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HYDRAULIC TIMER

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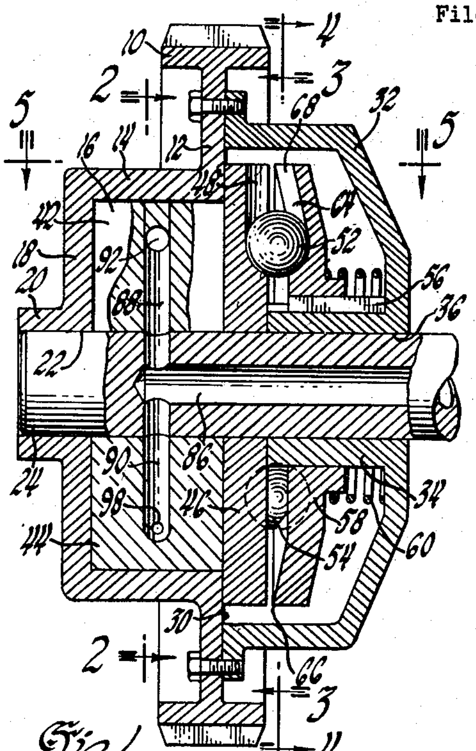

Fig. 1

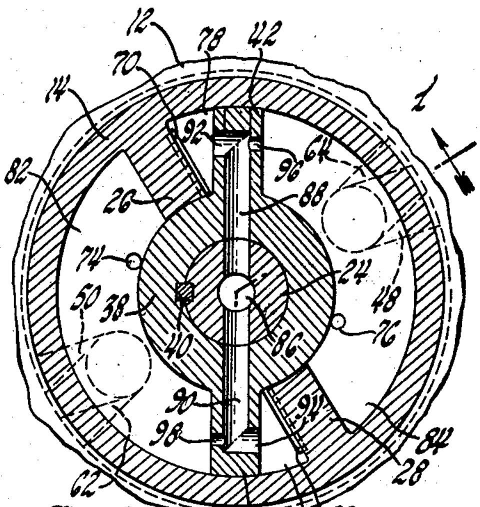

Fig. 2

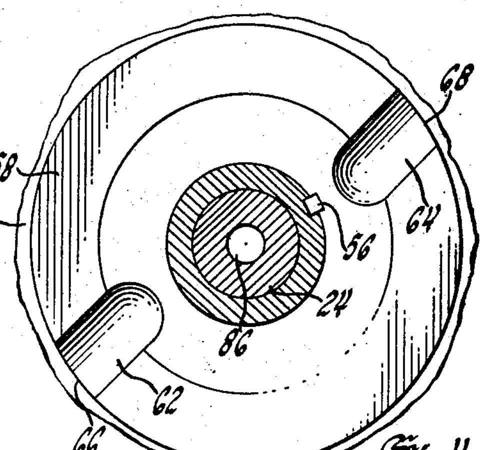

Fig. 4

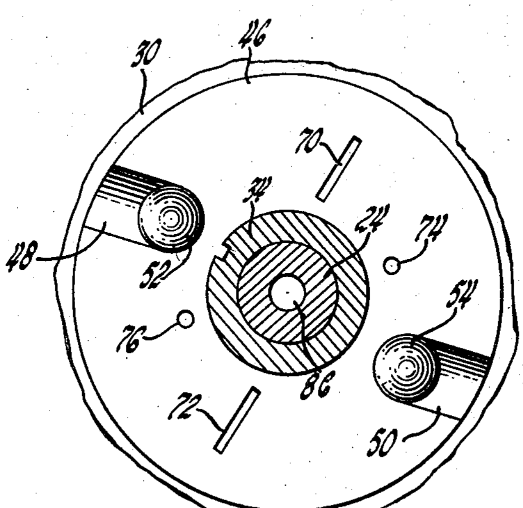

Fig. 3

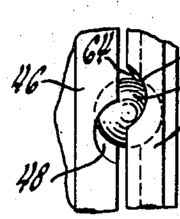

Fig. 5

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HYDRAULIC TIMER

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The invention relates to a hydraulic advance and retard mechanism and more particularly to such a mechanism which automatically advances and retards the cam shaft of an internal combustion engine in relation to the speed of the engine. The invention is also applicable to other mechanisms in which one member is to be rotated relative to a second member while torque is being continuously transmitted between the two members.

Advance and retard mechanisms previously proposed have included mechanical linkages between the two members which may be either hydraulically, mechanically or otherwise actuated. There are several inherent advantages in the use of a hydraulically actuated mechanism, however the mechanical advance and retard devices which are remotely actuated by fluid pressure do not utilize these advantages to the fullest extent. When the mechanical linkage is replaced by a hydraulic linkage, for example, shock loads are materially reduced and the complexity of the entire mechanism is decreased.

