Dec. 23, 1930. F. J. HARDMAN 1,785,902

IGNITION TIMER

Filed July 5, 1928 2 Sheets-Sheet 1

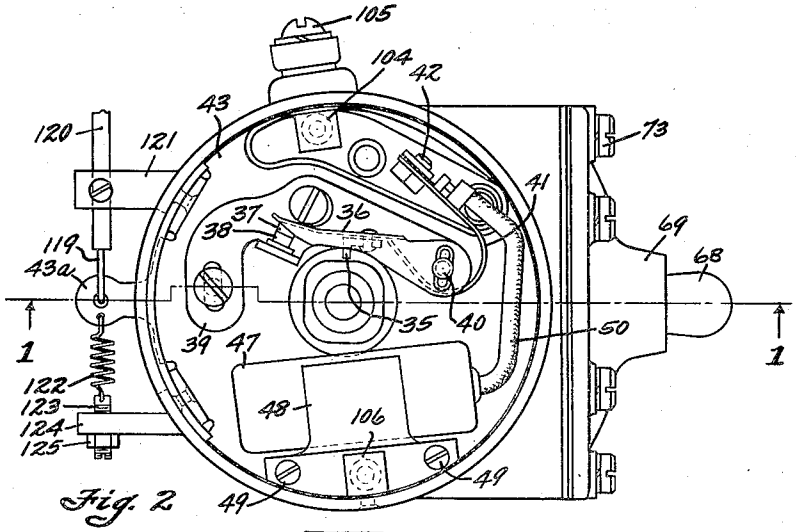

Fig. 2

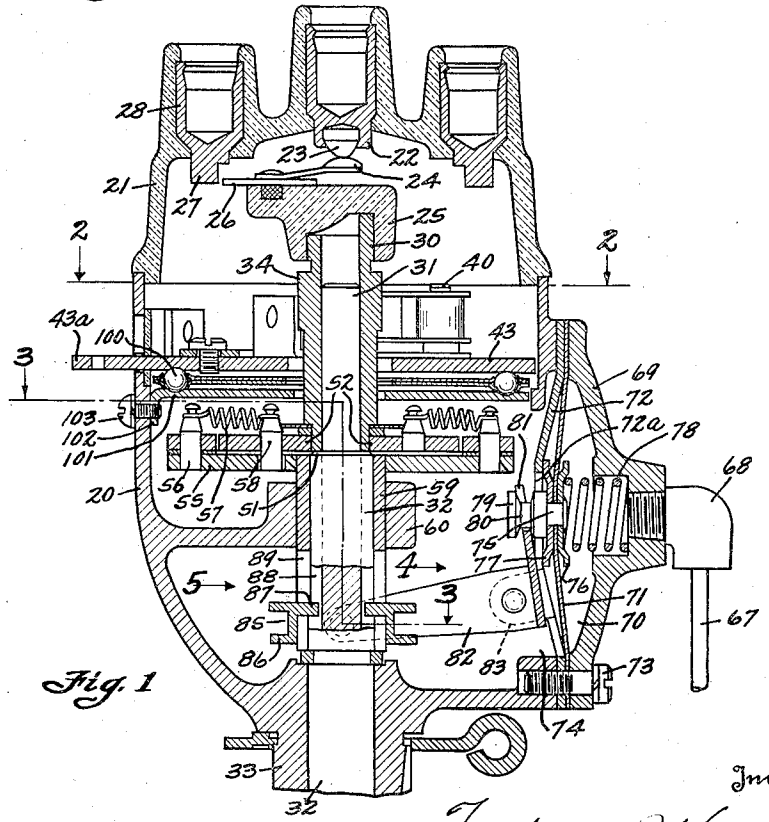

Fig. 1

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IGNITION TIMER

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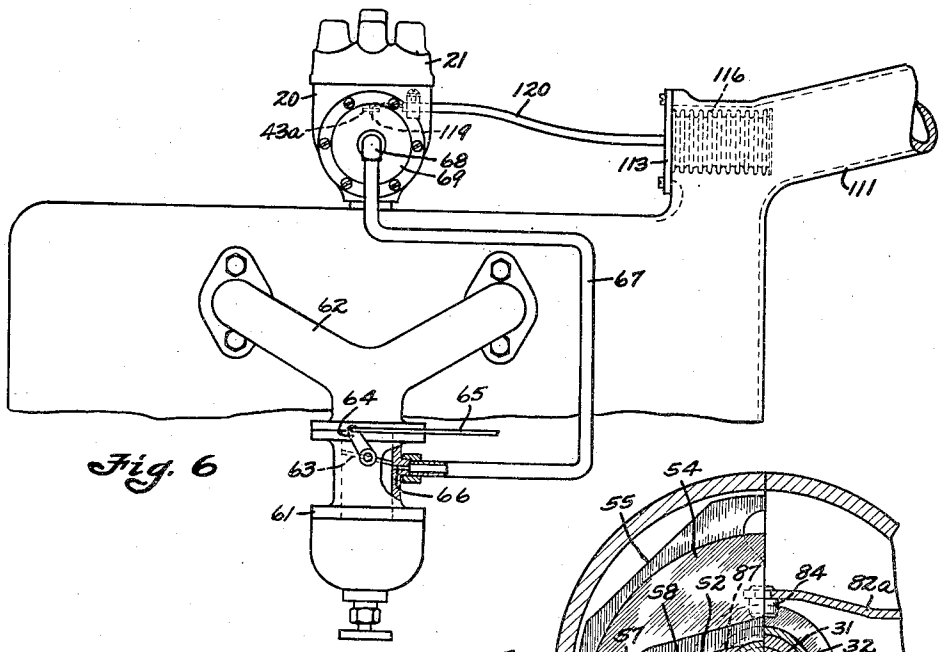

Fig. 6

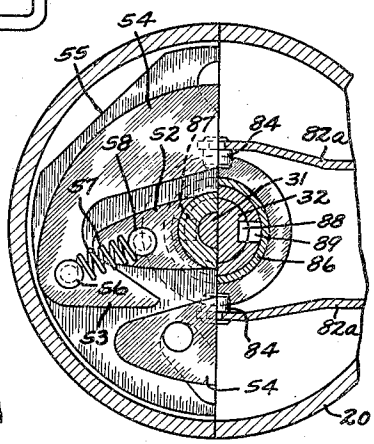

Fig. 3

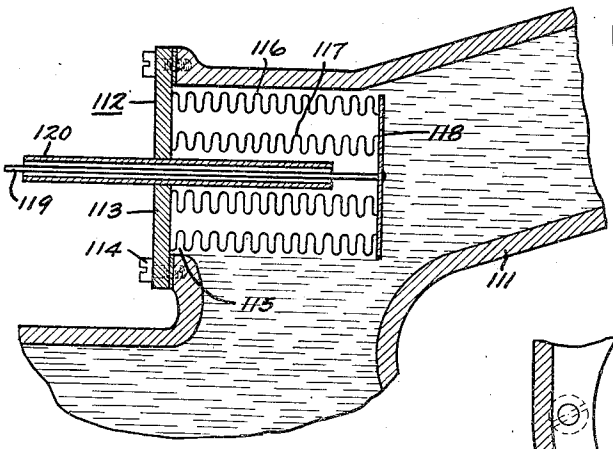

Fig. 7

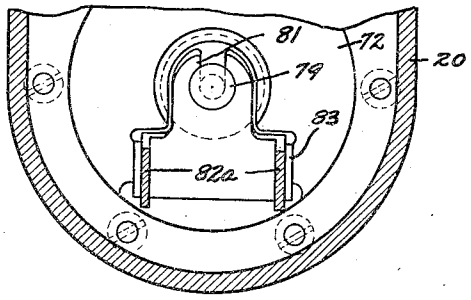

Fig. 4

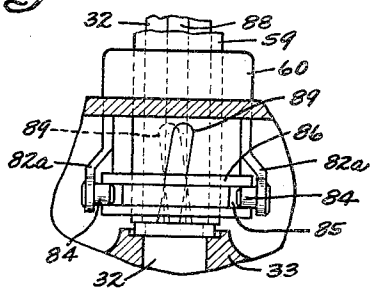

Fig. 5

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UNITED STATES PATENT OFFICE

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IGNITION TIMER

Application filed July 5, 1928. Serial No. 290,319.

This invention relates to ignition apparatus for internal combustion engines, and more particularly to the control of ignition timing in response to various engine operating conditions.

