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THE PATENTS ACT, 1970

(39 of 1970)

The patent Rule, 2003

COMPLETE SPECIFICATION

(See section 10 and rule 13)

TITLE OF THE INVENTION

ADJUSTBALE TIMING CHAIN GUIDE

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ADJUSTBALE TIMING CHAIN GUIDE

TECHNICAL FIELD

[0001] The present disclosure relates generally to the field of internal combustion engines. In particular, the present disclosure pertains to an adjustable chain guide for guiding and/or tightening of a timing chain in internal combustion (IC) engines.

BACKGROUND

[0002] A timing chain or chain or cam belt is a part of an IC engine that synchronizes rotation of one or more camshafts with crankshaft of the engine so that the engine's valves open and close at the proper timings during each intake stroke and exhaust stroke of the engine. The timing chain extends in an endless loop between the driving gear/sprocket located on the crankshaft and the driven gear/sprocket located on the camshafts. During operation of the engine, the timing chain forms a tight side and a slack side. The tight side is the span of the chain that carries tension to drive the driven gear from the driving gear, and comprises chain links leaving the driven gear and entering the driving gear. The slack side is the other span of timing chain that does not carry the driving tension, comprising links leaving the driving gear and entering the driven gear.

[0003] Performance and action of the timing chain differs dramatically between the tight side and the slack side. A tensioner chain guide is generally used on the slack side of the timing chain to take up or eliminate the slack in the timing chain. As the engine accelerates or decelerates, the tensioner chain guide may move the timing chain to maintain the tension in the timing chain. A fixed chain guide is generally used on one side of the timing chain. The fixed chain guide serves to maintain a desired path of the timing chain between the driving and the driven gears.

[0004] A conventional chain guide/ timing chain guide such as a tensioner chain guide or a fixed chain guide includes a carrier and a sideway lining body having a sliding surface that exhibits a convex curvature in the direction of movement of the timing chain. Generally, the carrier made of a metallic material or plastic material that provides a rigid shape structure. The carrier includes a flat, elongated main body portion with a pair of spaced mounting holes formed therein for fixing the carrier to an associated engine and a longitudinal edge with a row of tabs having a shape perpendicular to said main body portion. The sideway lining body is coupled to the tabs to be fixed thereon and the sliding surfaceis adapted to contact and guide the timing chain. In conventional designs of the chain guides, the carrier has fixed shape and size, and in most cases, the carrier of the chain guides of defined size and shape are designed based on requirement for reducing the slack in the timing chain and guide the timing chain to maintain a desired path between the driving gear and the driven gear specific to the engine model with which the chain guide is to be used. Thus, shape and size of chain guides are varied for different engines due to different shape and size requirement, leading to a multiplicity of timing chain guides, each having its own constituent parts requiring manufacture of large number of components. The multiplicity of timing chain guides poses problem in their manufacture and stocking to meet production requirements.

[0005] United States Patent document number US2017009849 discloses a guide rail or a tensioning rail for a chain drive of an internal combustion engine. The guide rail or a tensioning rail comprises at least two separate sliding elements and includes a sliding surface of a convex curvature in the direction of movement of the chain to provide support or tension to the chain drive. The sliding surface is arranged on a support. The support is a flat sheet-metal rail having two or a plurality of fastening sections bent as perpendicular fastening lugs. The sliding elements being adapted to be attached to these fastening lugs in a direction perpendicular to the direction of movement of the chain and to be locked in position thereon.

[0006] As can be seen, prior art reference discloses a timing chain guide/tensioner comprising a support made of metallic sheet provides fixed shape and size to the timing chain guide and has to be designed to meet specific requirement of engine model to which they are to be fitted. Therefore, the system and techniques as taught by the prior art reference do not provide solution for the problem of multiplicity of timing chain guide designs and need to manufacture and stock them.

[0007] There is, therefore, a need for improvement in art to provide a concept for chain guides for timing chain of IC engines that enables assembly of chain guides of different size and shapes to meet requirement of different engine models using a few common parts.

OBJECTS OF THE INVENTION

[0008] A general object of the present disclosure is to reduce manufacturing and other costs associated with chain guides for timing chains in internal combustion engines.

[0009] An object of the present disclosure is to provide a concept for chain guides for timing chains in internal combustion engines that provides eliminated need for manufacturing and stocking chain guides specific to each engine model.

[0010] Another object of the present disclosure is to provide a modular design for chain guides that enables to configure chain guides for different engine models using common parts thereby eliminating the need for manufacturing and stocking chain guides specific to each engine model.

SUMMARY

[0011] The present disclosure relates to a chain guide for timing chain of an internal combustion (IC) engine for guiding and/or tightening of the timing chain. In particular, the present disclosure pertains to a chain guide for timing chain having an adjustable shape and size to eliminate requirement of chain guide of various shape and sizes for different engine models.

[0012] In an aspect, the disclosed chain guide for timing chain of an internal combustion engine comprises a base and a sliding surface member (also referred to as sliding surface or sliding member, and all these terms used interchangeably hereinafter) affixed to the base, wherein the base is of modular structure that can be configured with a plurality of connectors that work like building blocks. Each of the connectors is interlocked to adjacent connectors such that joint between the connectors allows relative pivotal movement between the adjacent connectors to allow the base to take different curvatures as required. Thus, each base can have a plurality of connectors, wherein the plurality of connectors comprise one or more intermediate connectors and two end connectors. In an aspect, the sliding surface member can be made of a flexible material to allow the sliding member to take different curvatures as provided to the base, and can be fixed to a surface of the base that is perpendicular to the plane of positioning of the chain guide by means of threaded fasteners, specifically to the end connectors. The sliding surface member can have a surface for sliding contact with the timing chain.

