July 5, 1966 S. J. KRANC ETAL 3,258,937

AUTOMATIC HYDRAULIC ENGINE TIMING DEVICE

Filed June 25, 1964

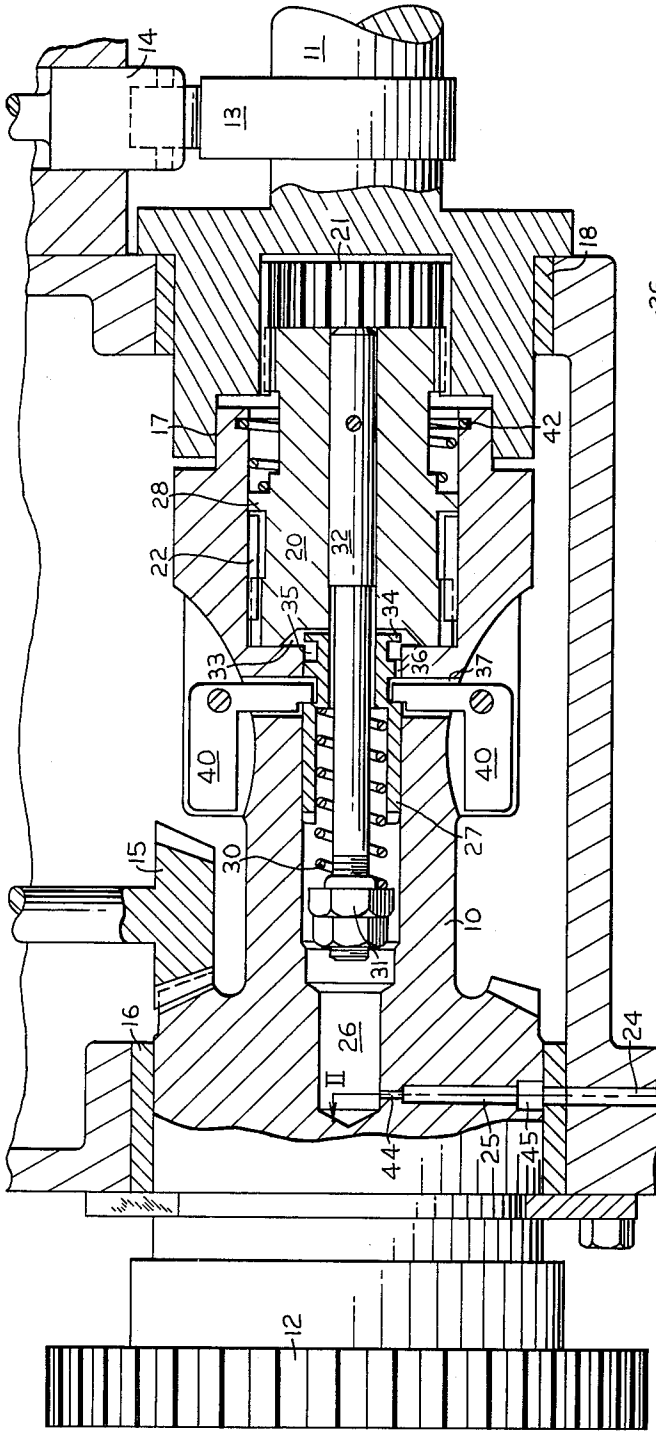


Fig-1-

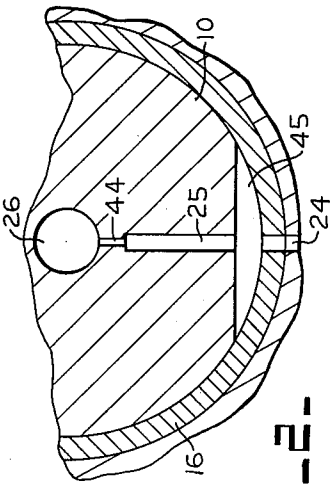


Fig-2-

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United States Patent Office

3,258,937

Patented July 5, 1966

3,258,937

AUTOMATIC HYDRAULIC ENGINE TIMING DEVICE

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Filed June 25, 1964, Ser. No. 377,923
2 Claims. (Cl. 64—25)

This invention relates generally to a coupling device between two shafts and more particularly to means for adjusting the angular phase relationship between such shafts for the purpose of varying the timing of an internal combustion engine or the like.

