **25** is a cross-sectional view taken along line **25**-**25** in FIG. **24**;
[0027] FIG. **26** is a cross-sectional view taken along line **26**-**26** in FIG. **24**;
[0028] FIG. **27** is a cross-sectional view taken along line **27**-**27** in FIG. **24**;
[0029] FIG. **28** is a top perspective view of a check plate, in accordance with an embodiment;
[0030] FIG. **29** is a side elevation view of a check plate, in accordance with an embodiment;
[0031] FIG. **30** is a perspective view of a hinge, in accordance with an embodiment;
[0032] FIGS. **31**A-**31**C are top, side elevation, and perspective views respectively of a coil spring, in accordance with an embodiment;
[0033] FIGS. **32**A-**33**C are top, side elevation, and perspective views respectively of a conical spring washer, in accordance with an embodiment;
[0034] FIGS. **33**A-**33**C are top, side elevation, and perspective views respectively of a wave spring, in accordance with an embodiment;
[0035] FIG. **34**A is a partial exploded view of a hinge in accordance with another embodiment;
[0036] FIG. **34**B is a partial exploded view of a hinge in accordance with another embodiment;
[0037] FIG. **35** is a partial side elevation view of the hinge of FIG. **34**A, in a first position;
[0038] FIG. **36** is a partial side elevation view of the hinge of FIG. **34**A, in a second position;
[0039] FIG. **37** is a partial exploded view of a hinge in accordance with another embodiment;
[0040] FIG. **38** is a bottom perspective view of a hinge pin with rolling engaging elements, in accordance with an embodiment;
[0041] FIG. **39** is a partial exploded view of a hinge in accordance with another embodiment;
[0042] FIG. **40** is a partial side elevation view of the hinge of FIG. **39**; and
[0043] FIG. **41** is a cross-sectional view taken along line **41**-**41** in FIG. **40**.

SUMMARY

[0044] In one aspect, a vehicle door hinge with integrated door check is provided. The vehicle door hinge includes a vehicle body bracket, a vehicle door bracket, a hinge pin, a door check plate, and a resiliently compressible bias. The vehicle body bracket may be securable to a vehicle body. The vehicle door bracket may be securable to a vehicle door. The hinge pin may define an axially extending hinge rotation axis. The hinge pin may provide a rotational connection between the vehicle body bracket and the vehicle door bracket that allows the vehicle door bracket to rotate about the hinge rotation axis relative to the vehicle body bracket between a door closed position and one or more door retention positions. The hinge pin may include one or more bearings. The door check plate may have a bearing engagement surface that is (i) axially opposed to the bearings, (ii) in contact with the bearings, and (iii) surrounding the hinge rotation axis. The bearing engagement surface may define one or more semi-circular paths. Each of the bearings may travel along one of the semi-circular paths as the vehicle door bracket rotates from the door closed position to the one or more door retention positions. Each semi-circular path may have a first end corresponding to the door closed position, and an elevation profile with a variable elevation that includes one or more retention portions. Each retention portion may correspond to one of the door retention positions. The resiliently compressible bias may be positioned to axially bias the bearing engagement surface against the bearings.
[0045] In another aspect, a vehicle door hinge with integrated door check is provided. The vehicle door hinge includes a vehicle body bracket, a vehicle door bracket, a hinge pin, and a door check plate. The vehicle body bracket may be securable to a vehicle body. The vehicle door bracket may be securable to a vehicle door. The hinge pin may define an axially extending hinge rotation axis. The hinge pin may provide a rotational connection between the vehicle body bracket and the vehicle door bracket that allows the vehicle door bracket to rotate about the hinge rotation axis relative to the vehicle body bracket between a door closed position and one or more door retention positions. The hinge pin may include one or more bearings. The door check plate may have a bearing engagement surface that is (i) axially opposed to the bearings, (ii) in contact with the

bearings, and (iii) surrounding the hinge rotation axis. The bearing engagement surface may define one or more semi-circular paths. Each of the bearings may travel along one of the semi-circular paths as the vehicle door bracket rotates from the door closed position to the one or more door retention positions. Each semi-circular path may have a first end corresponding to the door closed position, and an elevation profile with a variable elevation that includes one or more retention portions. Each retention portion may correspond to one of the door retention positions. The door check plate may be axially resiliently compressible and may axially bias the bearing engagement surface against the bearings.

[0046] In another aspect, a vehicle door hinge with integrated door check is provided. The vehicle door hinge includes a vehicle body bracket, a vehicle door bracket, and a hinge pin. The vehicle body bracket may be securable to a vehicle body. The vehicle door bracket may be securable to a vehicle door. The hinge pin may define an axially extending hinge rotation axis. The hinge pin may provide a rotational connection between the vehicle body bracket and the vehicle door bracket that allows the vehicle door bracket to rotate about the hinge rotation axis relative to the vehicle body bracket between a door closed position and one or more door retention positions. The hinge pin may include one or more bearings. A bearing engagement surface may be integrally formed into one of the vehicle body bracket and the vehicle door bracket. The bearing engagement surface may be (i) axially opposed to the bearings, (ii) in contact with the bearings, and (iii) surrounding the hinge rotation axis. The bearing engagement surface may define one or more semi-circular paths. Each of the bearings may travel along one of the semi-circular paths as the vehicle door bracket rotates from the door closed position to the one or more door retention positions. Each semi-circular path may have a first end corresponding to the door closed position, and an elevation profile with a variable elevation that includes one or more retention portions. Each retention portion may correspond to one of the door retention positions.

[0047] In another aspect, a door hinge with integrated door check is provided. The door hinge comprises a first bracket and a second bracket connected to the first bracket by a hinge pin, the second bracket rotatable relative to the first bracket about an axially extending hinge rotation axis of the hinge pin, the hinge pin comprising a plurality of bearings distributed about the hinge rotation axis; a door check plate surrounding the hinge rotation axis and axially displaceable along the hinge pin, the door check plate having a bearing engagement surface that is axially opposed to the plurality of bearings, the bearing engagement surface defining a plurality of curved paths, wherein a number of curved paths is equal to a number of bearings, each curved path having a path length and an elevation profile with a variable elevation along the path length, the path length and the elevation profile of each curved path being substantially identical, and a resiliently compressible bias positioned in contact with the door check plate, the resiliently compressible bias axially biasing the bearing engagement surface of the door check plate against the plurality of bearings whereby each of the plurality of bearings travels along the elevation profile of a respective one of the curved paths when the second bracket rotates relative to the first bracket.

