Aug. 20, 1935. H. L. DUNCAN 2,011,571

AUTOMATIC SPARK AND VALVE TIMING CONTROL

Filed May 20, 1929 3 Sheets-Sheet 1

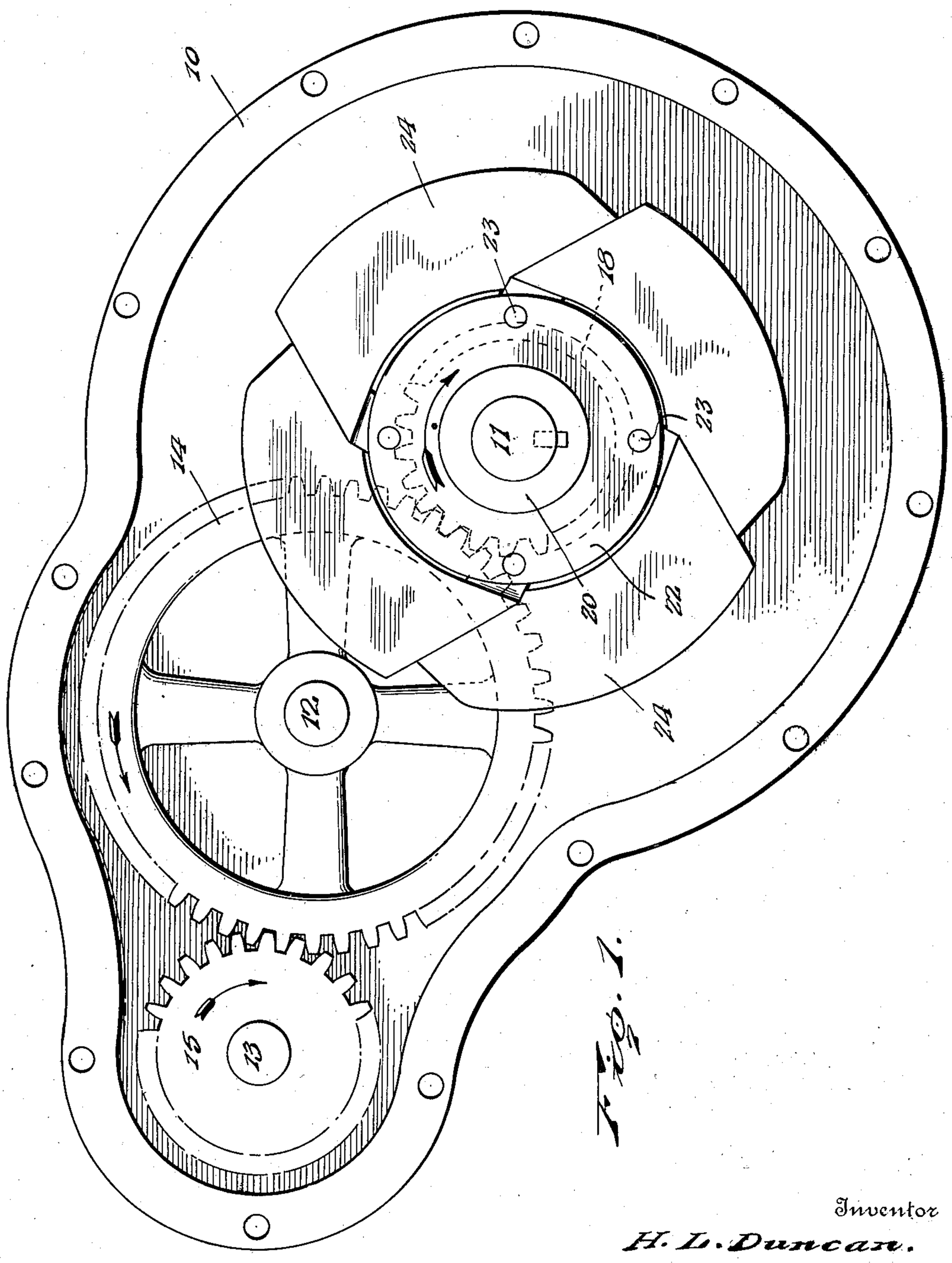

Fig. 1.

