Jan. 26, 1943. S. M. UDALE 2,309,226

IGNITION TIMER

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Fig. 2

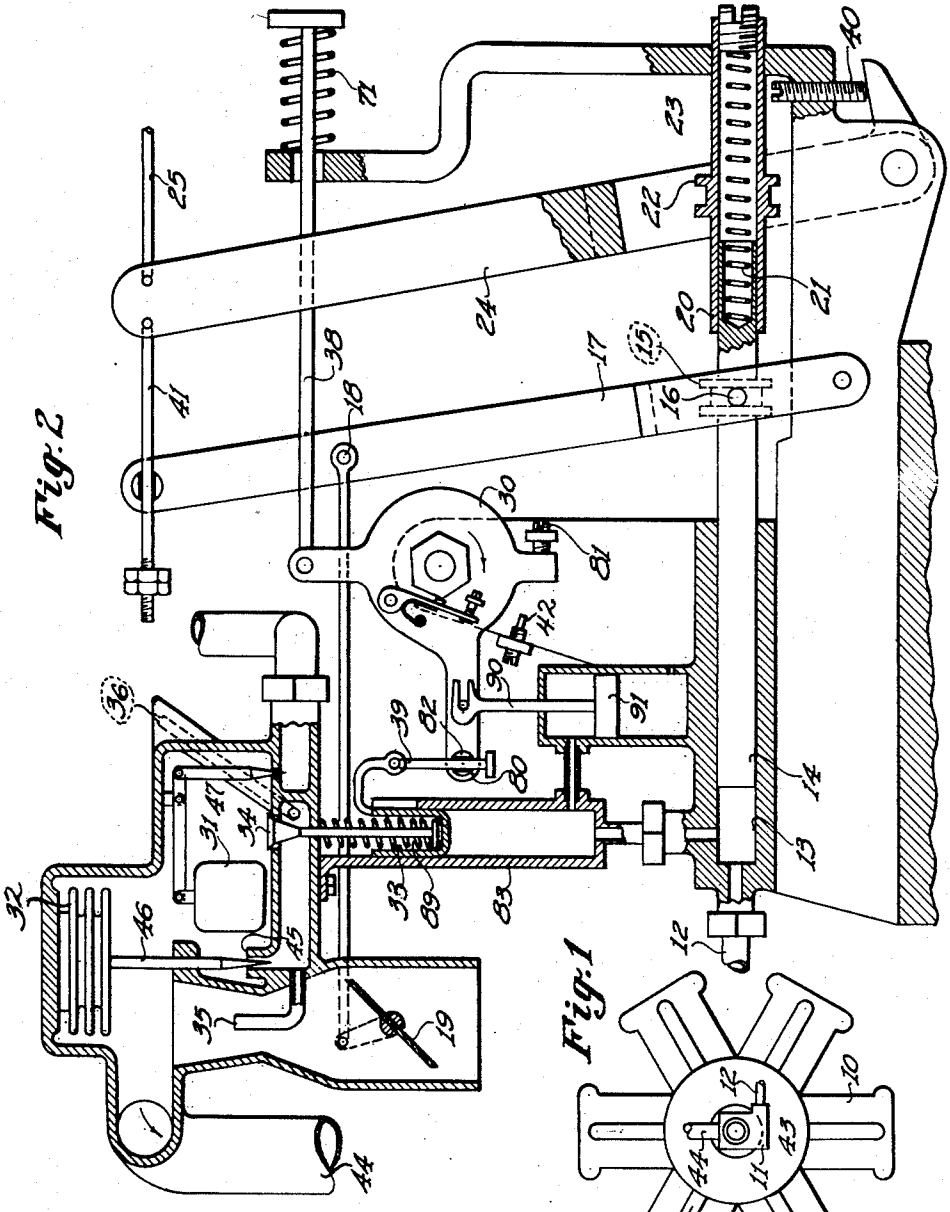


Fig. 1



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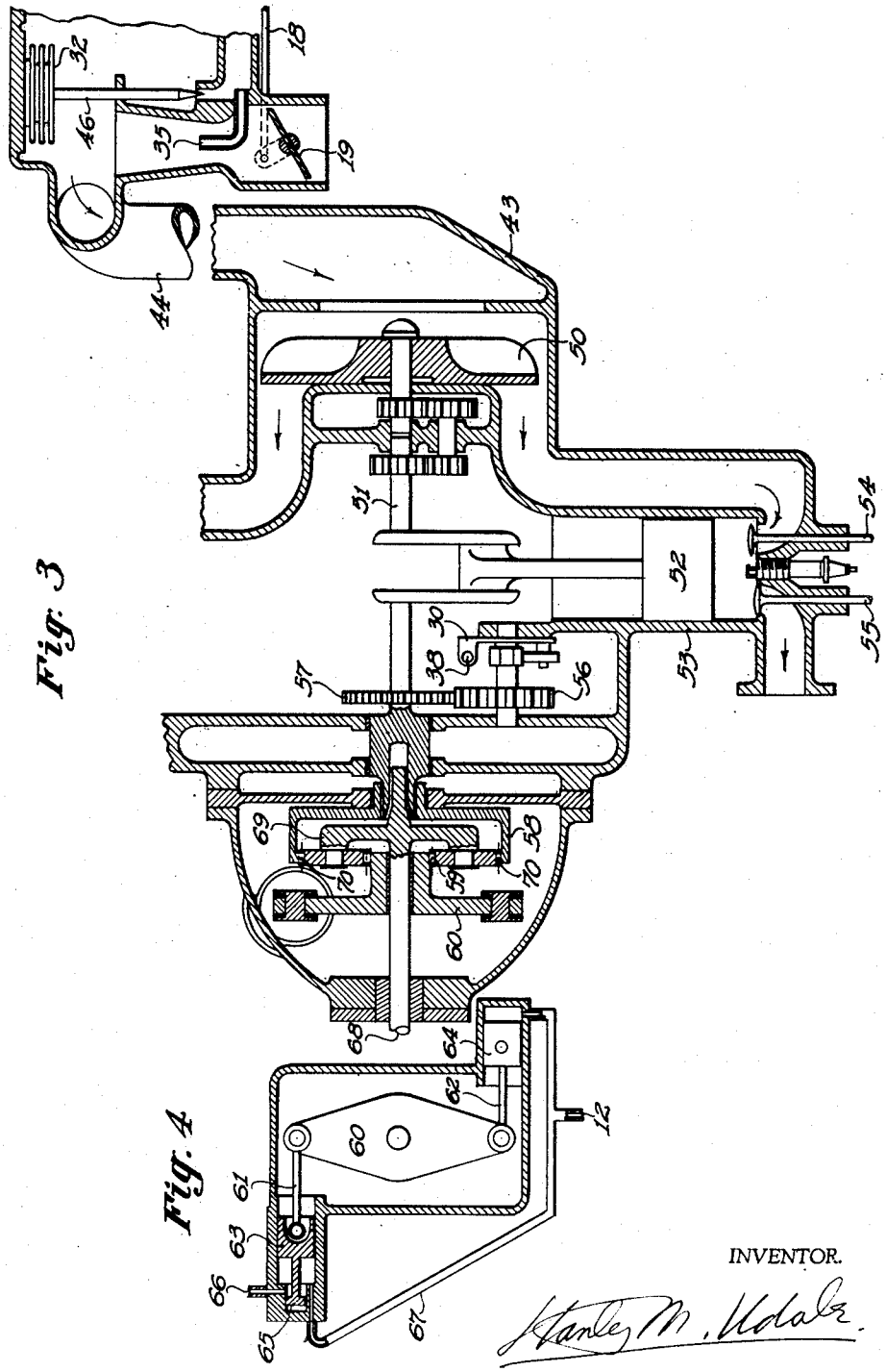



Fig. 3

Fig. 4

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Patented Jan. 26, 1943

2,309,226

# UNITED STATES PATENT OFFICE

2,309,226

## IGNITION TIMER

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Application May 8, 1942, Serial No. 442,199

3 Claims. (Cl. 123—117)

This application is a continuation in part of application Serial No. 334,329, filed May 10, 1940, entitled Torque controlled engine.

The object of this invention is to adjust the spark for maximum mileage on an airplane engine. In an airplane engine it has been found desirable to have a retarded spark when the engine is not running and to maintain a fixed (advanced) spark up to but not exceeding 70% of the rated torque. Beyond that as the torque increases the spark should be retarded slightly. It is desirable that the spark should be automatically retarded when cranking the engine for starting and that it should immediately be advanced to the maximum spark position. The spark thus remains at a fixed advance during the normal operation of the engine. Heretofore there has been some compromise and a fixed spark has frequently been used for normal and abnormal running so that the spark was not advanced as far as it may have been if maximum mileage were the only objective.

In the drawings:

Fig. 1 shows diagrammatically an air cooled engine having a torque responsive device.