[0048] In some embodiments, the elevation profile of each curved path has one or more upwardly sloped portions, one or more downwardly sloped portions, and one or more retention portions.

[0049] In some embodiments, each retention portion corresponds to a bracket retention position, each bracket retention position defining an angular position of the second bracket relative to the first bracket.

[0050] In some embodiments, each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.

[0051] In some embodiments, when the plurality of bearings are located on an upwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a first direction, and when the plurality of bearings are located on a downwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a second direction opposite the first

direction.
[0052] In some embodiments, the plurality of bearings comprise cylindrical sliding elements.
[0053] In some embodiments, the plurality of bearings comprise spherical sliding elements.
[0054] In some embodiments, the hinge pin rotates synchronously with one of the first bracket and the second bracket, and the door check plate rotates synchronously with the other of the first bracket and the second bracket.
[0055] In another aspect, a door hinge with integrated door check is provided. The door hinge comprises a first bracket and a second bracket connected to the first bracket by a hinge pin, the second bracket rotatable relative to the first bracket about an axially extending hinge rotation axis of the hinge pin, the hinge pin comprising a plurality of bearings distributed about the hinge rotation axis; and a door check plate surrounding the hinge rotation axis, the door check plate comprising a bearing engagement surface that is axially opposed to the plurality of bearings, the bearing engagement surface defining a plurality of curved paths, wherein a number of curved paths is equal to a number of bearings, each curved path having a path length and an elevation profile with a variable elevation along the path length, the path length and the elevation profile of each curved path being substantially identical, and an axially resiliently compressible material forming at least a portion of the door check plate, the axially resiliently compressible material axially biasing the bearing engagement surface against the plurality of bearings whereby each of the plurality of bearings travels along the elevation profile of a respective one of the curved paths when the second bracket rotates relative to the first bracket.
[0056] In some embodiments, the elevation profile of each curved path has one or more upwardly sloped portions, one or more downwardly sloped portions, and one or more retention portions.
[0057] In some embodiments, each retention portion corresponds to a bracket retention position, each bracket retention position defining an angular position of the second bracket relative to the first bracket.
[0058] In some embodiments, each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.
[0059] In some embodiments, when the plurality of bearings are located on an upwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a first direction, and when the plurality of bearings are located on a downwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a second direction opposite the first direction.
[0060] In some embodiments, the plurality of bearings comprise cylindrical sliding elements.
[0061] In some embodiments, the plurality of bearings comprise spherical sliding elements.
[0062] In some embodiments, the hinge pin rotates synchronously with one of the first bracket and the second bracket, and the door check plate rotates synchronously with the other of the first bracket and the second bracket.
[0063] In another aspect, a door hinge with integrated door check is provided. The door hinge comprises a first bracket and a second bracket connected to the first bracket by a hinge pin, the second bracket rotatable relative to the first bracket about an axially extending hinge rotation axis of the hinge pin, the hinge pin comprising a plurality of bearings distributed about the hinge rotation axis, the plurality of bearings rigidly coupled to the hinge pin; and a bearing engagement surface integrally formed into one of the first bracket and the second bracket, the bearing engagement surface being (i) axially opposed to the plurality of bearings, (ii) in contact with the plurality of bearings, and (iii) surrounding the hinge rotation axis, the bearing engagement surface defining a plurality of curved paths, wherein a number of curved paths is equal to a number of bearings, each curved path having a path length and an elevation profile with a variable elevation along the path length, the path length and the elevation profile of each curved path being substantially identical, and each of the plurality of bearings travels along the elevation profile of a

respective one of the curved paths when the second bracket rotates relative to the first bracket.
[0064] In some embodiments, the elevation profile of each curved path has one or more upwardly sloped portions, one or more downwardly sloped portions, and one or more retention portions.
[0065] In some embodiments, each retention portion corresponds to a bracket retention position, each bracket retention position defining an angular position of the second bracket relative to the first bracket.
[0066] In some embodiments, when the plurality of bearings are located on an upwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a first direction, and when the plurality of bearings are located on a downwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a second direction opposite the first direction.

DESCRIPTION OF VARIOUS EMBODIMENTS

[0067] Numerous embodiments are described in this application, and are presented for illustrative purposes only. The described embodiments are not intended to be limiting in any sense. The invention is widely applicable to numerous embodiments, as is readily apparent from the disclosure herein. Those skilled in the art will recognize that the present invention may be practiced with modification and alteration without departing from the teachings disclosed herein. Although particular features of the present invention may be described with reference to one or more particular embodiments or figures, it should be understood that such features are not limited to usage in the one or more particular embodiments or figures with reference to which they are described.
[0068] The terms “an embodiment,” “embodiment,” “embodiments,” “the embodiment,” “the embodiments,” “one or more embodiments,” “some embodiments,” and “one embodiment” mean “one or more (but not all) embodiments of the present invention(s),” unless expressly specified otherwise.
[0069] The terms “including,” “comprising” and variations thereof mean “including but not limited to,” unless expressly specified otherwise. A listing of items does not imply that any or all of the items are mutually exclusive, unless expressly specified otherwise. The terms “a,” “an” and “the” mean “one or more,” unless expressly specified otherwise.
[0070] As used herein and in the claims, two or more parts are said to be “coupled”, “connected”, “attached”, “joined”, “affixed”, or “fastened” where the parts are joined or operate together either directly or indirectly (i.e., through one or more intermediate parts), so long as a link occurs. As used herein and in the claims, two or more parts are said to be “directly coupled”, “directly connected”, “directly attached”, “directly joined”, “directly affixed”, or “directly fastened” where the parts are connected in physical contact with each other. As used herein, two or more parts are said to be “rigidly coupled”, “rigidly connected”, “rigidly attached”, “rigidly joined”, “rigidly affixed”, or “rigidly fastened” where the parts are coupled so as to move as one while maintaining a constant orientation relative to each other. None of the terms “coupled”, “connected”, “attached”, “joined”, “affixed”, and “fastened” distinguish the manner in which two or more parts are joined together.
[0071] As used herein and in the claims, a group of elements are said to ‘collectively’ perform an act where that act is performed by any one of the elements in the group, or performed cooperatively by two or more (or all) elements in the group.
[0072] Some elements herein may be identified by a part number, which is composed of a base number followed by an alphabetical or subscript-numerical suffix (e.g. **112***a*, or **112**.sub.1). Multiple elements herein may be identified by part numbers that share a base number in common and that differ by their suffixes (e.g. **112**.sub.1, **112**.sub.2, and **112**.sub.3). All elements with a common base number may be referred to collectively or generically using the base number without a suffix (e.g. **112**).