The invention includes a hydraulic advance and retard mechanism which is hydraulically actuated and connects two members through a fluid drive while a mechanical linkage is maintained in reserve which will continue to drive the controlled member should the hydraulic system become inoperative. The hydraulic actuation system is controlled by a governor sensitive to the speed of the engine, and this governor is preferably formed as an integral part of the advance and retard mechanism.

In the drawing:

Figure 1 illustrates an advance and retard mechanism embodying the invention and having parts broken away and in section.

Figure 2 is a partial view taken in the direction of arrows 2—2 of Figure 1 and having parts in section.

Figure 3 is a partial view taken in the direction of arrows 3—3 of Figure 1 and having parts in section.

Figure 4 is a partial view taken in the direction of arrows 4—4 of Figure 1 and having parts in section.

Figure 5 is a fragmentary view of a portion of the governor included in the mechanism of Figure 1 and taken in the direction of arrows 5—5 of Figure 1.

The advance and retard mechanism may be hydraulically actuated to advance a member from normally retarded position or to retard a member from a normally advanced position. The device shown in the drawing advances one member from a normally retarded position relative to a second member as the engine speed increases. Some engines, due to design and operating characteristics, give more satisfactory performance results by having the camshaft in a normally advanced position at idle speeds and retarding it as the engine speed increases. The mechanism embracing the invention may be readily modified to obtain this result while remaining within the scope of the invention.

A drive gear 10, which may be driven by the timing gears or equivalent linkage in timed relation to the engine crank shaft, may be formed with a radially extending web 12 and a cylindrical hub 14. Hub 14 is preferably

formed with an axially located cavity or chamber 16 which is defined by a radial wall 18 and the cylinder formed by hub 14. Web 12 and wall 18 are axially spaced and positioned adjacent either end of the cavity 16, web 12 extending radially outward from the cavity and wall 18 providing an end cover for the cavity. Wall 18 may be provided with a boss 20 which is axially drilled and reamed to form a bearing surface 22. A driven member 24, which may be the cam shaft of an internal combustion engine, is rotatably received within hub 14 and is in contact with bearing surface 22 for support by boss 20.

A plurality of equi-spaced driving vanes may be integrally formed with cylindrical hub 14 and extend radially inward in cavity 16. While two or more vanes may be used, only two vanes 26, 28 are illustrated for simplicity. Vanes 26 and 28 extend axially within cavity 16 from radial wall 18 to a transverse plane defined by the outer edge 30 of web 12. These vanes also extend inwardly from cylindrical hub 14 to a point radially spaced intermediate bearing surface 22 and hub 14. A cover 32 may be suitably secured to web 12 and extend axially in a direction opposite hub 14 and be provided with an inwardly extending hub 34. An internal bearing surface 36 is formed in hub 34 and is adapted to rotatably receive driven shaft 24. Bearing surfaces 22 and 36 therefore provide axially spaced supports for the shaft 24.

The portion of shaft 24 which passes through cavity 16 may have an annular hub 38 secured thereto by any convenient means such as key 40. Integrally formed with or secured to hub 38 are two or more equi-spaced driven vanes, the number of such vanes being equal to the number of driving vanes formed with cylindrical hub 14. Two such driven vanes 42 and 44 are illustrated. The external diameter of hub 38 is substantially equal to the internal diameter formed by the inwardly extending ends of vanes 26 and 28. The outer ends of vanes 42 and 44 are substantially equal to the internal diameter of that portion of hub 14 which defines cylindrical cavity 16. Vanes 42 and 44 are therefore circumferentially spaced from and coaxial with vanes 26 and 28 and are comparable to rotary pistons within arcuate chambers.

Cavity 16 is provided with a cover 46 which is axially positioned adjacent the outer surface 30 of web 12 and extends inwardly into rotatable engagement with shaft 24. Cover 46 may be positioned adjacent the edges of driven vanes 42 and 44 and be rotatable with respect to these vanes, web 12 and shaft 24.

The surface of cover 46 opposite the surface adjoining vanes 42 and 44 may be provided with two or more depressions which are preferably each formed with an arcuate cross section and are adapted to receive a governor ball-type weight within each depression. Two depressions 48 and 50, which are adapted to respectively receive governor ball weights 52 and 54, are illustrated. The depressions 48 and 50 extend radially outward from circumferentially spaced positions intermediate shaft 24 and cover 32 and are inclined in the radial transverse plane so that their extended center lines do not pass through the axis of shaft 24. The depressions are inclined in the same circumferential direction as is best illustrated in Figure 3.