The general purpose of the present invention is set forth in our assignee's patent to Backlund et al. No. 2,977,778. The cyclic time of fuel ignition in an engine is preferably made variable so that it can be changed at different engine speeds to obtain the greatest efficiency in engine operation. Devices for accomplishing this are known, as for example the device shown in the patent referred to above wherein a driving shaft and a fuel pump cam shaft are connected by a spiral spline. Flyweights which move in response to engine speed adjust the spline longitudinally of the shafts to impart slight relative rotation to the cam shaft thus changing the timing of pump operation and fuel injection which controls the time of fuel ignition. Such general procedure and construction are well known in the art and it is also common practice to adjust such a spline connection by fluid pressure. The fluid is generally derived from the lubricating oil system or from a fuel transfer pump which is engine driven. The disadvantages common to most known timing adjusters of this type are their size and complexity and also a tendency toward rapid operation or quick response to variations in engine speed which cause them to operate erratically and tend to hunt rather than to act smoothly and positively.

It is the object of the present invention to provide a relatively small simple and positively acting automatic hydraulic engine timing device which overcomes the disadvantages referred to above.

The manner in which the object of the present invention is attained is set forth in detail in the following specification wherein reference is made to the accompanying drawing disclosing a preferred form of the invention.

In the drawing:

FIG. 1 is a central longitudinal sectional view of an engine timing device embodying the present invention; and

FIG. 2 is a fragmentary section taken on the plane represented by the line II—II in FIG. 1.

FIG. 1 shows the timing device of the present invention between a driving shaft **10** and a driven shaft **11**. In this case, the driving shaft is formed integrally with a timing gear **12** which is one gear of a conventional engine driven gear train. The driven or cam shaft **11** has cams, one of which is shown at **13**, to actuate piston-type fuel pumps, the cam follower mechanism of one such pump being illustrated at **14**. In the assembly illustrated, a governor (not shown) is also driven from the shaft **10** as through a bevel gear **15**. The operation of the governor however has no bearing upon the present invention.

The shaft **10** is supported by a bearing **16** at one end and at the opposite end is piloted as at **17** in a recess formed in an enlarged end of the shaft **11**. This end of the shaft **11** is supported in a bearing **18**. An adjustable driving connection between the shafts **10** and **11** is provided by an internal coupling element **20** which has a splined connection disposed in recesses in the ends of the shafts. Splines **21** connecting the coupling element with the shaft **11** are straight and permit axial movement of the coupling element. Splines shown at **22** connect the coupling element with the shaft **10** and are of helical configuration so that axial movement of the coupling produces slight relative rotation of radial adjustment of the two shafts changing the position of the fuel pump cam and changing its timing in the engine cycle. Axial adjustment of the coupling **20** is effected by pressure of oil against its end which is disposed within the shaft **10**. Oil from a source such as an engine driven lubricating oil pump (not shown) enters through a passage **24** in the housing a radial passage **25** in the shaft and an axial passage **26** which communicates through a valve spool **27** with the recess in which the coupling **20** is received. The coupling has a radial flange **28** intermediate its ends which has a sliding fit with the bore in which it is received so that the coupling element acts in the manner of a piston within the bore.