[0073] Referring to FIGS. **1-3**, a vehicle **10** may include a body **14** and one or more doors **18**. Vehicle door **18** may have a rotational connection **22** to vehicle body **14** that allows vehicle door **18** to rotate between a door open position (shown in FIGS. **1** and **3**) and a door closed position (shown in FIG. **2**). In the door open position, things such as passengers and cargo may be loaded into the vehicle **10**. In the door closed position, the vehicle door opening **26** may be closed by vehicle door **18**, such as to inhibit things from fall out of the vehicle **10** through the vehicle door opening **26**.
[0074] Rotational connection **22** may include one or more vehicle door hinges **30** and a door check **34**. Vehicle door hinges **30** may include a vehicle body bracket **38** secured to vehicle body **14**, a vehicle door bracket **42** secured to vehicle door **18**, and a pin **46** that rotationally connects the vehicle body bracket **38** to the vehicle door bracket. As shown, pin **46** may define a hinge rotation axis **50**. Vehicle body bracket **38** can rotate relative to vehicle door bracket **42** about hinge rotation axis **50** between a door closed position and a door open position.
[0075] Door check **34** may include a bearing assembly **54** mounted to vehicle door **18**, an end stop **58** mounted to vehicle door **14**, and a door check strap **62**. Door check strap **62** has a thickness **70** that varies along its length. Bearing assembly **54** includes bearings **66** that clamp onto door check strap **62**.
[0076] Door check **34** provides variable resistance to the rotation of vehicle door **18** based on the thickness profile of door check strap **62**. Specifically, as vehicle door **18** is rotated between the door closed position (shown in FIG. **2**) and the door open position (shown in FIGS. **1** and **3**), bearings **66** slide along the length of door check strap **62**. The rotation resistance imparted by bearings **66** is positively correlated to the thickness of the portion of door check strap **62** that is located between bearings **66**. That is, bearings **66** provide greater rotation resistance when the portion of door check strap **62** that is between bearings **66** is thicker, and vice versa.
[0077] Door check **34** also provides an intermediate retention position **74**, which allows vehicle door **18** to maintain a stable position intermediate the open and closed positions. As shown, door check strap **62** defines a retention position **74** at a thickness minima flanked on both sides by portions **78** and **80** of increasing thickness. From retention position **74**, thickness **70** of door check strap **62** increases in both directions. Consequently (i) rotation resistance increases in both directions from retention position **74**, and (ii) force interactions on the sloped surfaces of portions **78** and **80** urge door check **34** to return to retention position **74**. Thus, absent a deliberate user application of force, door check **34** maintains vehicle door **18** in the intermediate position when bearings **66** are positioned at intermediate retention position **74**.
[0078] Embodiments herein relate to a hinge that integrates a door check. The hinge may provide the variable rotation resistance and/or retention position(s) associated with a traditional door check, without having a discrete door check assembly. All else being equal, this may reduce complexity, cost, weight, assembly, and maintenance associated with the discrete door check assembly, while preserving functionality. Moreover, embodiments disclosed herein may be more compact, allowing the door check functionality to be added to assemblies that heretofore could not accommodate a discrete door check assembly (e.g. due to size constraints, mechanical limitations, cost, or aesthetics).
[0079] FIG. **4** shows a hinge **100** in accordance with an embodiment. Hinge **100** may provide a rotational connection between any two objects. As an example, FIG. **5** shows a pair of hinges **100** providing a rotational connection **104** between a vehicle body **14** and a vehicle door **18**. Generally, a vehicle **10** may include any number of (e.g. one to four) hinges **100** and any number of (e.g. none to four) traditional hinges (e.g. hinge **30** in FIG. **3**) to collectively provide the rotational connection **104** between vehicle body **14** and vehicle door **18**. The at least one hinge **100** may provide rotational connection **104** with features of a door check (e.g. such as door check **34** of FIG. **1**). Accordingly, rotational connection **104** may be free of discrete door check assemblies (e.g. door check **34** in FIG. **1**) as shown, which may reduce design complexity, manufacturing cost, weight, required assembly, and maintenance which might have otherwise been associated with providing