It is known that the timing of the ignition should be advanced as the engine speed increases and should be relatively retarded as the engine load increases. It has also been discovered that the timing of the ignition should be relatively advanced when the engine is cold and relatively retarded when the engine is hot.

One of the objects of the present invention is to provide devices for controlling the timing of the ignition in accordance with engine speed, engine load and engine temperature. More particularly, it is an object to provide an ignition timer comprising a unitary structure including the ignition primary circuit interrupter and devices for controlling the timing of the ignition in the manner referred to.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred form of embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a vertical, sectional view of an ignition timer embodying the present invention.

Fig. 2 is a plan view of the timer with the distributor head removed, and is a view on the plane of the line 2—2 of Fig. 1.

Fig. 3 is a sectional view on the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary, sectional view looking in the direction of the arrow 4 of Fig. 1.

Fig. 5 is a fragmentary, sectional view looking in the direction of the arrow 5 of Fig. 1.

Fig. 6 is a fragmentary, diagrammatic, side elevation of an internal combustion engine equipped with an ignition timer and control unit embodying the present invention.

Fig. 7 is an enlarged sectional view of a temperature responsive unit for controlling the ignition timer.

In the drawings, 20 designates the housing of the timer which supports a conventional distributor head 21 carrying a center terminal socket 22 having a contact 23 for engaging a contact 24 supported by a rotor block 25 carrying a distributor segment 26 electrically connected with the contact 24 and rotated adjacent to a plurality of distributor posts which are arranged in a circular row. One of these posts is shown at 27 and is integral with a socket 28 for receiving a plug or terminal connector (not shown) attached to a wire leading to an engine spark plug.

The rotor block is supported by and driven by a cam carrying shaft 30 which rotates loosely about an extension 31 of a timer driving shaft 32 which is supported by a bearing provided by the tubular shank 33 of the timer housing. The shaft 30 is provided with a cam 34 which cooperates with a rubbing block 35 of a circuit breaker lever 36 carrying a contact 37 adapted to engage a stationary contact 38 supported by an adjustable bracket 39 which is adjustable about the pivot stud 40 of the lever 36. A leaf spring 41 conducts current from a terminal 42 to the lever 36 and urges the contact 37 toward the contact 38 and the rubbing block 35 toward the cam 34. The lever 36, bracket 39 and terminal 42 are supported by a plate 43, the lever 36 and the terminal plate 42 being insulated from the plate 43. Plate 43 is rotatable coaxially with the cam 34 and is carried by an anti-friction bearing 100 which rests upon a stationary supporting plate 101 having ears 102 attached by screws 103 to the housing 20. A condenser which is contained within a case 47 is attached by clip 48 and screws 49 to the plate 43. One of the condenser foils is electrically connected with the condenser case 47 and hence with the plate 43, and the other foil is connected with the terminal bracket 42 by a conductor 50. The terminal plate 42 is engageable with a brush 104 insulated from the timer housing and connected with an insulated terminal screw 105. The condenser clip 48 is engageable with a ground-

ing brush 106 attached to the housing. Thus the circuit interrupter is maintained in good electrical connection with the ignition primary circuit for various positions of angular adjustment of the plate 43.

The lower end of the cam carrying shaft 30 rests upon a shoulder 51 provided by the shaft 32 and is attached to a plate providing arms 52 each of which is adapted to cooperate with an arm 53 of a weight 54. Each weight 54 is supported by weight plate 55 and swings around a stud 56 attached to the plate 55. A spring 57 connects a stud 58 carried by an arm 52 with one of the studs 56 and in this way tends to move the plate 54 toward the shaft 32. The plate 55 is attached to and is driven by an intermediate tubular shaft 59 which is supported by a bearing 60 provided by a part of the housing 20 and which is loosely journalled upon the shaft 32.