[0013] In an aspect, while the joint between adjacent connector facilitates a degree of freedom for rotational relative movement of the corresponding adjacent connectors along an axis perpendicular to the plane of positioning of the chain guide, but resists relative motion to impart a certain level of resistance to change in shape of the base. This resistance is based on pressure from timing chain that the chain guide is expected to withstand during running of the engine. l

[0014] In an aspect, the joint between the connectors is based on a cylindrical cavity and a cylindrical shaped projection configured in the corresponding adjacent connectors respectively. The cylindrical cavity and the cylindrical shaped projection can be configured in the plane of positioning of the chain guide so that curvature of the chain guide can be adjusted in the desired plane. As can be appreciated, the cylindrical shaped projection works as a pin (and accordingly also referred to as pin) engaged in the cylindrical cavity that works like a hole to provide a limited relative pivotal movement between the two adjacent connectors.

[0015] In an aspect, while the pivotal movement between the adjacent connectors allows adjustment in curvature of the base, size of the base can be increased or decreased by adding or reducing intermediate connectors. Thus, requirement of the chain guide of different curvature and length for different engine models can be met by the proposed modular concept.

[0016] In another aspect, the cylindrical shaped projection can be in interference fit with the cylindrical cavity so that frictional forces between the two provide a requisite resistance to relative pivotal movement between the adjacent connectors to change in shape of the base.

[0017] In an aspect, side surfaces of the plurality connectors that are adjacent to the cylindrical cavity and the cylindrical shaped projection can be bevelled to provide relief for relative pivotal movement between the adjacent connectors.

[0018] In an aspect, each of the two end connectors of the base incorporates a hole to facilitate coupling of the chain guide with the internal combustion engine.

[0019] In an embodiment of application, chain guide can be configured as a fixed chain guide to provide support for timing chain of the internal combustion engine, In which case, the two end connectors of the base can be fixed to the internal combustion engine.

[0020] In an alternate embodiment of application, the chain guide can be configured as a tensioner chain guide for tightening of the timing chain of the internal combustion engine. In which case, one of the two end connectors of the base can be pivotally coupled to the internal combustion engine and the other end connector can be free to provide tension force to the timing chain.

[0021] Various objects, features, aspects and advantages of the inventive subject matter will become more apparent from the following detailed description of preferred embodiments, along with the accompanying drawing figures in which like numerals represent like components.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The accompanying drawings are included to provide a further understanding of the present disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the present disclosure and, together with the description, serve to explain the principles of the present disclosure.

[0023] FIG. 1 illustrates a conventional arrangement of chain guides for a timing chain of an internal combustion engine.

[0024] FIG. 2 illustrates an exemplary representation of the proposed concept for modular chain guide, in accordance with embodiments of the present disclosure.

[0025] FIG. 3 illustrates exemplary representation of the proposed concept for modular chain guide having adjacent interlocked connectors, showing forces working on the connectors and the joint between the connectors, in accordance with embodiments of the present disclosure.

[0026] FIGs. 4A to 4C illustrate exemplary curves showing observed longitudinal force recorded on timing chain fitted with a conventional chain guide, the proposed chain guide and three fixed chain guides, in accordance with embodiments of the present disclosure.

DETAILED DESCRIPTION

[0027] The following is a detailed description of embodiments of the disclosure depicted in the accompanying drawings. The embodiments are in such details as to clearly communicate the disclosure. However, the amount of detail offered is not intended to limit the anticipated variations of embodiments; on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the present disclosure as defined by the appended claims.

[0028] Embodiments explained herein relate to an improved chain guide for timing chain in internal combustion (IC) engines having shape and size adjustment feature to meet requirements of chain guide with different shape and size for different engines for effective guiding and tightening to the timing chain.

[0029] Typically, chain guide have a fixed shape and size defined by shape and size of its carrier/bases support/bracket and a sliding body coupled to the carrier. The carrier and the sliding body of the conventional may be of regular or irregular shape to provide better guiding and tightening to a timing chain.

[0030] FIG. 1 illustrates a typical installation 100 of timing chain for a timing chain of an internal combustion engine using conventional chain guides such as a fixed chain guide 102 and a tensioner chain guide 104. The fixed chain guide 102 can be fixed to the engine at both ends, and the tensioner chain guide 104 can be fixed to the engine at one end, with other end kept movable to remove any slack in the timing chain 106. The timing chain 106 is extended in an endless loop between a driving gear 108 and a driven gear 110 in the engine. The fixed chain guide 102 is used on the tight side of the timing chain 106 to maintain a desired path of the timing chain between the driving gear 108 and the driven gear 110 and the tensioner chain guide 104 is generally used on the slack side to reduce slackness in the timing chain 106 during operation of the IC engine. Each of the fixed chain guide 102 and the tensioner chain guide 104 comprises a carrier 112 and a sliding surface body 114 having a sliding surface that exhibits a convex curvature to be in contact with the timing chain 106 in a direction of movement of the timing chain 106. The sliding surface body 114 is fixed on the carrier 112. Generally, the carrier is made of a metallic sheet or a hard plastic material having fixed shape and size. The sliding surface body 114 can be made of a hard polymeric material that exhibits a fixed shape.

[0031] The shape and size of the conventional chain guides 102/104 is decided based on requirement for reducing the slack in the timing chain 106 and guiding the timing chain 106 to maintain a desired path of between the driving gear 108 and driven gear 110 specific to the engine with which the chain guide 102/104 is to be used. Therefore, each engine model generally requires designing and manufacturing of a separate set of chain guides with different shape and size.