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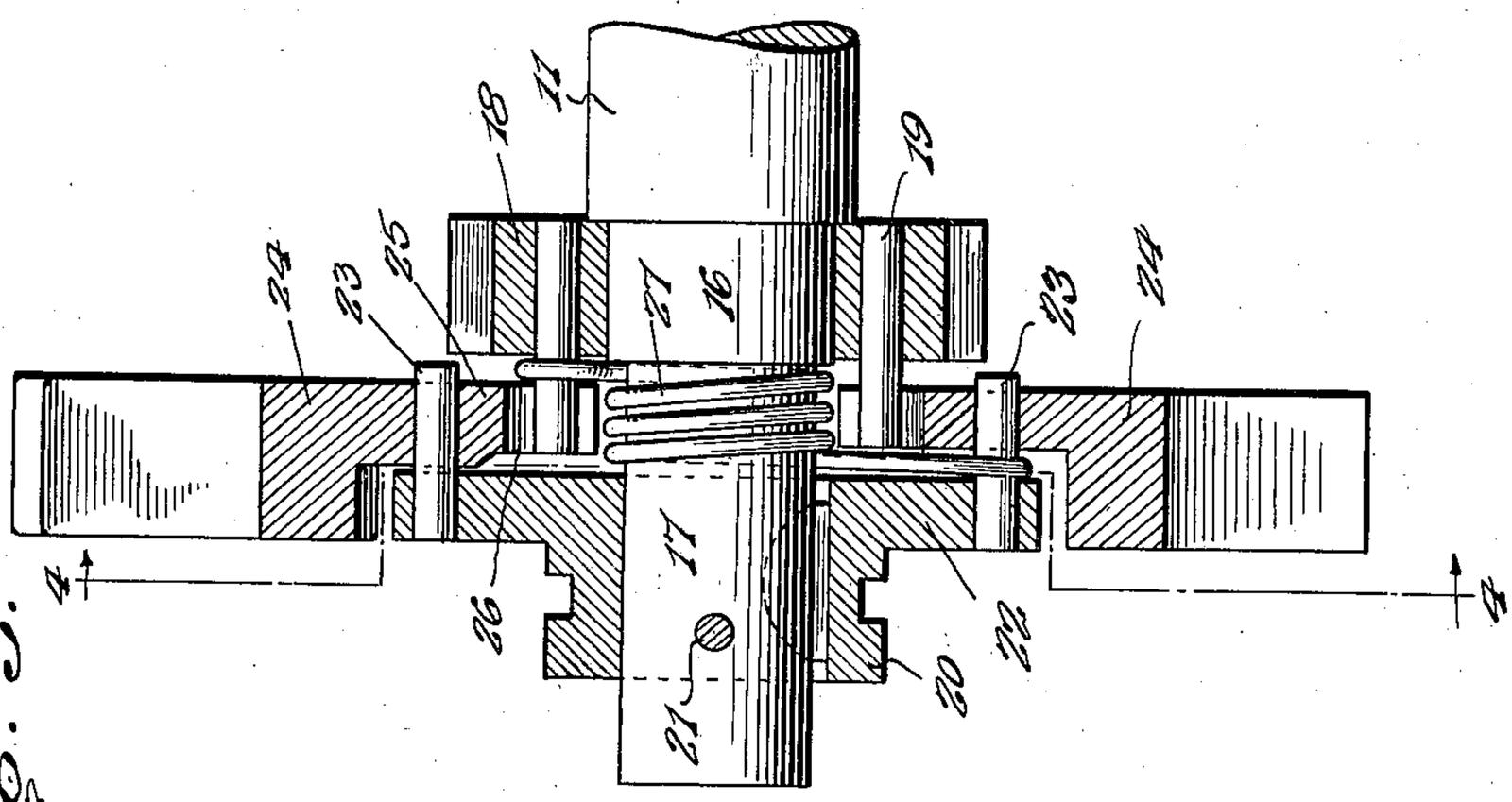

Fig. 3.