The intermediate shaft 59 is drivingly connected with the shaft 32 by means responsive to variations in suction in the intake passage of the engine. This passage is represented diagrammatically by a carburetor 61 and an intake manifold 62 (see Fig. 6). The throttle 63 of the carburetor 61 is operated by a lever 64 and a rod 65. The carburetor is provided with a passage 66 which is anterior to the throttle when closed and which is on the engine side of the throttle when the throttle is opened a substantial amount. The passage 66 is connected by a pipe 67 with an elbow 68 screwed into a cover plate 69 which forms one wall of a suction chamber 70. Another wall of the suction chamber 70 is provided by a metal diaphragm 71 which together with the cover 69 and a bracket 72 is attached by screws 73 to the housing 20. In this way the diaphragm and cover provide a closure for an opening 74 in the housing through which certain parts of the suction operated mechanism are removable. A rivet 75 secures to the diaphragm two dished washers 76 and 77. A spring 78 is located between the cover 69 and the washer 76 and tends to move the diaphragm 71 toward the left as viewed in Fig. 1 until the washer 77 engages the bracket 72. The bracket 72 is provided with an aperture 72*a* for receiving the head 79 of the rivet 75. The head 79 is provided with a groove 80 so that it may receive the forked end 81 of a lever 82 which is pivotally connected with ears 83 provided by the bracket 72. The lever 82 includes two arms 82*a* each carrying a stud 84 which is received by groove 85 in a collar 86 which slides along the intermediate shaft 59. The collar 86 is provided with lugs 87 extending into a longitudinal groove 88 in the shaft 32 and into an oblique slot 89 in the intermediate shaft 59.

The shaft 32 is driven by the engine in the usual manner and drives the intermediate shaft 59 through the lugs 87 of the collar 86. The intermediate shaft 59 drives the cam 34 through the cooperating weights 54 and lever arms 52. As the speed of the shaft increases, the weights 54 move outwardly due to centrifugal force and move the cam 34 clockwise relative to the shaft 32 in order to advance the timing of the ignition, the normal direction of rotation of the cam 34 being clockwise. In this way the spark is advanced automatically as the speed of the engine increases.

While the engine is idling, the throttle 63 will be opened only a slight amount and the passage 66 will be practically cut off from the influence of suction in the intake manifold 62. Therefore the spring 78 will be free to maintain the collar 86 in the position shown in Fig. 1 and the timing of the ignition will be relatively retarded. As the throttle 63 is opened to permit the engine to increase its speed, the passage 66 will be placed in communication with the engine intake so that the pressure in the suction chamber 70 will be sub-atmospheric. Therefore the diaphragm 71 will be moved to the right to cause the lever 82 to move clockwise and to move the collar 86 upwardly. The oblique slots 89 are so constructed that upward movement of the collar 86 will cause the shaft 59 to move clockwise as viewed from the top of the ignition timer. Therefore the cam 34 will be rotated clockwise relative to the shaft 32 and the timing of the ignition will be advanced.

When the engine load is suddenly increased, tending to reduce its speed, and the throttle 63 is opened to supply a greater amount of fuel to the engine, the suction in the intake 62 will be reduced; consequently the spring 78 will move the diaphragm 71 toward the left to a position in which equilibrium is established between the spring pressure and the pressure differential tending to move the diaphragm toward the right. Consequently the collar 86 will be moved downwardly a certain amount in order to retard the ignition in amount corresponding to the load of the engine.

It is apparent that the speed responsive centrifugal device and the suction responsive device for controlling the advancing and retarding of the timing ignition may operate cumulatively and differentially. As the speed of the engine increases, both devices may act cumulatively to rotate the cam 34 relative to the shaft 32 in such direction as to advance the timing of the ignition and vice versa as the speed decreases. There may be conditions under which the speed of the engine is increased while its load is being increased. The centrifugal device may tend to advance the position of the cam relative to the drive shaft while the suction control device may tend to retard it. Thus both devices may act differentially to control the position of the cam 34 relative to the drive shaft 32 so that the ignition will be timed proper-

ly to correspond with the engine speed and load conditions.

The means responsive to engine temperature for controlling the timing of the ignition spark by controlling the position of the bracket 43 includes a temperature responsive expansible and contractable device which is subjected to variations in engine temperature, preferably subjected to variations in the temperature of the circulating water which cools the engine combustion chambers. A portion of the conduit through which the water circulates is designated by numeral 111. This conduit encloses a temperature responsive unit designated in its entirety by numeral 112. This unit comprises a supporting plate 113 attached by screws 114 to the conduit 111 and covering an opening 115 therein. To plate 113 are attached two concentric metal bellows 116 and 117 which are also attached to a plate 118. The plate 118 is connected with a bracket extension 43*a* by a Bowden wire 119 slidable through a Bowden wire tube 120. The tube 120 passes through the plate 113 and is attached thereto adjacent one end, and the other end of the tube 120 is attached to a bracket 121, preferably integral with the housing 20. A spring 122 is attached to the bracket extension 43*a* and to a threaded rod 123 which passes loosely through a bracket 124 integral with the housing 20. The threaded rod receives a nut 125. The spring 122 tends to urge the bracket 43 in a counterclockwise direction to advance the timing of the ignition (normal direction of rotation of the cam 34 being clockwise as viewed in Fig. 2). The tension of the spring 122 can be varied by turning the nut 125 relative to the rod 123.