the discrete door check.
[0080] More generally, hinge **100** may provide a rotational connectional to, for example any type of door (e.g. cupboard door, building door, access panel door, appliance door (e.g. refrigerator door, oven door, dishwasher door, or laundry machine door)), electronic device (e.g. flip-open cellular phone, laptop screen, or scanner lid), tool (e.g. guillotine paper cutter, or table saw), toy, or any other objects having a rotational connection between parts.
[0081] Referring to FIGS. **4** and **6**, hinge **100**, in accordance with some embodiments, may include a first bracket **38** (securable to a first object, such as a vehicle body), a second bracket **42** (securable to a second object, such as a vehicle door), a hinge pin **108**, a check plate **112**, and a resiliently compressible bias **116**. Hinge pin **108** may be connected to one of brackets **38** and **42** so that hinge pin **108** and the one bracket **38** or **42** rotate synchronously about hinge rotation axis **50**. Similarly, check plate **112** may be connected to the other of brackets **38** and **42** so that check plate **112** and the one bracket **38** or **42** rotate synchronously about hinge rotation axis **50**. In the illustrated embodiment, hinge includes a bushing **118** to reduce friction at the interface of hinge pin **108** and hinge bracket layer **132**. Alternative embodiments may not include bushing **118**.
[0082] In use, hinge pin **108** physically interacts with check plate **112** when first bracket **38** rotates relative to second bracket **42** about hinge rotation axis **50** to generate variable resistance and/or retention position(s), which are traditionally associated with a discrete door check (e.g. door check **34** of FIG. **1**).
[0083] Hinge pin **108** may include a shaft **120**, a bearing mount **124**, and a plurality of bearings **128**. As shown, hinge pin shaft **120** may extend co-axially with hinge rotation axis **50** through layers **132** and **136** of hinge brackets **38** and **42** respectively. In some embodiments, hinge pin shaft **120** may be rigidly connected to one of layers **132** and **136** so that hinge pin **108** rotates synchronously with the corresponding bracket **38** or **42**. For example, hinge pin shaft **120** may be rigidly connected to one of layers **132** and **136** by a rivet, welds, fastener (e.g. bolt or screw), or by integrally forming hinge pin shaft **120** with the layer **132** or **136**. Alternatively or in addition, hinge pin shaft **120** may be non-circularly shaped to key into a non-circular layer opening **134** or **138** so that hinge pin **108** rotates synchronously with the corresponding bracket **38** or **42**.
[0084] Still referring to FIGS. **4** and **6**, bearing mount **124** may be connected to hinge pin shaft **120**. For example, bearing mount **124** may be rigidly connected to (e.g. integrally formed with) hinge pin shaft **120**. In the illustrated example, bearing mount **124** is connected to an axial end **140** of hinge pin shaft **120**. As shown, bearing mount **124** may carry a plurality of bearings **128**. Bearings **128** may be positioned on bearing mount **124** so that they are axially opposed to check plate **112**. This allows bearings **128** to physically engage check plate **112** as hinge rotates between positions.
[0085] Bearings **128** include engaging elements **144**. Engaging elements **144** may be sliding elements and/or rolling elements. For example, FIG. **6** illustrates needle bearings **128** with semi-cylindrical sliders **144**. As shown, sliding engaging elements **144** may be integrally formed with bearing mount **124**. In some embodiments, hinge pin **108** may be integrally formed as one solid piece of material (e.g. metal or hard plastic)—including shaft **120**, bearing mount **124**, and bearings **128**. FIG. **38** shows an embodiment in which bearings **128** includes rolling engaging elements **144**. As shown, needling bearings **128** may include cylindrical rollers **144**.
[0086] Referring to FIG. **6**, check plate **112** may be positioned between hinge pin bearing mount **124** and hinge bracket layer **132**. As shown, check plate **112** may include a bearing engagement surface **148** that is axially opposed to hinge pin bearings **128** and in contact with hinge pin bearings **128**. Check plate **112** may surround hinge pin shaft **120**. For example, check plate **112** may have a central opening **152** intersected by hinge rotation axis **50**. In use, bearings **128** may physically engage (e.g. slide over) bearing engagement surface **148**, and this physical engagement may provide variable resistance and/or retention position(s), which are traditionally associated with a discrete door check.

[0087] Still referring to FIG. **6**, resiliently compressible bias **116** may have any position and configuration suitable to urge hinge pin bearings **128** into constant contact with check plate bearing engagement surface **148**. For example, resiliently compressible bias **116** may be positioned axially between check plate **112** and hinge bracket layer **132**. In some embodiments, resiliently compressible bias **116** may surround hinge pin shaft **120**. As shown, resiliently compressible bias **116** may have a central opening **156** intersected by hinge rotation axis **50**. In use, resiliently compressible bias **116** may provide a variable spring force based on the rotational position of bearings **128** relative to bearing engagement surface **148**. This variable spring force may cooperate with bearings **128** and bearing engagement surface **148** to provide variable resistance and/or retention position(s), which are traditionally associated with a discrete door check.
[0088] Referring to FIGS. **6-11**, check plate bearing engagement surface **148** may define a plurality of curved (e.g. semi-circular) paths **160**. Each semi-circular path **160** may include a first end **164** corresponding to a door closed position, and a second end **166**. In use, each bearing **128** may move (e.g. slide) along a respective (i.e. different one of) semi-circular path **160** between the first and second ends **164**, **168** as hinge **100** is rotated between the closed and open positions. As shown, each semi-circular path **160** may have an elevation profile with a variable elevation (i.e. the elevation changes along the semi-circular path **160**).
[0089] The elevation profile of each semi-circular path **160** may include (i) one or more upwardly sloped portions **168** where the elevation profile is sloped such that it increases in a direction towards the first end **164**, (ii) one or more downwardly sloped portions **172** where the elevation profile is sloped such that it decreases in a direction towards the first end **164**, and (iii) one or more retention portions **176** extending from a low-elevation end of an upwardly sloped portion **168** and a low-elevation end of a downwardly sloped portion **172**. Upwardly sloped portions **168** and downwardly sloped portions **172** may collectively form at least 50% or at least 70% of each semi-circular path **160**, such that there may be a generally continuously changing rotation resistance between ends **164**, **166** and any retention positions **176**.
[0090] Each semi-circular path **160** may be substantially identical. That is, the semi-circular path **160** associated with each hinge pin bearing **128** may be substantially the same as the semi-circular path **160** associated with each other hinge pin bearing **128**. Further, semi-circular paths **160** may be symmetrically distributed to allow the path-positions engaged by all hinge pin bearings **128** at a given moment to have the same elevation. In the illustrated embodiment, hinge pin **108** includes three bearings **128** circumferentially distributed (e.g. circumferentially spaced apart) around hinge rotation axis **50**, and similarly check plate **112** includes three semi-circular paths **160**. In other embodiments, hinge pin **108** may include any number of bearings **128** (and corresponding number of semi-circular paths **160**), such as for example, one to twenty bearings **128** and semi-circular paths **160**. For the application of a vehicle door **18**, three semi-circular paths **160** of up to 120 degrees each (e.g. 90 to 120 degrees) provides a suitable range of motion.
[0091] Check plate bearing engagement surface **148** may be hard (e.g. substantially non-compressible). For example, check plate bearing engagement surface **148** may be composed of metal, stone, or hard plastic. This may allow the hard rolling or sliding engaging elements **144** of bearings **128** to roll or slide better across check plate bearing engagement surface **148**.
[0092] FIGS. **12-13** show that when hinge pin bearings **128** engage a low-elevation portion of their respective semi-circular paths **160** (FIG. **10**) on check plate bearing engagement surface **148**, resiliently compressible bias **116** is relatively less compressed. FIGS. **14-15** show that when hinge pin bearings **128** engage a higher-elevation portion of their respective semi-circular paths **160** (FIG. **10**) on check plate bearing engagement surface **148**, resiliently compressible bias **116** is relatively more compressed. Accordingly, when hinge pin bearings **128** move along sloped portions of their semi-circular paths **160**, there will be rotational resistance created when moving “uphill” (i.e. in a direction of increasing elevation) because doing so involves forcing resiliently compressible bias **116** to further compress, and vice versa.