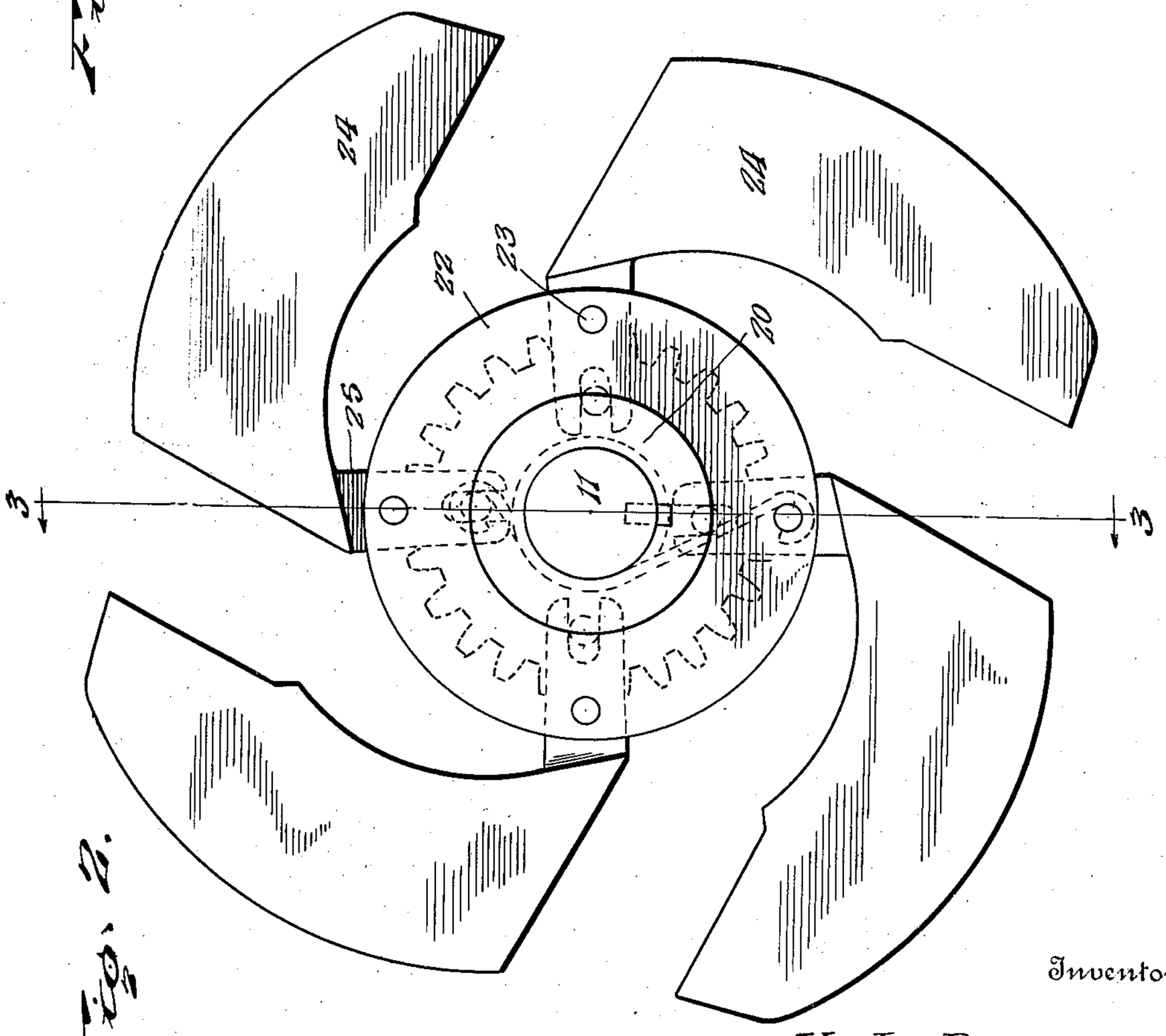

Fig. 2.

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Fig. 5.