The space between the plates 113 and 118 and between the bellows 116 and 117 is hermetically sealed from the water circulating through the conduit 111 and from the chamber within the bellows 117 which is open to atmosphere. This hermetically sealed chamber contains a volatile liquid which expands readily with increase in temperature. It is therefore apparent that when the engine is cold, the circulating water being cold, the space occupied by the liquid in the hermetically sealed chamber will be less than when the engine is operating at a higher temperature. Therefore when the engine is cold the bracket 43 will be urged by the spring 122 into a position giving a relatively advanced timing of the ignition spark. When the engine is relatively warm, the volatile liquid will expand to cause the plate 118 to move toward the right as viewed in Fig. 7 in order to move the bracket extension 43*a* upwardly as viewed in Fig. 2, and to move the bracket 43 in such manner as to retard the timing of the ignition.

The temperature responsive control of ignition spark timing is advantageous since it has been found that the timing of the ignition should be more advanced when the engine is cold than when the engine is warm in order that the engine will operate most efficiently.

It is therefore apparent that the present invention provides unitary structure which comprises an engine operated circuit interrupter and means responsive to engine speed, engine load and engine temperature conditions for varying the time relation between the cycle of engine operations and the cycle of interrupter operations.

While the form of embodiment of the present invention as herein disclosed, constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

What is claimed is as follows:

1. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine, and means responsive to engine temperature and to engine speed for varying the time relation between the cycle of engine operations and the cycle of interrupter operations.

2. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine, and means responsive to engine temperature and to engine load conditions for varying the time relation between the cycle of engine operations and the cycle of interrupter operations.

3. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine, and devices responsive to engine temperature, to engine speed and to engine load conditions for varying the time relation between the cycle of engine operations and the cycle of interrupter operations.

4. Ignition apparatus for internal combustion engines comprising, in combination a circuit interrupter operated by the engine and comprising a rotatable cam, an engine driven shaft for rotating the cam, a circuit breaker operated by the cam, and a plate supporting the circuit breaker and rotatable coaxially with respect to the cam; a device for varying the angular relation between the cam and drive shaft in response to engine speed; and a device responsive to variations in engine temperature for angularly adjusting the circuit breaker plate.

5. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine and comprising a rotatable cam, an engine driven shaft for rotating the cam, a circuit breaker operated by the cam, and a plate supporting the circuit breaker and rotatable coaxially with respect to the cam; a device for varying the angular relation between the cam and drive shaft in response to engine load conditions; and a device responsive to varia-

tions in engine temperature for angularly adjusting the circuit breaker plate.

6. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine and comprising a rotatable cam, an engine driven shaft for rotating the cam, a circuit breaker operated by the cam, and a plate supporting the circuit breaker and rotatable coaxially with respect to the cam; a device for varying the angular relation between the cam and drive shaft in response to engine speed; a device for varying the angular relation between the cam and drive shaft in response to engine load conditions; and a device responsive to variations in engine temperature for angularly adjusting the circuit breaker plate.

7. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine, devices responsive to engine temperature, devices responsive to engine load conditions, and devices responsive to engine speed conditions, each of said devices being operable to vary the time relation between the cycle of engine operations and the cycle of interrupter operations.

8. Ignition apparatus for internal combustion engines comprising, in combination, a circuit interrupter operated by the engine and comprising a rotatable cam, an engine driven shaft for rotating the cam, a circuit breaker operated by the cam, and a plate supporting the circuit breaker and rotatable coaxially with respect to the cam; means responsive to engine speed for varying the angular relation between the cam and drive shaft, and means responsive to variations in engine temperature for varying the angular relation between the cam and circuit breaker plate, either of said means operable to control the time occurrence of said circuit interrupter independent of the control factor of the other of said means.

In testimony whereof I hereto affix my signature.

FREDERICK J. HARDMAN.