[0032] In an embodiment, the present disclosure provides a modular chain guide that can be configured using a set of connectors to meet specific requirements in respect of shape and size for each engine model. In an aspect, the disclosed chain guide can include a base having a plurality of connectors. The plurality of connectors can include one or more intermediate connectors and two end connectors, wherein the intermediate connectors and the end connectors can be standard modules that work as building blocks for fabricating chain guides that are unique to each engine model.

[0033] In an embodiment, each connector of the plurality of connectors can be interlocked to its adjacent connectors by a pivot joint such that the pivot joint facilitates a degree of freedom to the corresponding adjacent connectors along an axis perpendicular to the plane of positioning of the base.

[0034] In an embodiment, the pivot joint can be based on a cylindrical cavity that works like a hole, and a cylindrical shaped projection that works like a pin, configured in the corresponding adjacent connectors respectively such that the cylindrical shaped projection is in interference fit with the cylindrical cavity that can resists relative pivotal movement between the adjacent connectors to impart a certain level of resistance to change in shape of the base. In an embodiment, the interference fit between the adjacent connectors can be worked out based on desired torsional stiffness between adjacent connectors, which in turn can be based on likely force transferred from the timing chain to the chain guide during working of the engine.

[0035] In an embodiment, the chain guide can also include a sliding surface member having a surface for sliding contact with the timing chain. The sliding surface member can be coupled to a surface of the base perpendicular to the plane of positioning of the base. The sliding surface member can be coupled to the two end connectors of the base by one or more threaded members such as screws and thereby preventing disconnection of the sliding surface member from the base. In addition, the sliding surface member can have a cross section that wraps around the base for a firm fitment over the base.

[0036] In an embodiment, side surfaces of the plurality connectors that lie adjacent to the cylindrical cavity and the cylindrical shaped projection are bevelled to provide relief for relative pivotal movement between the adjacent connectors of the plurality of end connectors.

[0037] In an embodiment, the pivotal joint and pivotal movement between the adjacent connectors can facilitate adjustment in shape of the base to meet different shape requirements of the chain guide for different engines.

[0038] In an embodiment, a number of intermediate connectors in the base can be increased or decreased to meet requirement of size of the base depending on size requirement of the chain guide for different engines.

[0039] In an embodiment, each of the two end connectors can include a hole to facilitate coupling of the chain guide with the associated engine.

[0040] In an embodiment, the chain guide in accordance with the present disclosure, can be configured as a fixed chain guide to provide support and maintain a desired path of the timing chain during operating condition of the engine. In which case, the two end connectors can be fixed to the internal combustion engine with assistance of fasteners through the holes provided thereon.

[0041] In an embodiment, the chain guide in accordance with the present disclosure, can be configured as a tensioner chain guide for tightening of the timing chain. In which case, one of the two end connectors can be pivotally coupled to the engine with assistance of the hole provided thereon, and the other end connector can be free to provide tension force to the timing chain to remove slack in the timing chain, and can be coupled to a suitable actuator for pushing it towards the chain.

[0042] FIG. 2 illustrates an exemplary representation of the proposed adjustable chain drive, in accordance with embodiments of the present disclosure. As shown, the disclosed chain guide (also referred to as adjustable chain guide or a modular chain guide) 200 includes a base 202 made up of a plurality of connectors. The plurality of connectors can include at least one or more intermediate connectors 204 and two end connectors 206-1 and 206-2 (collectively referred to as end collector 206); and a sliding surface member 208 coupled to the base 202.

[0043] In an embodiment, each of the connectors 204/206 can be interlocked to its adjacent connector by a pivot joint 210 such that the pivot joint facilitates a degree of freedom to the corresponding adjacent connectors along an axis perpendicular to the plane of positioning of the chain guide 200.

[0044] In an embodiment, the pivot joint 210 can be based on a cylindrical cavity and a cylindrical shaped projection configured in the corresponding adjacent connectors 204/206 respectively such that the cylindrical shaped projection working as a pin is in interference fit with the cylindrical cavity working as a hole. The interference fit between the two can resist relative pivotal movement between the adjacent connectors.

[0045] In an embodiment, the interference fit between the adjacent connectors of the plurality of connectors is based on required torsional stiffness of adjacent connectors. The required torsional stiffness can in turn be determined based on amount of torque that the cylindrical shaped projection is subjected to during working of the engine due to force exerted by the timing chain on the chain guide 200. Detailed calculations for this has been explained against FIG. 3 below.

[0046] In an embodiment, the pivotal joint 210 and pivotal movement between the adjacent connectors can facilitate adjustment in shape of the base 202 to meet different shape requirements of the chain guide 200 for different engines.

[0047] In an embodiment, a number of intermediate connectors 204 in the base can be increased or decreased depending on requirement of size of the base 202 to meet different size requirements of the chain guide 200 for different engines.

[0048] In an embodiment, the sliding surface member 208 can be coupled to a surface of the base perpendicular to the plane of positioning of the base. The sliding surface member 208 provides a smooth surface for sliding of the timing chain. In an embodiment, the sliding surface member 208 can be coupled to the two end connectors 206-1 and 206-2 of the base 202 by one or more threaded fasteners, such as screws 214, for firmly holding the sliding surface member 208 with the base 202. In an embodiment, each of the two end connector can include a hole 216 to receive the screws 214.

[0049] In an embodiment, side surfaces 218 of the plurality connectors are adjacent to the cylindrical cavity and the cylindrical shaped projection can be bevelled as a chamfer to provide relief for adequate relative pivotal movement between the adjacent connectors 204/206.