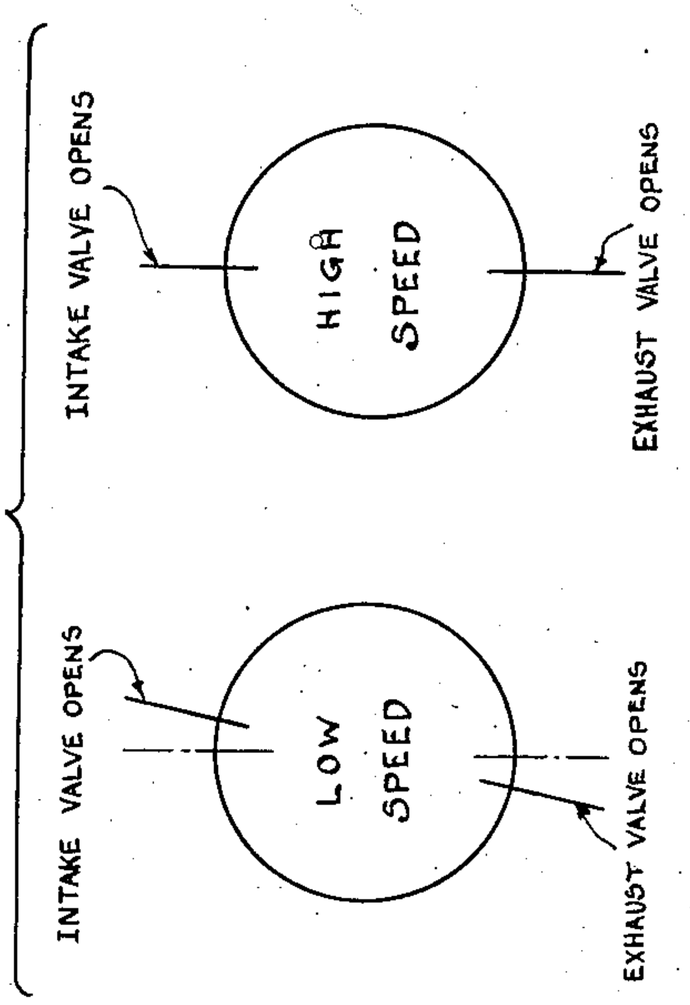

Fig. 6.

Fig. 4.

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2,011,571

AUTOMATIC SPARK AND VALVE TIMING CONTROL

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Application May 20, 1929, Serial No. 364,609

6 Claims. (Cl. 123—90)

This invention relates to an improved mechanism for automatically varying both the ignition and valve timing of an internal combustion engine in relation to the speed of the motor.

The invention seeks, among other objects, to provide a mechanism which will materially increase the flexibility of the engine, will increase the power and speed thereof, will tend to reduce the formation of carbon in the engine cylinders and will, at the same time, effect a saving in consumption of fuel.

A further object of the invention is to provide a mechanism which may be incorporated in an engine as originally built or may be applied as an attachment to engines already made.

And the invention seeks as a still further object, to provide a mechanism which will function as a counter-balance to the engine crank shaft.

Other objects of the invention not specifically stated in the foregoing will appear during the course of the following description.

In the drawings:

Figure 1 is an elevation showing the timing gear case and gears of a conventional motor vehicle engine and showing my improved mechanism in position on the engine crank shaft, the cover plate of the gear case being removed,

Figure 2 is an elevation showing the governor arms of the mechanism extended,

Figure 3 is a vertical sectional view on the line 3—3 of Figure 2, looking in the direction indicated by the arrows,

Figure 4 is a vertical sectional view on the line 4—4 of Figure 3, looking in the direction indicated by the arrows, the governor weights, however, being shown retracted,

Figure 5 is a diagrammatic view showing how the valve timing is advanced by the mechanism, and

Figure 6 is a diagrammatic view showing how the ignition timing is advanced by the mechanism.

Referring now more particularly to the drawings, the numeral 10 indicates the usual timing gear case of a conventional internal combustion engine. Projecting at their forward ends into the gear case are the engine crank shaft 11, the cam shaft 12 and the distributor shaft 13. The cam shaft 12 is provided with the usual cams for operating the intake and exhaust valves of the engine in the customary manner and similarly, the shaft 13 operates the distributor in the usual manner. However, it has been deemed unnecessary to show this mechanism. Fixed to the cam shaft 12 is a gear 14 and meshing with said gear is a gear 15 fixed to the distributor shaft 13, said gears being of the usual two to one ratio.

As shown in Figure 3, the forward end of the crank shaft 11 is provided with stepped portions 16 and 17 and in accordance with the present invention, I provide a drive gear 18 which rotatably fits the portion 16 of the shaft, this gear being loose on the shaft. Fixed to the gear at suitably spaced points is a plurality of forwardly projecting pins 19, any approved number of which may be employed.

Keyed upon the reduced portion 17 of the crank shaft in spaced parallel relation to the gear 18 is a governing collar 20 which is also secured to the shaft by a pin 21. This collar is provided at its inner end with a radial flange 22 and fixed to said flange is a plurality of rearwardly projecting pins 23 equi-distantly spaced circumferentially of said flange. In the present instance I have shown the use of four of said pins to accommodate an equal number of governor weights 24. However, the number of these weights may be varied as found most desirable. As shown in Figure 4, the weights are curved to fit, when retracted, about the periphery of the flange 22 of the collar 20, and projecting from the inner ends of the weights are arms 25 which are apertured to freely receive the pins 23 so that the weights are thus mounted to rock upon said pins. Formed on the inner ends of the arms are yokes 26 which straddle the forward end portions of the pins 19 of the gear 18.