[0093] Returning to FIGS. **6-11**, when the position of hinge **100** is such that hinge pin bearings **128** are located on upwardly sloped portions **168**, rotation towards first end **164** may be resisted. In some cases, the forces generated at the interface of bearings **128** and bearing engagement surface **148** may urge hinge **100** to rotate "downhill" towards second end **166**. Similarly, when the position of hinge **100** is such that hinge pin bearings **128** are located on downwardly sloped portions **172**, rotation towards second end **166** may be resisted. In some cases, the forces generated at the interface of bearings **128** and bearing engagement surface **148** may urge hinge **100** to rotate "downhill" towards first end **164**.

[0094] When the position of hinge **100** is such that hinge pin bearings are located at retention portions **176**, rotations towards the first and second ends **164**, **168** may both entail bearings **128** climbing "uphill" and thus, rotation away from retention portions **176** is resisted. Within each semi-circular path **160**, each retention portion **176** corresponds with a retention position for hinge **100** where rotating hinge **100** is inhibited absent deliberate user application of force. Thus, the object (e.g. vehicle door) whose rotation is controlled by hinge **100** may be stably positioned at the retention position (e.g. intermediate or fully open position) until deliberately rotated away.

[0095] In some embodiments, the prevailing spring force of resiliently compressible bias **116**, which produces reciprocal forces at the interfaces of hinge pin bearings **128** and check plate bearing engagement surface **148**, may be responsible for producing some rotational resistance. For example, bearing movement along level (i.e. non-sloped) portions of semi-circular paths **160** may exhibit greater rotational resistance where those portions are characterized by higher elevations. This can allow the elevations of semi-circular paths **160** to contribute rotational resistance independent of slope.

[0096] In some embodiments, the rotational resistance is attributable to check plate bearing engagement surface **148** being soft (e.g. resiliently compressible). For example, check plate **112** may include a bearing engagement surface composed of rubber. In other embodiments, hinge pin bearings **128** may have a design that exhibits substantial resistance to sliding at high loads (such as forces produced by bias **116**) even when check plate bearing engagement surface **148** is rigid (e.g. composed of metal, stone, or hard plastic).

[0097] FIG. **16** is a top plan view of a check plate bearing engagement surface **148**. FIGS. **17-19** are examples of elevation profiles **178** along a semi-circular path **1601** of check plate bearing engagement surface **148**. As shown, semi-circular path **1601** can have any elevation profile of variable elevation along the path length. Further, semi-circular path **1601** can have any number of retention portions **176** (e.g. one to ten retention portions **176**)—where each retention portion **176** corresponds to a retention position for the hinge. FIG. **17** shows an example with one retention portion **176**, FIG. **18** shows an example with two retention portions **176**, and FIG. **19** shows an example with three retention portions **176**.

[0098] The hinge pin can include bearings of any size, shape, and configuration suitable for sliding across check plate bearing engagement surface. FIGS. **6-9** show an example of hinge pin **108** that includes needle bearings **128**. FIGS. **20-22** show an alternative embodiment of hinge pin **108** that includes bearings **128** having engaging elements **144**, which may be semi-spherical sliding elements or spherical rolling elements.

[0099] Referring to FIGS. **23-27**, in some embodiments, check plate bearing engagement surface **148** may be formed as a transversely concave track **180** (i.e. concave in cross-sections transverse to semi-circular paths **160**—e.g. cross-sections taken alone radial planes). Concave track **180** may be sized to mate with bearings **128** (FIG. **21**), and may help to maintain alignment between bearings **128** (FIG. **21**) and semi-circular paths **160**.

[0100] Each semi-circular path **160** may have any elevation profile described and shown herein with association with this and other embodiments of bearing engagement surface **148**, including the embodiment of FIGS. **10-13** which has a flat surface instead of a transversely concave surface **148**. For example, FIGS. **25-27** show cross-sections taken at different positions along semi-circular path