Fig. 2 shows the control means for the carburetor and ignition devices controlled by the torque responsive means of Fig. 1.

Fig. 3 shows the carburetor attached to a conventional engine having a supercharger and torque control.

Fig. 4 shows the end view of the torque control.

The invention is shown diagrammatically in the drawings in which a radial air-cooled engine is shown diagrammatically at 10 on which is mounted a torque-responsive device 11, a supercharger 43 and a mixture outlet 44 which delivers an explosive mixture to the supercharger 43. This engine 10 and supercharger 43 are drawn to a small scale whereas Fig. 2 is drawn to a larger scale. The torque-responsive device 11 is connected by a pipe 12 which is therefore shown to a small scale in Fig. 1 and to a larger scale in Fig. 2.

The pipe 12 communicates with the cylinder 13 in which reciprocates a piston 14 which constitutes a torque control. The torque indicating device corresponds to one of those described in the S. A. E. Journal for June, 1939, pages 271 to 276 and specifically to Fig. 4, on page 273, and is made sufficiently powerful so that it can operate the piston 14. This piston 14 carries a collar 15 with which engages a pin 16 projecting from the lever 17. This lever 17 is connected by the rod 18 with the throttle 19. The piston 14 is guided in the cylinder 20 which carries a compression spring 21 so that the pressure in the cylinder 13 is balanced by the compression of the spring 21. The cylinder 20 carries a collar 22 with which engages a pin 23 projecting from a manually controlled lever 24 which is controlled by the manually controlled rod 25. This lever 24 is connected by a one-way connection 41 with the lever 17 and the limit to the opening movement of the lever 24 is determined by an adjustable stop 40, which stop 40 serves as a torque control for the engine and therefore indirectly serves as a power control.

The carburetor is shown diagrammatically having an anterior throttle 19, a fuel and air nozzle 35 which is supplied with a small quantity of air admitted through a restricted orifice 36 and is supplied with fuel through a restricted fuel entrance 45 controlled by a needle valve 46 which, in its turn, is controlled by partially evacuated aneroid capsules 32. A float 31 is located in the float chamber 47, which chamber is subjected to the inlet manifold suction and controls the float mechanism which supplies fuel to this constant level supply chamber 47.

A piston 33 is shown located in the cylinder 83 connected by a pipe with the cylinder 13. This piston 33 is held in position shown by a preloaded spring 89 and carries a metering valve 34 which admits extra fuel to the fuel nozzle when the maximum torque is reached and exceeded. This valve 34 is actually much smaller than the valve shown. A one-way link 39 is connected to an arm 88 of a circuit breaker plate 30 so as to rotate the circuit breaker and so retard the spark slightly when maximum torque is recorded.

In order to retard the spark so that the engine may be started safely a spring 71 engages with the rod 38 and pulls the circuit breaker 30 clockwise so that it engages with the stop 42.

A second torque-responsive piston 91 is located in a second cylinder and connected by a link 90 with an arm 88 of the circuit breaker 30. The upper portion of this second cylinder is connected to the lower part of the cylinder 83 through an open passage.

Whenever the engine is running the piston 91 is pushed down by the torque-responsive pressure existing above the piston 91 and the spring 71 being relatively weak yields and the circuit breaker 30 is thus rotated anti-clockwise until it engages with the stop 81, which is the fully advanced position of the timer.

The link 39 slides through a rotatable pin 82 mounted on the arm 88. The torque pressures

developed in the cylinder 13 and hence in the cylinder 83 in which the piston 13 slides, are sufficiently great to overcome any force that may be exerted by the piston 91 in the cylinder 92. In other words, the spark advance is controlled by the torque and is modified only slightly by the effect of the spring 71. The reason for this is that at all altitudes, some torque will be developed with the throttle 19 partly open. Hence there will be a substantial pressure on the piston 91 which will fully advance the spark. The torque pressure in the cylinder 13 acting on the piston 33 will compress the preloaded spring 89, which spring tends to hold the valve 34 closed. The torque pressures are designed to be sufficiently powerful to overcome the effect of the spring 71.

At extremely high altitudes with the throttle 19 wide open, the torque pressures in the chamber 13 will not be sufficiently powerful to compress the spring 89 and the spark will be fully advanced.