[0050] In an embodiment, each of the two end connectors 206 of the base 202 can include holes, such as hole 220, to facilitate coupling of the chain guide 200 with the associated internal combustion engine.

[0051] FIG. 2 further illustrates details of the intermediate connector 204 and the end connectors 206. As shown the end connectors 206 can include the cylindrical shaped projection 222 at one end which interlocks with the cylindrical cavity 224 of the adjacent intermediate connector 204. As stated earlier, the fit between the cylindrical shaped projection 222 and the cylindrical cavity 224 can be an interference fit. Also shown are details of the intermediate connectors 204, which can include the cylindrical shaped projection 222 at both ends. In an embodiment, at least one of the one or more intermediate connectors 204 can include a cylindrical cavity 224 at both ends. To meet the requirement where there are even number of intermediate connectors 204, there can be an intermediate connector 204 with cylindrical cavity 224 at one end and the cylindrical shaped projection 222 at other end.

[0052] In an embodiment, the chain guide 200 can be used as a fixed chain guide for timing chain of the internal combustion engine to provide support and maintain a desired path of the timing chain during operating condition of the engine. In an embodiment, the two end connectors 206 of the base 202 can be fixed to the associated internal combustion engine with assistance of a fastener fitted through the holes 220 provided in the end connectors 206.

[0053] In an embodiment, the chain guide 200 can be used as a tensioner chain guide for tightening of the timing chain of the internal combustion engine. One of the two end connectors 206 of the base 202 can be pivotally coupled to the associated internal combustion engine with assistance of the hole provided thereon and the other end connector 206 can be free to provide tension force to the timing chain to remove slack in the timing chain.

[0054] FIG. 3 shows forces working on the connectors and the joint between the connectors, in accordance with embodiments of the present disclosure. Based on various forces that are known to act on the chain guide and forces in the interference fit between the cavity 224 (i.e. hole as shown on left side of the FIG. 3) and the cylindrical projection 222 (i.e. pin as shown on left side of the FIG. 3), required radial interference δ between the cavity 224 and the cylindrical projection 222 (as shown in FIG. 3) can be calculated based on following equations:

$$F_c \times l_1 = F_f \times r_1$$

Therefore, $F_f = (F_c \times l_1) / r_1$

$$T = F_f \times r_1$$

$$T = K_t \times \Theta$$

$$K_t = T / \Theta$$

$$F_f = F_{int} \times \mu$$

$$F_{int} = F_f / \mu$$

Pressure due to interference is given by-

$$P = \frac{\delta}{\frac{d_0}{E_0}\left(\frac{{d_0}^2 + d^2}{{d_0}^2 - d^2} + \upsilon_0\right) + \frac{d_i}{E_i}\left(\frac{{d_i}^2 + d^2}{d^2 - {d_i}^2} + \upsilon_i\right)}$$

Where, F_c = Chain Force

F_f= Frictional Force

K_t= Torsional Stiffness

F_{int}= Force required for interference fit

Θ = Angular rotation between links

μ = Coefficient of Friction

P= Pressure

T = Torque

l_1 = Distance between force application and pivot point

r_1 =Pin radius of initial link

δ= Radial Interference

d = Nominal pin diameter link

d_0 = Pin internal diameter of initial link

υ_0 = Poisson’s ratio for initial link

E_0 = Young’s modulus of the initial link

d_i=Pin outer diameter of next link

υ_i= Poisson’s ratio for next link

E_i= Young’s modulus of the next link

[0055] Also shown in FIG. 3 is relief 302-1 and 302-2 (collectively referred to as relief302) on respective sides of the joint, which are caused because of beveling of side surfaces of the connectors 204/206 that are adjacent to the cylindrical cavity 224 and the cylindrical shaped projection 222. As can be understood by those skilled in the art, relief 302 allow the respective connectors 204/206 to undergo relative pivotal movement to change curvature of the base 202.

[0056] FIGs. 4A to 4C illustrate exemplary curves showing longitudinal force recorded on timing chain fitted with a conventional chain guide, the proposed chain guide and three fixed chain guides, in accordance with embodiments of the present disclosure. All the curves show recorded longitudinal force on the timing chain soon after the engine is started. As can be understood, any difference in behavior of the chain guides shall reflect on the recorded longitudinal force on the timing chain. While FIG. 4A pertains to a configuration fitted with conventional chain guides such as chain guides 102/104, FIG. 4B pertains to the configuration fitted with proposed chain guides 200 as disclosed in FIG. 2. FIG. 4C pertains to a configuration fitted with three conventional chain guides similar to chain guides 102/104, but of smaller size such that three of them replace a single conventional chain guide 102/104. As can be seen from the recorded curves 402, 404 and 406, there is no appreciable difference in the recorded longitudinal force on the timing chain soon after start of the engine. This indicates that the proposed design for the chain guides retains the integrity of the conventional chain guides and shall not result in any deterioration in performance.

[0057] While the foregoing describes various embodiments of the invention, other and further embodiments of the invention may be devised without departing from the basic scope thereof. The scope of the invention is determined by the claims that follow. The invention is not limited to the described embodiments, versions or examples, which are included to enable a person having ordinary skill in the art to make and use the invention when combined with information and knowledge available to the person having ordinary skill in the art.

ADVANTAGES OF THE INVENTION

[0058] The present disclosure reduces manufacturing and other costs associated with chain guides for timing chains in internal combustion engines.

[0059] The present disclosure provides a concept for chain guides for timing chains in internal combustion engines that provides eliminated need for manufacturing and stocking chain guides specific to each engine model.