160, each one with a different elevation **184**. In some embodiments, semi-circular paths **160** may have any of elevation profiles **178** shown and described with reference to FIGS. **17-19**.
[0101] As a further example, FIGS. **28-29** show an embodiment of check plate **112** having a check plate bearing engagement surface **148** formed with a transversely concave track **180** and an elevation profile similar to check plate **112** of FIG. **10**.
[0102] FIG. **30** shows an embodiment of hinge **100** having two door check integrated pin assemblies **192** having any configuration described herein. For example, each assembly **192** may include a hinge pin **108**, a check plate **112**, and a resiliently compressible bias **116** as shown in FIG. **6**.
[0103] Referring to FIG. **6**, hinge **100** may include any resiliently compressible bias suitable to urge hinge pin bearings **128** into constant contact with check plate bearing engagement surface **148**. In the illustrated example, resiliently compressible bias **116** is a coned-disc spring (also referred to as conical spring washer or disc spring). Alternatively or in addition, hinge **100** may include a coil spring **116** (see, e.g. FIGS. **31**A-**31**C), a conical spring washer **116** (see, e.g. FIGS. **32**A-**32**C), a wave spring **116** (see, e.g. FIGS. **33**A-**33**C), or a resiliently compressible bias of another design. In some embodiments, resiliently compressible bias may be composed of, e.g. a flat cylindrical disc of resiliently compressible material such as for example rubber.
[0104] Referring to FIG. **34**A, in some embodiments hinge **100** may not include a discrete resiliently compressible bias **116**. Instead, the hinge **100** may include a check plate **112** that is resiliently compressible in at least the axial direction **188**. For example, check plate **112** may be entirely or partially composed of a resiliently compressible material, such as rubber. An advantage of this design is that it may omit the resiliently compressible bias, which may reduce the unit cost, part count, and size hinge **100**. For example, check plate bearing engagement surface **148** may be composed of a rigid material (e.g. metal, stone, or hard plastic) and a remainder of check plate **112** below check plate bearing engagement surface **148** may be composed of a resiliently compressible material (e.g. rubber).
[0105] FIG. **34**B shows an alternative embodiment in which check plate **112** includes an upper portion **196** (including check plate bearing engagement surface **148**) composed of rigid material (e.g. metal, stone, or hard plastic), and a lower portion **204** composed of resiliently compressible material (e.g. rubber). Lower portion **204** may be permanently joined (e.g. by adhesive or other means) to upper portion **196**.
[0106] As shown in FIGS. **35-36**, check plate **112** may exhibit greater axial compression when bearings **128** are positioned at higher-elevation locations on bearing engagement surface **148**, and lesser axial compression when bearings **128** are positioned at lower-elevation locations on bearing engagement surface **148**.
[0107] Referring to FIG. **37**, in some embodiments hinge **100** may not include a discrete check plate **112**. Instead, a bearing engagement surface **148** with an elevation profile of variable elevation may be integrally formed (e.g. stamped, machined, or molded) into hinge bracket layer **132**. An advantage of this design is that it may omit the resiliently compressible bias and check plate, which may reduce the unit cost and size of hinge **100**. In this embodiment, bearings **128** and/or hinge bracket layers **132**, **136** may compress or deflect in response to interactions between bearings **128** and bearing engagement surface **148** in place of compressing the resiliently compressible member shown and described herein in connection with other embodiments.
[0108] Reference is now made to FIGS. **39-41**. Any embodiment disclosed herein may further include a protective cover **208**. Protective cover **208** may help prevent dust, dirt, debris, or paint (e.g. paint applied during a factory painting step in the manufacturing of hinge **100** or in the manufacturing of the assembly to which hinge **100** is attached (e.g. a vehicle)) from fouling hinge **100**. For example, protective cover **208** may help prevent such dust, dirt, debris, or paint from depositing on bearings **128** and/or bearing engagement surface **148**. Such deposits might otherwise impair the performance of hinge **100**. For example, deposits on bearings **128** and/or bearing

engagement surface **148** may impede bearings **128** from smoothly sliding or rolling over bearing engagement surface **148**.
[0109] As shown, protective cover **208** may overlie at least a portion of hinge pin **108**. In the illustrated example, protective cover **208** covers hinge pin outer end **212**, hinge pin bearing mount **124**, and hinge pin bearings **128**. In some embodiments, protective cover **208** may further cover at least a portion of check plate **112**.
[0110] Protective cover **208** may have any shape and size suitable to mitigate dust, dirt, debris, and/or paint from depositing on bearings **128** and/or bearing engagement surface **148**. For example, protective cover **208** may include a transversely extending end wall **216** having an end wall perimeter **220**, and an axially extending sidewall **224** extending axially away from end wall **216**. Sidewall **224** may surround at least a portion of hinge pin **108**. For example, sidewall **224** may surround hinge pin bearing mount **124** and hinge pin bearings **128**. In some embodiments, sidewall **224** may further surround at least a portion of check plate **112**. As shown, protective cover **208** may have a circular cross-sectional shape, although other shapes are also feasible.
[0111] Protective cover **208** may be made of any material suitable to mitigate dust, dirt, debris, and/or paint from depositing on bearings **128** and/or bearing engagement surface **148**, and that is suitable for the environment (e.g. ambient temperature) in which hinge **100** will operate. In some embodiments, protective cover **208** may be made of rubber, metal, or plastic. Where hinge **100** is applied to a vehicle, protective cover **208** may be made of rubber, metal, or high temperature plastic so that it can withstand the high temperatures of the factory paint application process.
[0112] Protective cover **208** may be permanently or removably connected to hinge pin **108** in any suitable manner. For example, protective cover **208** may be connected to hinge pin **108** by adhesive, a fastener (e.g. screw or bolt), or a friction-fit (also referred to as a press-fit).
[0113] While the above description provides examples of the embodiments, it will be appreciated that some features and/or functions of the described embodiments are susceptible to modification without departing from the spirit and principles of operation of the described embodiments. Accordingly, what has been described above has been intended to be illustrative of the invention and non-limiting and it will be understood by persons skilled in the art that other variants and modifications may be made without departing from the scope of the invention as defined in the claims appended hereto. The scope of the claims should not be limited by the preferred embodiments and examples, but should be given the broadest interpretation consistent with the description as a whole.
Items
[0114] Item 1: A vehicle door hinge with integrated door check, the vehicle door hinge comprising:
[0115] a vehicle body bracket securable to a vehicle body; [0116] a vehicle door bracket securable to a vehicle door; [0117] a hinge pin defining an axially extending hinge rotation axis, the hinge pin providing a rotational connection between the vehicle body bracket and the vehicle door bracket that allows the vehicle door bracket to rotate about the hinge rotation axis relative to the vehicle body bracket between a door closed position and one or more door retention positions, [0118] the hinge pin comprising one or more bearings; [0119] a door check plate having a bearing engagement surface that is (i) axially opposed to the bearings, (ii) in contact with the bearings, and (iii) surrounding the hinge rotation axis, [0120] the bearing engagement surface defining one or more semi-circular paths, each of the bearings travelling along one of the semi-circular paths as the vehicle door bracket rotates from the door closed position to the one or more door retention positions, [0121] each semi-circular path having a first end corresponding to the door closed position, and an elevation profile with a variable elevation that includes one or more retention portions, each retention portion corresponding to one of the door retention positions, and [0122] a resiliently compressible bias positioned to axially bias the bearing engagement surface against the bearings.
[0123] Item 2: The vehicle door hinge of any preceding claim, wherein: [0124] the elevation profile

