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TIMING GEARS

Filed April 13, 1964

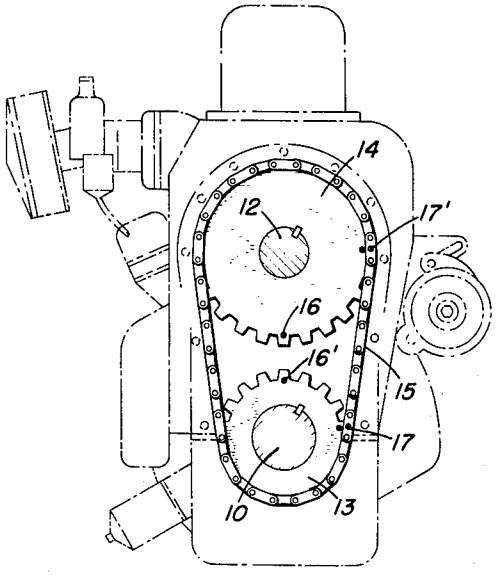


FIG. 1.

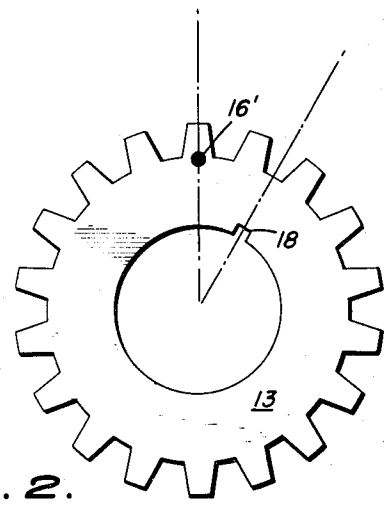


FIG. 2.

FIG. 3.

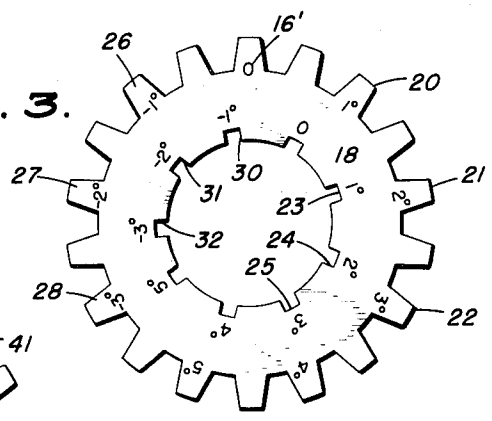
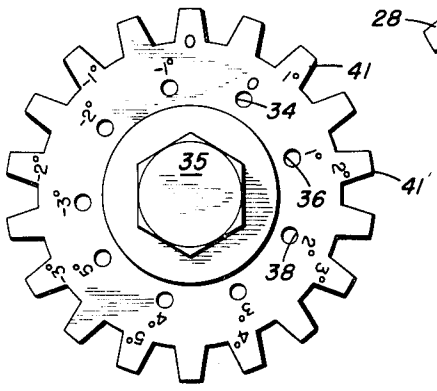


FIG. 4.



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TIMING GEARS

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The present invention relates to timing gears for internal combustion engines. More particularly, it relates to a static timing gear for coupling the crank shaft to the valve operating cam shaft of a reciprocating combustion engine.

Best performance is obtained from an internal combustion engine when the intake and exhaust valves are operated at a precise point in the engine cycle. Valve timing is accomplished by coupling the valve operating cam shaft to the crank shaft by a gear train or by a gear and silent chain arrangement. The duration of valve opening, either for intake or exhaust is determined by the shape of the camshaft lobes. The time of valve events relative to piston position is determined by the relative position of the camshaft to the crankshaft when these two are permanently coupled together.