[0060] The present disclosure provides a modular design for chain guides that enables to configure chain guides for different engine models using common parts thereby eliminating the need for manufacturing and stocking chain guides specific to each engine model.

We Claim:

1. A chain guide for timing chain of an internal combustion engine, said chain guide comprising:

   a base having a plurality of connectors, said plurality of connectors comprising one or more intermediate connectors and two end connectors; and

   a sliding surface member fixed to the base and having a surface for sliding contact with the timing chain;

   wherein each connector of the plurality of connectors is interlocked to its adjacent connector by a joint that facilitates a degree of freedom for rotational relative movement of the corresponding adjacent connectors along an axis perpendicular to the plane of positioning of the chain guide, and yet resists relative motion to impart a certain level of resistance to change in shape of the base.

2. The chain guide as claimed in claim 1, wherein the joint is based on a cylindrical cavity and a cylindrical shaped projection configured in the corresponding adjacent connectors respectively; wherein the cylindrical cavity and a cylindrical shaped projection configured in the plane of positioning of the chain guide, and wherein the cylindrical shaped projection is in interference fit with the cylindrical cavity that resists relative pivotal movement between the adjacent connectors of the plurality of connectors to impart the resistance to change in shape of the base.

3. The chain guide as claimed in claim 1, wherein the sliding surface member is coupled to a surface of the base that is perpendicular to the plane of positioning of the chain guide.

4. The chain guide as claimed in claim 3, wherein the sliding surface member is made of a flexible material to enable it to take a shape along the surface of the base to which it is affixed.

5. The chain guide as claimed in claim 3, wherein the sliding surface member is coupled to the two end connectors of the base by one or more threaded fasteners.

6. The chain guide as claimed in claim 2, wherein the pivotal movement between the adjacent connectors allows adjustment in curvature of the base, and number of intermediate connectors is increased or decreased to meet size requirement of the chain guide for different engines.

7. The chain guide as claimed in claim 6, wherein side surfaces of the plurality connectors that are adjacent to the cylindrical cavity and the cylindrical shaped projection are bevelled to provide relief for relative pivotal movement between the adjacent connectors.

8. The chain guide as claimed in claim 1, wherein each of the two end connectors of the base comprises a hole to facilitate coupling of the chain guide with the internal combustion engine.

9. The chain guide as claimed in claim 1, wherein chain guide is a fixed chain guide to provide support for timing chain of the internal combustion engine, and wherein the two end connectors of the base are fixed to the internal combustion engine.

10. The chain guide as claimed in claim 1, wherein chain guide is a tensioner chain guide for tightening of the timing chain of the internal combustion engine, and wherein one end connector of the two end connectors of the base is pivotally coupled to the internal combustion engine and the other end connector is free to provide tension force to the timing chain.

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<u>ABSTRACT</u>

ADJUSTBALE TIMING CHAIN GUIDE

A modular chain guide 200 for timing chain of internal combustion engines is disclosed, comprising: a base 202 having a plurality of connectors 204/206, said plurality of connectors comprising one or more intermediate connectors 204 and two end connectors 206. A sliding surface member 208 is fixed to the base 202 for sliding contact with timing chain. Each connector 204/206 is interlocked to its adjacent connector by a joint 210 that allows rotational relative movement of between adjacent connectors, and yet resists relative motion to impart a certain level of resistance to change in shape of the base 202. The joint is based on a cylindrical cavity 224 and a cylindrical shaped projection 222 configured in the corresponding adjacent connectors. Cylindrical projections 222 are in interference fit with cavity 224 that resists relative pivotal movement between connectors 204. 206 to impart the resistance to change in shape of base 202.

FIG. 2 shall be the reference figure.