of each semi-circular path includes one or more upwardly sloped portions where the elevation profile slopes upwardly towards the first end.
[0125] Item 3: The vehicle door hinge of any preceding claim, wherein: [0126] the elevation profile of each semi-circular path includes one or more downwardly sloped portions where the elevation profile slopes downwardly towards the first end.
[0127] Item 4: The vehicle door hinge of any preceding claim, wherein: [0128] the elevation profile of each semi-circular path includes one or more upwardly sloped portions where the elevation profile slopes upwardly towards the first end, [0129] the elevation profile of each semi-circular path includes one or more downwardly sloped portions where the elevation profile slopes downwardly towards the first end, and [0130] each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.
[0131] Item 5: The vehicle door hinge of any preceding claim, wherein: [0132] when the bearings are located on an upwardly sloped portion of their respective semi-circular path, the hinge pin is urged to rotate relative to the door check plate away from the door closed position, and [0133] when the bearings are located on a downwardly sloped portion of their respective semi-circular path, the hinge pin is urged to rotate relative to the door check plate toward the door closed position.
[0134] Item 6: The vehicle door hinge of any preceding claim, wherein: [0135] the bearings comprise cylindrical sliding elements.
[0136] Item 7: The vehicle door hinge of any preceding claim, wherein: [0137] the bearings comprise spherical sliding elements.
[0138] Item 8: The vehicle door hinge of any preceding claim, wherein: [0139] the bearing engagement surface comprises a transversely concave track aligned with the bearings.
[0140] Item 9: The vehicle door hinge of any preceding claim, wherein: [0141] the hinge pin rotates synchronously with one of the vehicle body bracket and the vehicle door bracket, and [0142] the door check plate rotates synchronously with the other of the vehicle body bracket and the vehicle door bracket.
[0143] Item 10: A vehicle door hinge with integrated door check, the vehicle door hinge comprising: [0144] a vehicle body bracket securable to a vehicle body; [0145] a vehicle door bracket securable to a vehicle door; [0146] a hinge pin defining an axially extending hinge rotation axis, the hinge pin providing a rotational connection between the vehicle body bracket and the vehicle door bracket that allows the vehicle door bracket to rotate about the hinge rotation axis relative to the vehicle body bracket between a door closed position and one or more door retention positions, [0147] the hinge pin comprising one or more bearings; [0148] a door check plate having a bearing engagement surface that is (i) axially opposed to the bearings, (ii) in contact with the bearings, and (iii) surrounding the hinge rotation axis, [0149] the bearing engagement surface defining one or more semi-circular paths, each of the bearings travelling along one of the semi-circular paths as the vehicle door bracket rotates from the door closed position to the one or more door retention positions, [0150] each semi-circular path having a first end corresponding to the door closed position, and an elevation profile with a variable elevation that includes one or more retention portions, each retention portion corresponding to one of the door retention position, and [0151] wherein the door check plate is axially resiliently compressible and axially biases the bearing engagement surface against the bearings.
[0152] Item 11: The vehicle door hinge of any preceding item, wherein: [0153] the elevation profile of each semi-circular path includes one or more upwardly sloped portions where the elevation profile slopes upwardly towards the first end.
[0154] Item 12: The vehicle door hinge of any preceding item, wherein: [0155] the elevation profile of each semi-circular path includes one or more downwardly sloped portions where the elevation profile slopes downwardly towards the first end.

[0156] Item 13: The vehicle door hinge of any preceding item, wherein: [0157] the elevation profile of each semi-circular path includes one or more upwardly sloped portions where the elevation profile slopes upwardly towards the first end, [0158] the elevation profile of each semi-circular path includes one or more downwardly sloped portions where the elevation profile slopes downwardly towards the first end, and [0159] each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.
[0160] Item 14: The vehicle door hinge of any preceding item, wherein: [0161] when the bearings are located on an upwardly sloped portion of their respective semi-circular path, the hinge pin is urged to rotate relative to the door check plate away from the door closed position, and [0162] when the bearings are located on a downwardly sloped portion of their respective semi-circular path, the hinge pin is urged to rotate relative to the door check plate toward the door closed position.
[0163] Item 15: A vehicle door hinge with integrated door check, the vehicle door hinge comprising: [0164] a vehicle body bracket securable to a vehicle body; [0165] a vehicle door bracket securable to a vehicle door; [0166] a hinge pin defining an axially extending hinge rotation axis, the hinge pin providing a rotational connection between the vehicle body bracket and the vehicle door bracket that allows the vehicle door bracket to rotate about the hinge rotation axis relative to the vehicle body bracket between a door closed position and one or more door retention positions, [0167] the hinge pin comprising one or more bearings; [0168] a bearing engagement surface integrally formed into one of the vehicle body bracket and the vehicle door bracket, the bearing engagement surface being (i) axially opposed to the bearings, (ii) in contact with the bearings, and (iii) surrounding the hinge rotation axis, [0169] the bearing engagement surface defining one or more semi-circular paths, each of the bearings travelling along one of the semi-circular paths as the vehicle door bracket rotates from the door closed position to the one or more door retention positions, [0170] each semi-circular path having a first end corresponding to the door closed position, and an elevation profile with a variable elevation that includes one or more retention portions, each retention portion corresponding to one of the door retention position.
[0171] Item 16: The vehicle door hinge of any preceding item, wherein: [0172] the elevation profile of each semi-circular path includes one or more upwardly sloped portions where the elevation profile slopes upwardly towards the first end, [0173] the elevation profile of each semi-circular path includes one or more downwardly sloped portions where the elevation profile slopes downwardly towards the first end, and [0174] each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.
[0175] Item 17: The vehicle door hinge of any preceding item, wherein: [0176] when the bearings are located on an upwardly sloped portion of their respective semi-circular path, the hinge pin is urged to rotate relative to the door check plate away from the door closed position, and [0177] when the bearings are located on a downwardly sloped portion of their respective semi-circular path, the hinge pin is urged to rotate relative to the door check plate toward the door closed position.
[0178] Item 18: The vehicle door hinge of any preceding item, wherein: [0179] the bearings comprise cylindrical sliding elements.
[0180] Item 19: The vehicle door hinge of any preceding item, wherein: [0181] the bearings comprise spherical sliding elements.
[0182] Item 20: The vehicle door hinge of any preceding item, wherein: [0183] the bearing engagement surface comprises a transversely concave track aligned with the bearings.