Freely surrounding the reduced portion 17 of the crank shaft 11 to lie between the gear 18 and the collar 20 is a coil spring 27. As seen in Figure 4 this spring is provided at its ends with hooks 28 one of which engages the forward end portion of one of the pins 19 of the gear 18 while the other of said hooks engages the rearward end portion of one of the pins 23 of the collar 20. Thus, as will be seen, this spring will, since the collar is fixed to the crank shaft, tend to counter-rotate the gear 18 for retracting the governor weights 24 and will normally hold said weights retracted. As will be perceived, the gear 18 and associated parts may be readily embodied in the construction of an engine as originally manufactured or may be readily applied as an attachment to the forward ends of the crank shafts of engines already in use. As is usual, the gears 14 and 18 are of a two to one ratio.

The spring 27 will, at low engine speeds, hold the governor weights 24 retracted so that said weights will hug the flange 22 of the collar 20

or, at best, will be swung outwardly by centrifugal force comparatively little. Thus, as shown at the left of Figure 6, the ignition will be retarded. Considering one cylinder of the engine as typical, the time of opening of the intake and exhaust valves of the cylinder will, as shown at the left of Figure 5, be similarly retarded. As the speed of the engine is accelerated, the governor weights **24** will, as shown in Figure **2**, be swung outwardly with the result that the gear **18** will be advanced in clockwise direction about the crank shaft **11**. Accordingly, the gear **14** will be turned by the gear **18** for advancing the cam shaft **12** while the gear **15** will in turn, be rotated by the gear **14** for advancing the distributor shaft **13**. Considering one cylinder of the engine as typical, the time of opening of the intake and exhaust valves of the cylinder, as shown at the right of Figure 5, will be advanced while as shown at the right of Figure 6 the ignition will also be advanced. As will be appreciated, the governor weights **24** will, as the speed of the engine is decreased, be retracted for retarding the valve action as well as also retarding the ignition. Thus, as will be seen, the mechanism will function to simultaneously advance or retard the valve action and ignition in direct relation to the speed of the motor. Accordingly, as the speed of the motor is increased, the fuel gases will be admitted to the cylinders progressively earlier, while the exhaust gases will be likewise permitted to escape progressively earlier, the ignition being timed in step with the valve action. As will be appreciated, the flexibility of the motor will thus be greatly increased while overheating will be prevented. Furthermore, due to the earlier exhaust of the burnt fuel gases, very little if any, back pressure in the engine cylinders will be present with the result that an increase in power will also be obtained.

Attention is now directed to the fact that by associating the governor weights **24** with the crank shaft, these weights will tend to counterbalance said shaft. When the speed of the engine is suddenly accelerated, the weights will of course, due to their inertia, tend to absorb the shock and similarly when the speed of the engine is suddenly checked, the governor weights will tend to absorb the shock on the crank shaft.

Having thus described the invention, I claim:

1. As a means for controlling the timing of the inlet and exhaust valves of an internal combustion engine, wherein the timing is responsive to the speed of the crank shaft, the combination with the crank and cam shafts, of speed responsive means carried by the crank shaft and operatively connected with the cam shaft, said means including a speed responsive device carried by the crank shaft and bodily movable therewith rotatively in permanent synchronism with the crank shaft speed of rotation and additionally movable in reaction to such speed to provide the variable speed-responsive action of the device, and an element forming a part of the cam shaft driving means and carried by and loose relative to the crank shaft to permit rotation relatively to the crank shaft, said element being operatively connected with the speed responsive device to be driven thereby, the operative relation between the device and element being such that the element is shifted rotatively on its axis by position changes of the device provided by speed changes of the crank shaft to thereby change the timing activity of the cam shaft, whereby the speed responsive device is positioned remote from the cam shaft and is directly responsive to the speed of the crank shaft.

2. As a means for controlling the timing of the ignition and the inlet and exhaust valves of an internal combustion engine, wherein the timing is responsive to the speed of the crank shaft, the combination with the crank, cam and timer shafts, of speed responsive means carried by the crank shaft and operatively connected with the cam and timer shafts, said means including a speed responsive device carried by the crank shaft and bodily movable therewith rotatively in permanent synchronism with the crank shaft speed of rotation and additionally movable in reaction to such speed to provide the variable speed-responsive action of the device, and an element forming a part of the cam and timer shaft driving means and carried by and loose relative to the crank shaft to permit rotation relatively to the crank shaft, said element being operatively connected with the speed responsive device to be driven thereby, the operative relation between the device and element being such that the element is shifted rotatively on its axis by position changes of the device provided by speed changes of the crank shaft to thereby change the timing activity of the cam and timer shafts, whereby the speed responsive device is positioned remote from the cam and timer shafts and is directly responsive to the speed of the crank shaft.