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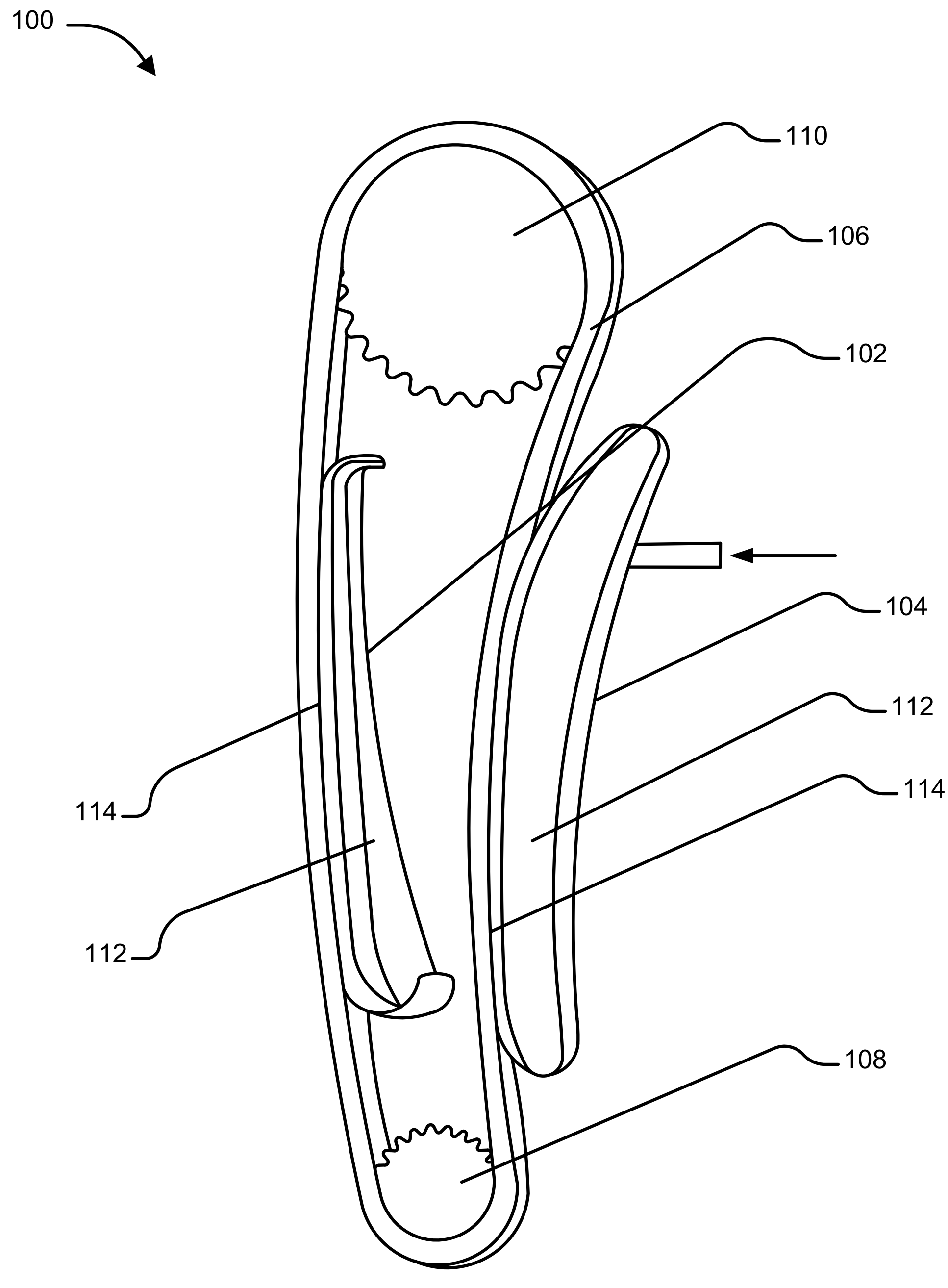

FIG. 1

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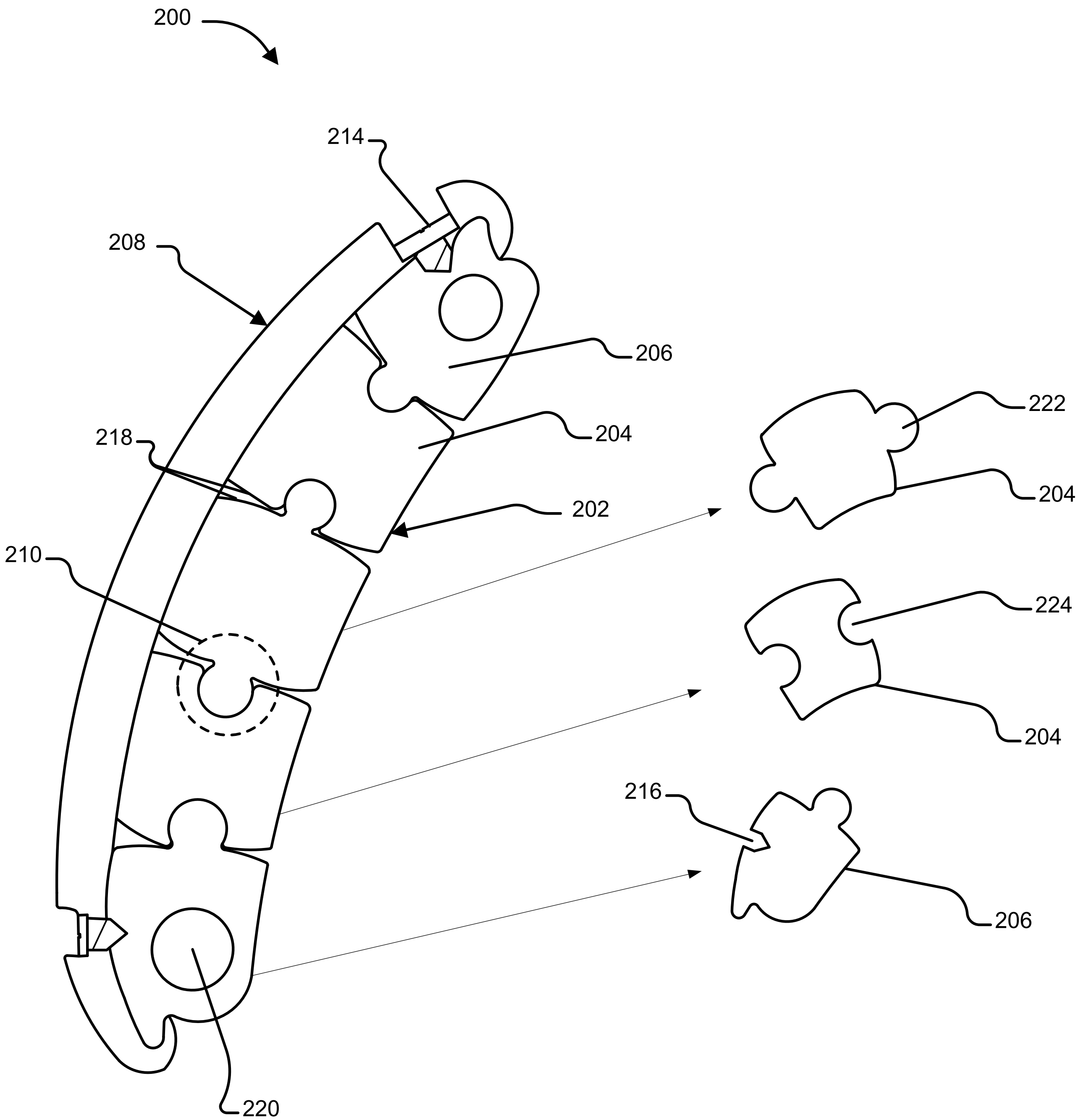