Claims

1. A door hinge with integrated door check, the door hinge comprising: a first bracket and a second bracket connected to the first bracket by a hinge pin, the second bracket rotatable relative to the first bracket about an axially extending hinge rotation axis of the hinge pin, the hinge pin comprising a plurality of bearings distributed about the hinge rotation axis; a door check plate surrounding the hinge rotation axis and axially displaceable along the hinge pin, the door check plate having a bearing engagement surface that is axially opposed to the plurality of bearings, the bearing engagement surface defining a plurality of curved paths, wherein a number of curved paths is equal to a number of bearings, each curved path having a path length and an elevation profile with a variable elevation along the path length, the path length and the elevation profile of each curved path being substantially identical, and a resiliently compressible bias positioned in contact with the door check plate, the resiliently compressible bias axially biasing the bearing engagement surface of the door check plate against the plurality of bearings whereby each of the plurality of bearings travels along the elevation profile of a respective one of the curved paths when the second bracket rotates relative to the first bracket.

2. The door hinge of claim 1, wherein the elevation profile of each curved path has one or more upwardly sloped portions, one or more downwardly sloped portions, and one or more retention portions.

3. The door hinge of claim 2, wherein each retention portion corresponds to a bracket retention position, each bracket retention position defining an angular position of the second bracket relative to the first bracket.

4. The door hinge of claim 2, wherein each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.

5. The door hinge of claim 2, wherein: when the plurality of bearings are located on an upwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a first direction, and when the plurality of bearings are located on a downwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a second direction opposite the first direction.

6. The door hinge of claim 1, wherein the plurality of bearings comprise cylindrical sliding elements.

7. The door hinge of claim 1, wherein the plurality of bearings comprise spherical sliding elements.

8. The door hinge of claim 1, wherein: the hinge pin rotates synchronously with one of the first bracket and the second bracket, and the door check plate rotates synchronously with the other of the first bracket and the second bracket.

9. A door hinge with integrated door check, the door hinge comprising: a first bracket and a second bracket connected to the first bracket by a hinge pin, the second bracket rotatable relative to the first bracket about an axially extending hinge rotation axis of the hinge pin, the hinge pin comprising a plurality of bearings distributed about the hinge rotation axis; and a door check plate surrounding the hinge rotation axis, the door check plate comprising a bearing engagement surface that is axially opposed to the plurality of bearings, the bearing engagement surface defining a plurality of curved paths, wherein a number of curved paths is equal to a number of bearings, each curved path having a path length and an elevation profile with a variable elevation along the path length, the path length and the elevation profile of each curved path being substantially identical, and an axially resiliently compressible material forming at least a portion of the door check plate, the axially resiliently compressible material axially biasing the bearing engagement surface against the plurality of bearings whereby each of the plurality of bearings travels along the elevation profile of a respective one of the curved paths when the second bracket rotates relative to the first bracket.

10. The door hinge of claim 9, wherein the elevation profile of each curved path has one or more

upwardly sloped portions, one or more downwardly sloped portions, and one or more retention portions.

11. The door hinge of claim 10, wherein each retention portion corresponds to a bracket retention position, each bracket retention position defining an angular position of the second bracket relative to the first bracket.

12. The door hinge of claim 10, wherein each retention portion is defined between a low-elevation end of an upwardly sloped portion and a low-elevation end of a downwardly sloped portion.

13. The door hinge of claim 10, wherein: when the plurality of bearings are located on an upwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a first direction, and when the plurality of bearings are located on a downwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a second direction opposite the first direction.

14. The door hinge of claim 9, wherein the plurality of bearings comprise cylindrical sliding elements.

15. The door hinge of claim 9, wherein the plurality of bearings comprise spherical sliding elements.

16. The door hinge of claim 9, wherein: the hinge pin rotates synchronously with one of the first bracket and the second bracket, and the door check plate rotates synchronously with the other of the first bracket and the second bracket.

17. A door hinge with integrated door check, the door hinge comprising: a first bracket and a second bracket connected to the first bracket by a hinge pin, the second bracket rotatable relative to the first bracket about an axially extending hinge rotation axis of the hinge pin, the hinge pin comprising a plurality of bearings distributed about the hinge rotation axis, the plurality of bearings rigidly coupled to the hinge pin; and a bearing engagement surface integrally formed into one of the first bracket and the second bracket, the bearing engagement surface being (i) axially opposed to the plurality of bearings, (ii) in contact with the plurality of bearings, and (iii) surrounding the hinge rotation axis, the bearing engagement surface defining a plurality of curved paths, wherein a number of curved paths is equal to a number of bearings, each curved path having a path length and an elevation profile with a variable elevation along the path length, the path length and the elevation profile of each curved path being substantially identical, and each of the plurality of bearings travels along the elevation profile of a respective one of the curved paths when the second bracket rotates relative to the first bracket.

18. The door hinge of claim 17, wherein the elevation profile of each curved path has one or more upwardly sloped portions, one or more downwardly sloped portions, and one or more retention portions.

19. The door hinge of claim 18, wherein each retention portion corresponds to a bracket retention position, each bracket retention position defining an angular position of the second bracket relative to the first bracket.

20. The door hinge of claim 18, wherein: when the plurality of bearings are located on an upwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a first direction, and when the plurality of bearings are located on a downwardly sloped portion of their respective curved path, the hinge pin is urged to rotate relative to the door check plate about the hinge rotation axis in a second direction opposite the first direction.