Hub 34 of cover 32 may be provided with an external spline or key 56 which is adapted to receive a governor driving plate 58 on which an internal spline or a keyway is formed to cooperate with external spline or key 56. Plate 58 is therefore non-rotatably mounted on hub 34 and may be axially slidable on spline or key 56. A compression spring 60 may be provided between plate 58 and cover 32 to urge plate 58 axially toward cover 46. The side of plate 58 adjacent cover 46 is provided with depressions 62 and 64 which are similar to depressions

48 and 50, but are oppositely inclined in the radial transverse plane. The opposite inclinations are best illustrated in Figure 2. The outer ends 66 and 68 of depressions 62 and 64 are axially spaced from the inner ends of these depressions in a direction toward cover 46, thus causing the bottom of depressions 62 and 64 to form an acute angle with the bottom of depressions 48 and 50. The apex of the angle so formed is radially outward of the depressions as is best shown in Figure 1.

Cover 46 and plate 58 in combination with the ball weights 52 and 54, which ride in the respective depressions formed in the cover and the plate, constitute a centrifugal governor which is responsive to engine speed. When cover 32 is rotated through gear 10 and web 12, plate 58 is driven at the same angular velocity, driving ball weights 52 and 54 and cover 46. As the speed of plate 58 increases, ecntrifugal forces acting on the ball weights 52 and 54 overcome the relatively inclined planes presented by the bottoms of depressions 62 and 64 and the force exerted by spring 60. The weights move radially outward in the depressions formed in cover 46 and plate 58 in response to these forces. Since the depressions are oppositely inclined, this radial movement of the weights causes rotational movement of cover 46 relative to plate 58.

Cover 46 is provided with a plurality of vane positioning ports which are equal in number to the vanes 26 and 28, two such ports 70 and 72 being illustrated. While these ports are shown as having a rectangular cross section, they may be formed with variable areas to obtain advance and retard actuation of the shaft 24 at rates other than that obtained by rectangular ports or orifices. Oil and air-escape orifices are also provided in cover 46 and are so circumferentially spaced from ports 70 and 72 that any of the vanes 26, 28, 42 and 44 may be positioned between any two adjacent ports and orifices without covering either. Two such orifices 74 and 76 are shown. The chamber 78 formed by adjacent vanes 26 and 42 and the chamber 80 formed by adjacent vanes 28 and 44 act as fluid receiving pockets. The chambers 82 and 84, respectively formed by vanes 26, 44 and 28, 42, act as torque damping chambers.

Shaft 24 is provided with a centrally drilled fluid supply passage 86 which terminates radially inward from hub 38. Fluid under pressure, which may be engine lubricating oil, is supplied to this passage. Any fluid pressure source is suitable so long as it delivers a sufficiently high pressure at all engine speeds to overcome the torque transmitted to the driving shaft. Since the mechanism's timing action is not a function of the pressure to obtain hydraulic governor actuation, the pressure need not vary with engine speed. Radially extending fluid passages 88 and 90 are drilled through shaft 24, hub 38 and vanes 42, 44 and connect at their inner ends with axial passage 86 in shaft 24. Passages 88 and 90 terminate radially inward from the outer ends of vanes 42 and 44. Tangentially extending passages 92 and 94 are drilled in vanes 42 and 44 transversely of the axis of hub 38 and respectively connect passages 88 and 90 with chambers 78 and 80. Orifices 96 and 98 are provided for filling torque damping chambers 82 and 84 and are appreciably smaller in cross section area than passages 92 and 94. Orifices 96 and 98 connect passages 88 and 90 with torque damping chambers 82 and 84.

When cover 46 is rotated relative to plate 58 by the centrifugal action of the governor ball weights, vane-positioning ports 70 and 72, which are normally uncovered, are rotated relative to vanes 26 and 28 until the fluid under pressure, which is supplied to chambers 78 and 80 through the above-described passages, is prevented from escaping from those chambers due to the restriction of the positioning ports by vanes 26 and 28. This causes a build-up of fluid pressure in chambers 78 and 80 which acts on the respective vanes defining those chambers and causes vanes 42 and 44 to rotate relative to vanes 26 and 28. This rotary movement is transmitted through hub 38 to shaft 24 and the shaft is therefore rotated relative to driving gear 10. Fluid under pressure is continually delivered through passages 96 and 98 to torque-damping chambers 82 and 84. This fluid, and any air trapped in the damping chambers, is vented through orifices 74 and 76. As the speed of the engine increases, pockets or chambers 78 and 80 are enlarged as dictated by the vane-positioning ports 70 and 72, thereby advancing the shaft 24 relative to the drive member 10 in accordance with the speed of the engine until an equilibrium condition is again obtained.