Ordinarily, this timing is not subject to adjustment as the proper timing is a design factor of the engine. The accumulation of errors resulting from production tolerances, or chain or gear wear, may make a fine adjustment in the timing desirable. The timing adjustment can be made by assembling the crank shaft and cam shaft gear with the gear teeth meshing in a position advanced or retarded from the design position. Such a method usually results in a timing change well beyond the desired amount of adjustment. Typically, one gear tooth displacement at the cam shaft results in an 8° change in valve timing, whereas the appropriate change for maximum performance might be only 1′ from the design value. There are currently available two means for making such a fine adjustment. One involves the use of an off-set key for fixing either the crank shaft or cam shaft timing gear to its shaft. Another means involves the use of eccentrically bored bushings in a bolt-on adaptor. Both means require that many parts be available in an assorted range of sizes, since the exact change in timing necessary for maximum performance is determined by experiment.

The present invention has as its principal object the provision of means for making selective adjustments in the valve timing of an internal combustion engine, which requires only a single replacement gear graduated for a plurality of adjustments. Other objects and many attendant advantages will become apparent as an understanding of the invention is gained through study of the following detailed description and the accompanying drawings.

Briefly, the invention comprises the provision in an automotive timing gear of a plurality of keyways for fixing the timing gear, which may be either cam shaft gear or crank shaft gear, to its shaft. A plurality of timing marks are spaced about the periphery of the gear and indicia are provided for correlating the various keyways with the proper timing mark.

In the drawings:

FIGURE 1 is an elevation of a portion of an engine block in which the valve timing train is exposed.

FIGURE 2 is an elevation of a typical stock timing gear.

FIGURE 3 is an elevation of the timing gear of the invention.

FIGURE 4 is an elevation of a modification of the timing gear of FIGURE 3.

Referring to FIGURE 1, the typical coupling between the engine crank shaft **10** and cam shaft **12** is shown. The ratio of crank shaft gear **13** to cam shaft gear **14** provides a one-half speed reduction between crank shaft speed and cam shaft speed for a 4-cycle engine. Coupling between the gears is provided by a sprocket chain **15**, although it is not unusual to provide directly meshing gears. The index or timing marks **16**, **16′**, indicate the proper positioning of cam shaft **12** relative to crank shaft **10**. One arrangement for assembling the gears provides for aligning the marks **16**, **16′** along the line joining the centers of shafts **10** and **12**. Another arrangement provides index marks **17** and **17′** related to marks placed on particular sprockets of chain **15**. The keyed connection between the gears and their respective shafts prevents slippage of the gears on the shafts and thereby maintains a selected valve timing throughout the life of the engine, excepting changes due to wear.

In FIGURE 2, the crank shaft gear **13** is shown disassembled from the engine. It may be seen that the index mark **16′** is separated from the gear keyway **18** by a particular angle referred to as a stock central angle. This angle determines the timing of the valve events relative to piston position. Valve timing is changed by varying the central angle. With a stock gear as shown in FIGURE 2, timing can be varied only in increments amounting to the pitch of the gear. A change in timing equal to the gear pitch may be far in excess of that required for optimum engine performance. For example a gear arrangement might comprise an 18 tooth crank gear meshing with a 36 tooth cam gear. The smallest timing increment obtainable by slipping a gear tooth would therefore amount to 10°.

FIGURE 3 illustrates the gear of the invention. The original stock central angle is retained as indicated by zero index mark **16′** and the keyway **18**. Additional timing marks as at **20**, **21** and **22** are spaced about the periphery of the gear. Timing marks are placed progressively about the gear each in association with a gear tooth. Each of the timing marks **20**, **21** and **22** are identified as to the amount of variation in timing angle. Spaced about the bore of the gear are a plurality of additional keyways **23**, **24** and **25**. Each keyway is spaced from the original keyway **18** an amount equalling the stock control angle plus an increment. Keyways **23**, **24** and **25** bear indicia correlated to the new timing marks **20**, **21** and **22**. For example, if it is desired to vary the timing in 1° increments mark **20** is identified as 1° and keyway **23** is likewise identified as 1°. In forming keyway **23**, the spacing between keyways **18** and **23** is made equal to the original stock central angle plus 1°. Similarly, mark **21** is identified as 2° and keyway **24** is identified as 2°. The spacing between keyway **24** and keyway **23** is then equal to the original stock central angle plus 1°, and the accumulated spacing between timing mark **21** and keyway **24** is, of course, 2°. Retardation in valve timing may be provided as well as advancement. In this case, moving counter clockwise about the periphery on the gear from the original timing mark **16′** a plurality of new timing marks **26**, **27** and **28** are provided. New keyways **30**, **31** and **32** are formed progressing counter clockwise from the original keyway **18**. Keyways **30**, **31** and **32** are spaced from original keyway **18** an amount equal to the stock central angle less the desired timing increment. For example, if 1° increments are desired, keyway **30** is spaced from the original keyway **18** an amount equal to the stock central angle less 1°. Keyway **31** is spaced from keyway **30** an amount equal to the original stock angle also less 1° for an accumulated total of 2° retardation in valve timing, and so on.