3. As a means for controlling the timing of the ignition and the inlet and exhaust valves of an internal combustion engine, wherein the timing is responsive to the speed of the crank shaft, and wherein the valve movements are controlled by the cam shaft, the combination with the crank, cam and timer shafts, of speed responsive means carried by the crank shaft and operatively connected with the cam and timer shafts, said means including a centrifugal governor carried by the crank shaft and bodily movable therewith rotatively in permanent synchronism with the crank shaft speed of rotation and additionally movable in reaction to such speed to provide the variable speed-responsive action of the device, and an element forming a part of the cam and timer shaft driving means and carried by and loose relative to the crank shaft to permit rotation relatively to the crank shaft, said element being operatively connected with the centrifugal governor to be driven thereby, the operative connection between the governor and element being such that the element is shifted rotatively on its axis by position changes of the crank shaft to thereby change the timing activity of the cam and timer shafts, whereby the governor is positioned remote from the cam and timer shafts and is directly responsive to the speed of the crank shaft.

4. As a means for controlling the timing of the ignition and the inlet and exhaust valves of an internal combustion engine, wherein the timing is responsive to the speed of the crank shaft, and wherein the valve movements are controlled by the cam shaft, the combination with the crank, cam and timer shafts, of speed responsive means carried by the crank shaft and operatively connected with the cam and timer shafts, said means including a centrifugal governor carried by the crank shaft and bodily movable therewith rotatively in permanent synchronism with the crank shaft speed of rotation and additionally movable in reaction to such speed to provide the variable speed-responsive action of the device, an element forming a part of the cam and timer shaft driv-

ing means and carried by and loose relative to the crank shaft to permit rotation relatively to the crank shaft, said element being operatively connected with the centrifugal governor to be driven thereby, the operative connection between the governor and element being such that the element is shifted rotatively on its axis by position changes of the crank shaft to thereby change the timing activity of the cam and timer shafts, whereby the governor is positioned remote from the cam and timer shafts and is directly responsive to the speed of the crank shaft, and a resistance means operatively connecting the governor and element and variable as to power by element shifting movements, said latter means and the centrifugal force characteristic of the governor cooperating to cushion the advance of the element in presence of rapid increase of speed of the crank shaft and to cause increased responsiveness of the governor to decrease in speed of the crank shaft, whereby vibrations due to speed changes of the crank shaft will be dampened.

5. In an internal combustion engine, the combination of a crank shaft, a cam shaft, a distributor shaft, tappet inlet and exhaust valves actuated by the cam shaft, a distributor actuated by the distributor shaft, a gear fixed to the distributor shaft, a gear fixed to the cam shaft meshing with the distributor gear, said gears being of the usual two to one ratio, a loose gear on the crank shaft meshing with the cam shaft gear, said loose gear being rotative relative to the crank shaft, and a centrifugal governor having a direct drive connection with the crank shaft to provide bodily movement of the governor in a path concentric with the crank shaft axis and in permanent speed synchronism with the crank shaft, said governor being operatively connected to rotate the loose gear independent of the crank shaft by speed-responsive movements of the governor to simultaneously vary the timing of the inlet valves, exhaust valves and distributor.

6. In an internal combustion engine, the combination of a crank shaft, a cam shaft, a distributor shaft, inlet and exhaust valves actuated by the cam shaft, a distributor actuated by the distributor shaft, a timing gear case, a gear in the gear case fixed to the distributor shaft, a gear in the gear case fixed to the cam shaft and meshing with the distributor gear, said gears being of the usual two to one ratio, a gear in the gear case loose on the crank shaft and meshing with the cam shaft gear, said loose gear being rotative relative to the crank shaft, and a centrifugal governor in the gear case having a direct drive connection with the crank shaft to provide bodily movement of the governor in a path concentric with the crank shaft axis and in permanent speed synchronism with the crank shaft, said governor being operatively connected to the loose gear and imparting rotary movement to the loose gear independent of the crank shaft by speed-responsive movements of the governor to simultaneously vary the timing of the inlet valves, exhaust valves and distributor.

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