Should the fluid pressure within chambers 78 and 80 at any time be insufficient to transmit torque from the gear 10 to shaft 24, vanes 42 and 44 will approach and contact vanes 26 and 28 and a mechanical linkage will be affected. This reserve drive permits the shaft 24 to be driven even though the advance and retard system is inoperative.

The mechanism for hydraulically adjusting the camshaft timing may be readily substituted in the space normally occupied by the camshaft drive gear with a minimum amount of changes. Oil under pressure is normally supplied to a passage in the camshaft corresponding to passage 86 in order to lubricate the cams, eliminating the need to provide a new fluid supply system. The mechanism will effectively control the camshaft timing through an engine speed sensitive hydraulically adjustable drive. Should the fluid pressure supply be interrupted, the drive and driven vanes will engage and continue to drive the camshaft in the position normally assumed at engine idle. This mechanical safety feature permits the engine to be operated as necessary without undue strain on the system.

What is claimed is:

1. Means for advancing and retarding an engine camshaft with respect to an engine crankshaft, said means including a drive member and a driven member forming a fluid pressure chamber therebetween, said drive member being operatively connected for rotation with said crankshaft and said driven member being operatively and drivingly connected with said camshaft, and crankshaft speed responsive means for controlling the pressure of fluid in said chamber to advance and retard said camshaft with respect to said crankshaft.

2. In a mechanism for arcuately displacing a driven member relative to a drive member, a speed responsive device having drive and driven elements, said drive element being secured for rotation with said drive member, means hydraulically connecting said drive member with said driven member, a source of hydraulic pressure and control means actuated by said speed responsive device for controlling said pressure in said hydraulic connecting means whereby said driven member is arcuately displaced relative to said driving member.

3. An advance and retard mechanism for a camshaft in an internal combustion engine including a camshaft drive gear adapted to be driven by the crankshaft of said engine, said gear having a hub with a variable volume arcuate chamber formed therein, said camshaft extending coaxially through said hub and having a piston secured thereto, said piston being adapted to move in said chamber, means for supplying fluid under pressure to said chamber, a chamber cover having a chamber exhaust control orifice, said cover being coaxial with and rotatable relative to said gear and said camshaft, and means responsive to the speed of said drive gear for arcuately positioning said cover and said orifice relative to said chamber whereby the volume of said chamber is varied in accordance with drive gear speed.

4. In combination in a hydraulic timing device having drive and driven members, a variable volume chamber adapted to contain hydraulic fluid for transmitting torque hydraulically to said driven member from said drive member and control means responsive to the speed of

said driving member for controlling said hydraulic fluid in said chamber.

5. A hydraulically actuated positioning mechanism for arcuately positioning a driven member relative to a drive member, said mechanism including a first variable volume hydraulic chamber having fluid therein for transmitting torque from said drive member to said driven member and a second variable volume hydraulic chamber having fluid therein for damping torque fluctuations between said drive member and said driven member and means for controlling the volumes of said chambers whereby said driven member is arcuately positioned relative to said drive member in accordance with the speed of said drive member.

6. A hydraulically actuated timing mechanism including driving vanes and driven vanes and a source for delivering hydraulic fluid under pressure intermediate said vanes and means for automatically controlling the application of said fluid under pressure intermediate said vanes to relatively displace said driving vanes and said driven vanes.

7. In combination, a driving member having an arcuate chamber formed therein, a driven member having a rotary piston positioned for arcuate movement within

said chamber and means for moving said piston in said chamber in relation to the speed of said driving member.

8. In an advance and retard mechanism between two rotatable members, first means for hydraulically advancing and retarding and driving one of said members relative to the other of said members in accordance with the speed of one of said members and second means adapted to drive said one member by said other member when said first means is inoperative.

References Cited in the file of this patent

UNITED STATES PATENTS

1,957,181	Mitchel	May 1, 1934
1,980,379	Burnett	Nov. 13, 1934
1,987,307	Niven	Jan. 8, 1935
2,057,354	Withers et al.	Oct. 13, 1936
2,072,474	Helming	Mar. 2, 1937
2,121,560	Duncan	June 21, 1938
2,159,017	Duncan	May 23, 1939
2,162,243	Browne	June 13, 1939
2,785,668	Dehmer	Mar. 19, 1957

FOREIGN PATENTS

841,286	France	Feb. 1, 1939