In Fig. 3 the carburetor is shown connected through the pipe 44 with the supercharger 50 contained within the housing 43. This supercharger is driven by a crank shaft 51 connected with a piston 52 which reciprocates in the cylinder 53 having the usual inlet and outlet valves 54 and 55. The spark control rod 38 is shown connected to the circuit breaker plate 30, and the circuit breaker itself is shown driven by the two to one gears 56 and 57. The details of the torque control are copied from page 273 of the June, 1939, number of the S. A. E. Journal, Figure 4, and consist of the following:

An internal gear 58 driven by the crank shaft 51 drives an external gear 59 which is connected to the diamond-shaped piece 60 which is connected through the connecting rods 61 and 62 to the pistons 63 and 64. A valve 65 admits high pressure oil to the line 66. The pressure in the pipe 67 is thus automatically maintained equal to that of the torque created by the engine. The high pressure oil, the pressure of which varies with the torque, is connected through the pipe 12 to the apparatus shown in Fig. 2. The propeller take-off is through the shaft 68 which carries the arm 69 upon which are mounted gears 70, 70, which engage with both the external gear 58 and the internal gear 59. Any torque that may be applied to the propeller on the shaft 68 is transmitted through the shaft 68 to the spider 69 which carries the pinion 70. If the torque goes up, the pressure in the pipe 12 goes up, and vice versa.

*Operation*

When the manually controlled lever 24 is moved to the left to open the throttle 19 by compressing the spring 21, the engine runs with the throttle 19 wide open until the torque responsive device 11 creates sufficient pressure so as to compress the spring 21 and thus close the throttle 19 until the torque created in the device 11 just balances the compression of the spring 21 which is determined by the adjustment of the lever 24. If the plane is now flown to the normal heights for which these engines are designed to operate, namely two or three miles above sea level, the throttle 19 will gradually open in order to maintain the torque determined by the position of the lever 24 and this will continue until the throttle 19 is wide open, and thereafter the torque will fall as the air density falls, until finally the plane can climb no more because the power is not great enough and the air density is too low to support the plane.

When the plane reaches the point at which it can no longer maintain its maximum torque, the fuel needle valve 34 closes and the rod 39 descends and the torque pressure in 13 is no longer operative to retard the spark. Under these conditions, the circuit breaker 30 is maintained in contact with the stop 81 until such time as the torque pressure in 13 is sufficiently great to raise the rod 39 to retard the spark. Under these conditions, the spring 71 is made sufficiently weak so that the pressure in the cylinder 13 when it overcomes the preloaded spring 89, is only modified slightly by the spring 71 and the retardation is mainly controlled by the pressure responsive torque existing in the cylinder 13.

The link 90 is pivotally connected to the lever 80 and serves as a piston rod for the piston 91 which is substantially the same area as the piston 32 and is subjected to the same pressure. The piston 91 is supported by the relatively light spring 71 so that at relatively low torque the piston 91 descends and advances the spark. When excessive pressures exist in 83, the piston 32 overcomes the piston 91 because the piston 32 acts at a longer leverage on the arm 80. Hence, the piston 91 is moved upwardly despite the increase of pressure. When the engine is not running the spring 71 takes over and retards the spark. The moment the engine fires, and the throttle is moved the slightest degree away from idle, torque is developed and immediately torque is developed, the piston 91 moves down compressing the spring 71 and the spark is fully advanced and the circuit breaker 30 engages with the stop 81.

What I claim is:

1. An ignition timer for an internal combustion engine having a torque indicating device, comprising a yieldable means for retarding the ignition timer, means responsive to the operation of the engine for overcoming said yieldable means so as to advance the spark, torque responsive means for retarding the ignition timer, said torque responsive means being inoperative until the torque exceeds substantially 70% of the rated torque of the engine.

2. An ignition timer for an internal combustion engine having a torque indicating device, comprising yieldable means for retarding the ignition when the engine is not running, torque responsive means for overpowering said yieldable means so as to advance the ignition timer whenever any substantial torque pressure is developed in the torque indicating device, additional torque responsive means responsive only to torques in excess of substantially 70% of the rated torque of the engine for retarding the ignition timer, said second mentioned torque responsive means having a mechanical advantage over the first mentioned torque responsive means.

3. An ignition timer for an internal combustion engine having a torque indicating device and a carburetor having an air entrance and a throttle valve controlling the flow through said entrance, comprising means independent of said throttle for holding said timer in the advanced position under all normal engine operating conditions, torque responsive timing means adapted to retard but not to advance the time of ignition and operative when the torque developed by the engine exceeds 70% of the engine's rated torque and said torque responsive and ignition retarding means being adapted to overpower said advancing means so as to retard said time of ignition during periods of excessive torque.

STANLEY M. UDALE.