FIG. 2

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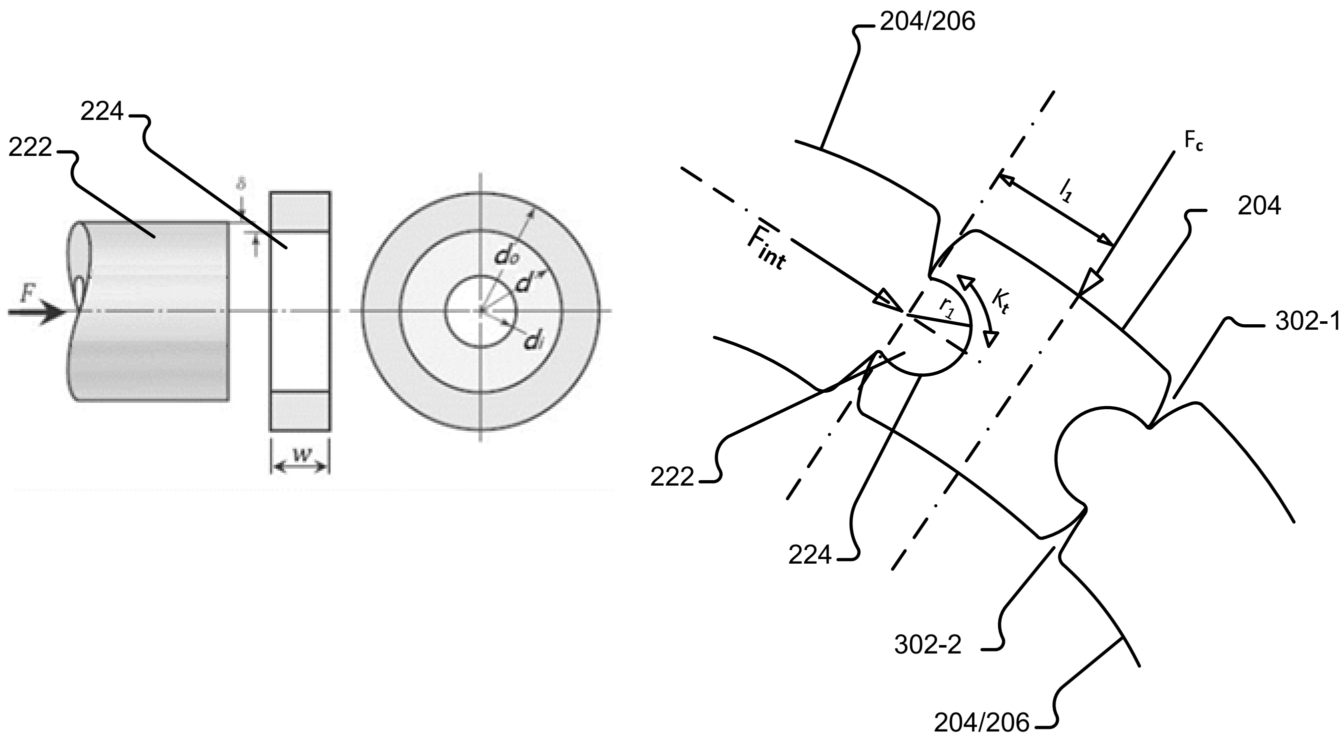

FIG. 3

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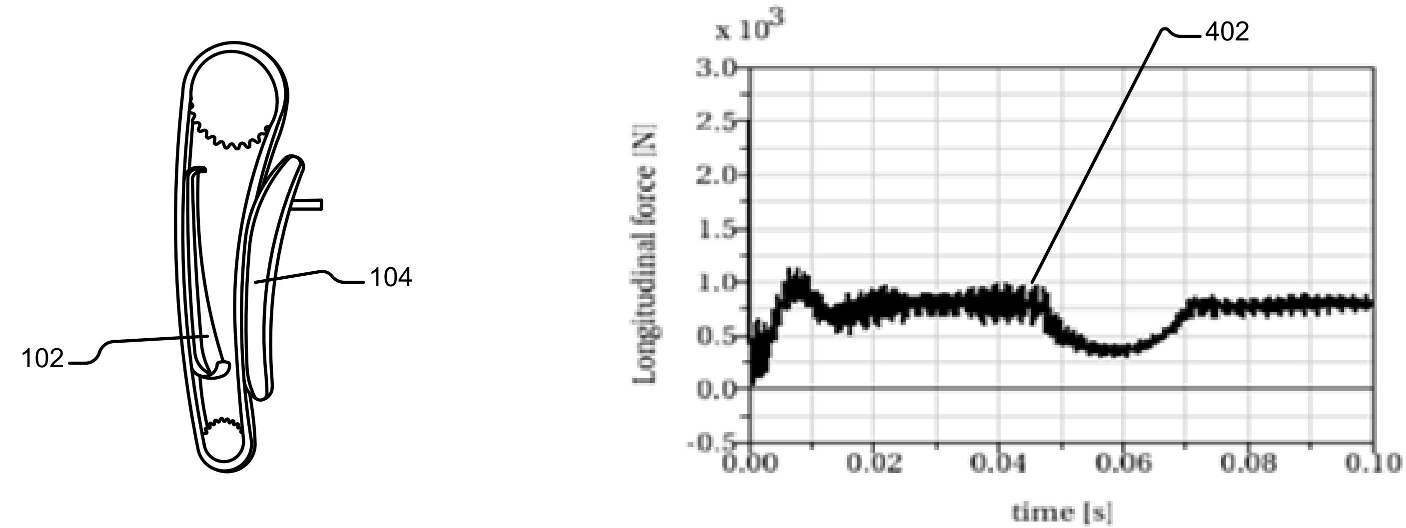