The valve spool **27** is normally held in its open or low engine speed position, as shown, by a spring **30** which acts between the spool and a seat formed by nuts **31** on the end of a shaft **32** secured to the coupling **20** as shown. This spring **30** also acts through the shaft **32** to hold the coupling in the position shown which is its low engine speed position. Oil entering the bore **26** of the shaft **10** passes through the interior of the spool **27** and into a cavity **33** in the end of the piston-like coupling **20**. At low speed it passes a land of the valve shown at **34**, thence through a circumferential groove **35** and a longitudinal groove **36** to an opening **37** in the shaft from which it can escape through passages (not shown) to the engine crankcase.

Two flyweights **40** are pivoted in suitable recess formed in the shaft **10** and engage a groove circumscribing the valve element **27** so that outward movement of the flyweights resulting from increase in engine speed moves the valve spool to its closed position or to the left as shown in FIG. 1. As the land **34** tends to close the end of the bore in which the spool slides, the pressure of oil which cannot escape from the cavity **33** moves the coupling toward the right to advance the timing of the fuel pump cam.

A coil spring **42** augments the action of spring **30** in urging the coupling member **20** toward the left. The use of two springs is desirable in order to avoid enlarging the device to accommodate a spring of greater size in place of the spring **30**. Heavy spring force tends to dampen the action as the coupling is moved to the right by oil pressure and also requires greater oil pressure which tends to insure against bubbles of air becoming entrapped in the oil and reducing the desirable positive action. While increase in the size of spring **30** would tend to move the coupling member **20** toward the left it would also produce greater opposition to the flyweight action which closes the valve. Thus the use of spring **42** which augments spring **30** in opposing oil pressure eliminates the necessity of larger flyweights thus maintaining the overall size and weight of the timing device at a desirable minimum.

When engine speed is reduced, both springs **30** and **42** tend to return the coupling element **20** to the low speed position shown forcing oil which held it in the high speed position out through the opening provided by the low speed position of the valve member **27**. In order to prevent this return from occurring too rapidly and to prevent hunting due to surges of pressure in the lubricating oil system and other causes, a quantity of oil is permitted to occupy the space on the side of the coupling member **20** in the recesses where the splines **22** are provided. When the coupling member has been moved to the right, oil occupies this annular recess and completely surrounds the splines. Return of the coupling member toward the

left will necessitate oil being forced out of this recess by the flange **28** and some of the oil being forced through the interstices between the meshing splines. This produces effective cushioning and damping action and is made possible by the relative positions of the splines and the flange **28**.

The oil cavities are small and the annual discharge orifice provided by the valve element **27** is limited in size so that it could be possible for pressure from the lubricating oil system to build up faster than it is discharged through this valve orifice thus causing movement of the coupling members **20** even at low engine speed. To insure against excessive supply of oil to the timing device, it is limited as by a restriction in the passage **25** shown at **44**. Were such a restriction too small, it would be easily clogged by particles of foreign matters in the oil. Consequently the volume of oil is further limited by permitting oil to flow from passage **24** to passage **25** intermittently rather than continuously. This is accomplished by providing a slot of limited length as shown at **45** in FIG. 2 in the shaft **10** and in a position to register with the passage **24** intermittently as the shaft rotates.

We claim:

1. A means to adjust the angular phase relationship between rotary driving and driven parts in an engine timing train which comprises a coupling element slidably connected to both parts and having a helical spline connection with one part to vary the angular phase upon sliding adjustment thereof, such parts being recessed to receive and confine said coupling element for sliding adjustment, means to direct fluid under pressure to one end of the confining recess, normally open valve means relieving fluid pressure from said end, flyweights carried by one of said rotating parts to close said valve means upon increase in rotary speed to entrap pressure at said end and effect sliding of said coupling element away from a normal slow speed position, resilient means opposing action of the flyweights and tending to return the coupling to normal, a second resilient means tending to return the coupling to normal, and means to damp the return movement of said coupling, the dampening means including means to trap fluid which actuates the coupling and force it through interstices of the helical spline.

2. The combination of claim **1** with means to restrict the supply of fluid under pressure to said one end of the confining recess to a quantity capable of being full relieved by said valve means.

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