In use, the gears are assembled with aligned timing marks as may be directed originally for the engine except that the timing mark chosen is the one representing the desired variation in valve timing. The gear is assembled to the shaft using the keyway in the gear corresponding to the desired variation in valve timing.

The modification of FIGURE 4 differs from the gear of FIGURE 3 in the manner of attachment of the gear to its shaft. In this instance, the gear is fixed to its shaft by means of a pin passed through the hole **34** in the gear body. The gear is held in place by a bolt **35** passed through the hub of the gear and threaded into the gear. The principles of FIGURE 3 apply to the gear of FIGURE 4 requiring only that additional holes **36** and **38** be provided for receiving the shaft pin, and that these holes be spaced from the original hole **34** an amount equal to the increment in timing desired. New timing marks **41**, **41'** are spaced about the periphery of the gear, as in FIGURE 3.

The invention may be varied in minor respects from the embodiments specifically disclosed. It is to be understood therefore that the appended claims constitute the sole limitation upon the practice of the invention.

The invention claimed is:

1. A timing assembly for coupling a pair of shafts for rotation with a selected constant phase angle therebetween, comprising a first shaft, a first gear fixed to said first shaft and rotating therewith, a second shaft, a second gear on said second shaft, means coupling said first and second gears, and means fixing said second gear to said second shaft with selected phase displacement, said last named means including keying means on said second shaft and a plurality of keyways at various angular spacings in said second gear, the selection of one of which to cooperate with said shaft keying means determines the phase relationship between said first and second shafts.

2. A timing gear comprising a gear body, a reference keyway in said gear, a reference timing mark at the periphery of said gear body separated from said reference keyway by a first angle, a second timing mark at the periphery of said gear body separated from said reference mark by an angle equal to said first angle, a second keyway in said gear separated from said reference keyway by an angle equal to said first angle plus a second incremental angle and indicia enumerating said second incremental angle adjacent said timing mark and said second keyway.

3. A timing gear as claimed in claim **2** wherein the sum of said first angle and said second incremental angle is less than said first angle.

4. A timing gear comprising a gear, a reference keyway in said gear, a reference timing mark on said gear, a plurality of keyways spaced by a constant angle plus an incremental angle from said reference keyway, a plurality of secondary timing marks on said gear, the secondary marks being spaced from one another and from said reference mark by said constant angle, and indicia associated with each of said secondary marks and said plurality of keyways enumerating said incremental angle in the spacing of said plurality of keyways.

5. A timing gear assembly comprising a shaft, a gear fitted to said shaft, keying means securing said gear and said shaft against relative rotation, said means including a keyway on said shaft, a plurality of keyways on said gear, one of said plurality serving as reference, the remainder of said plurality being spaced by various angles from said reference, indicia adjacent each gear keyway identifying the spacing of the same from said reference keyway and a plurality of equally spaced index marks about the periphery of said gear, each of said index marks bearing indicia correlating each mark with a particular gear keyway.

6. A timing gear comprising a gear body, means for mounting said gear axially upon a shaft, a plurality of apertures in said gear body, one of which is selected for receiving means for securing the gear and the shaft upon which it is mounted against relative rotation, said apertures being spaced from one another by various unequal angles, a plurality of timing marks on said gear spaced apart by equal angles, and indicia for each of said marks and said apertures correlating a particular mark with a particular aperture and enumerating the angular spacing between said particular aperture and said particular mark.

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