FIG. 4A

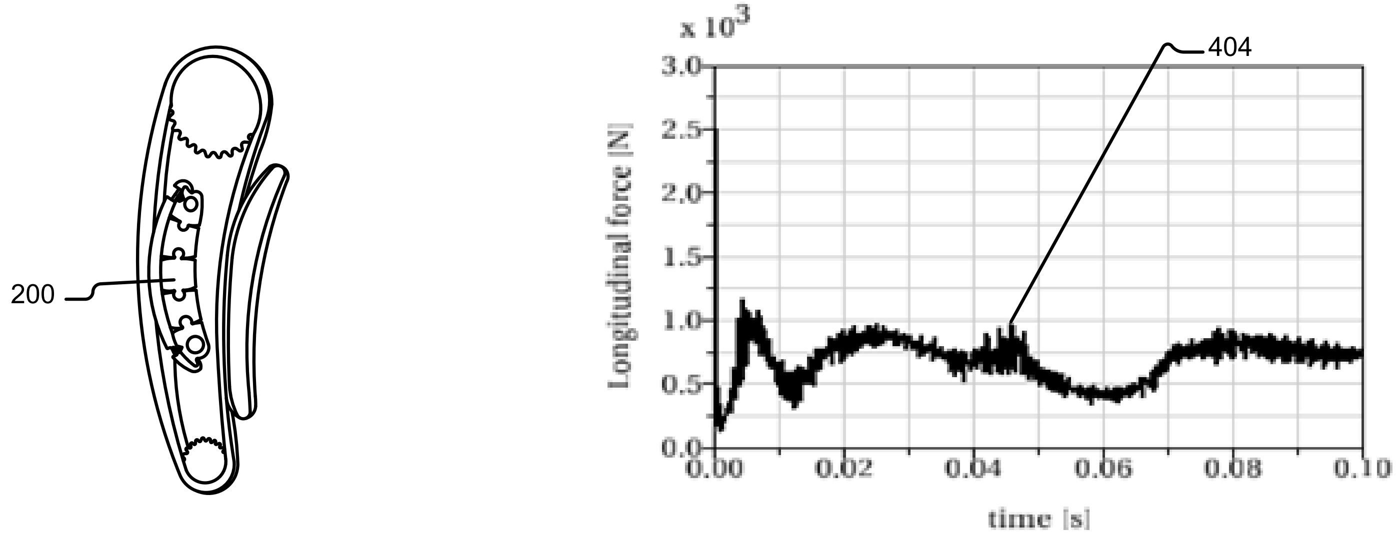

FIG. 4B

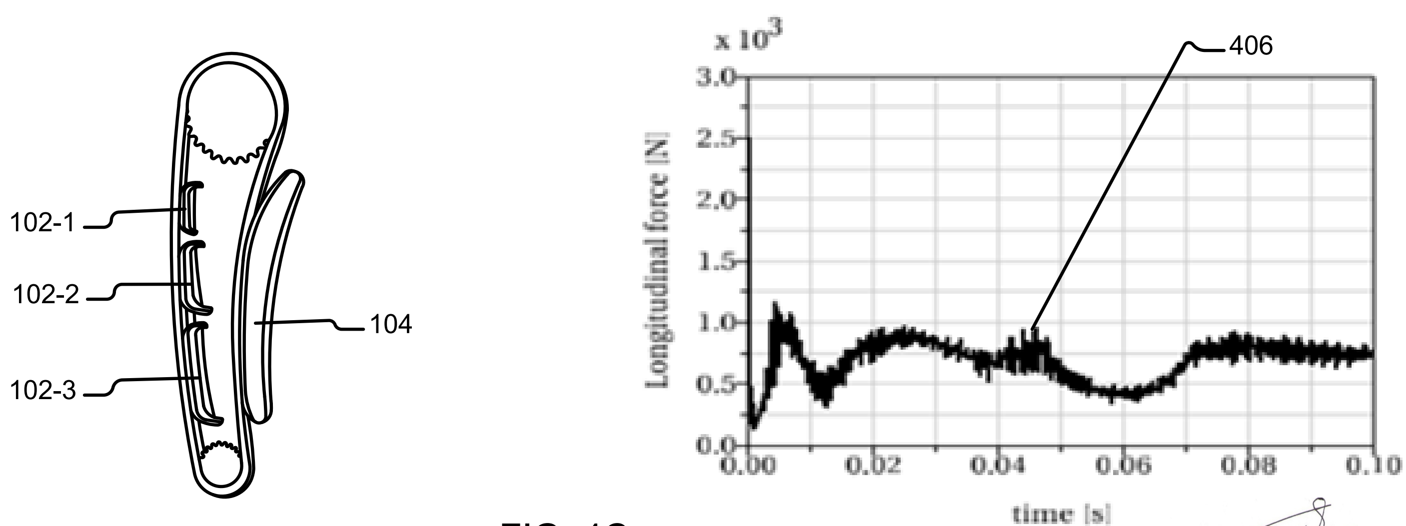

FIG. 4C

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