June 15, 1937. F. T. HICKS 2,084,267

IGNITION SYSTEM

Filed June 4, 1935

Fig. 1

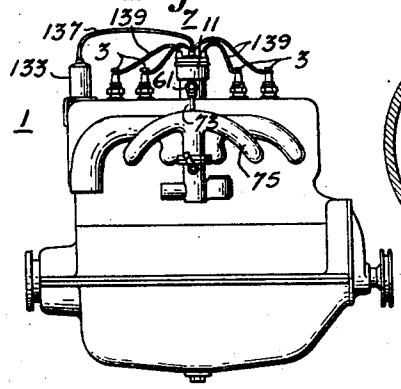


Fig. 5

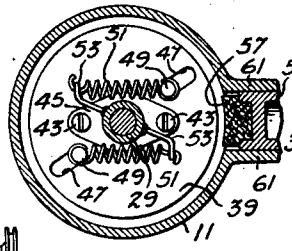


Fig. 4

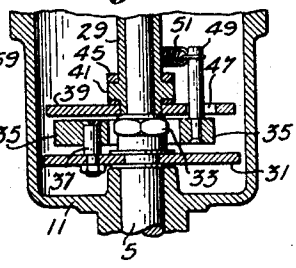


Fig. 6

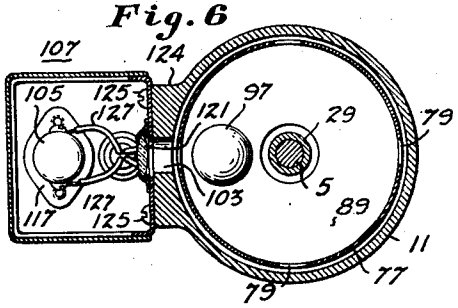


Fig. 2

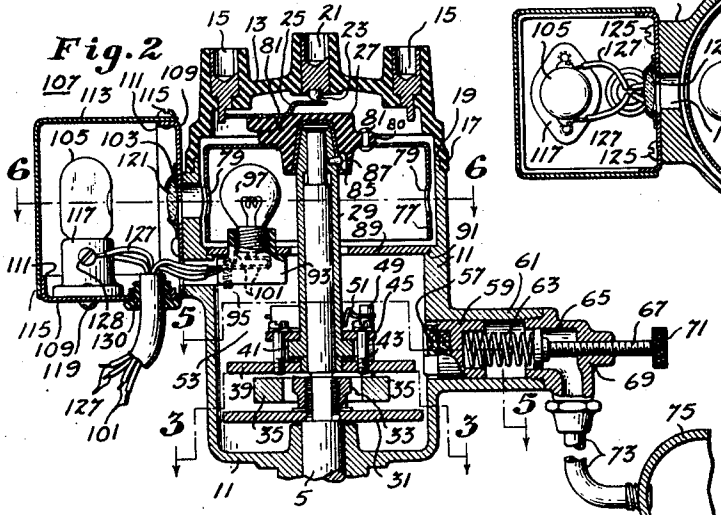


Fig. 3

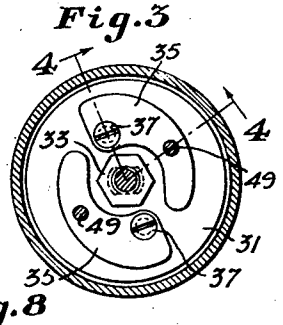


Fig. 7

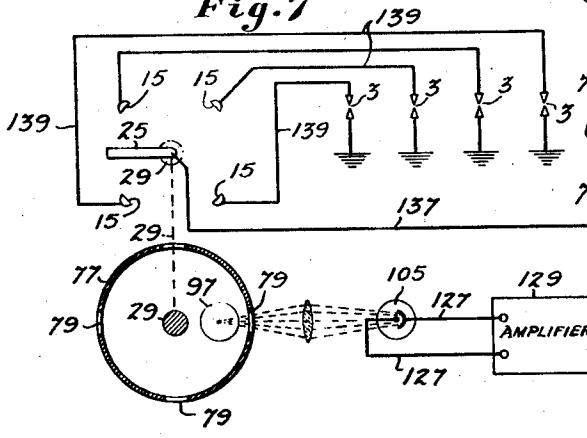
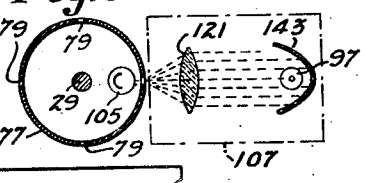


Fig. 8



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IGNITION SYSTEM

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Application June 4, 1935, Serial No. 24,854

11 Claims. (Cl. 123—148)

My invention pertains to a space effect control system for actuating accurately timed operations, and more particularly to a light controlled ignition system for internal combustion engines.

It is an object of my invention to provide an improved ignition system for internal combustion engines comprising means for supplying electrical energy to produce igniting sparks which is actuated by a light sensitive device controlled by a sharply focussed beam of light projected through apertures in a shutter member rotated in accordance with the operation of the engine whereby accurately timed sparks are provided.

It is a further object of my invention to provide an ignition system actuated by a controlled space effect, thus eliminating errors of operation introduced by friction, inertia, wear and corrosion of mechanically engaging parts.

The invention itself, however, both as to its organization and its method of operation, together with additional objects and advantages thereof, will best be understood from the following description of specific embodiments, when read in conjunction with the accompanying drawing, in which:

Fig. 1 is a side elevational view showing an internal combustion engine provided with an ignition system controlled in accordance with my invention;

Fig. 2 is a vertical sectional view of the distributor and the associated ignition controlling elements;

Figs. 3, 4 and 5 are sectional views thereof illustrating the speed and load responsive elements for varying the timed relation of the spark in accordance with operating conditions of the engine;

Fig. 6 is a transverse sectional view on line 6—6 of Fig. 2;

Fig. 7 is a diagrammatic view schematically representing the cooperative relation of the elements in the system; and

Fig. 8 is a plan view showing a modified mounting arrangement for the light source and the photo-cell.

Referring more particularly to Fig. 1 of the drawing, my light controlled ignition system is illustratively disclosed on a four cylinder internal combustion engine in which the individual cylinders of the engine are fired by conventional spark plugs 3. As will be understood, the engine 1 may comprise any number of cylinders of either the 2-cycle or the 4-cycle type used for marine or automotive installations of any nature, or for stationary power plants or other purposes.

In accordance with the usual practice, the engine is provided with a timer shaft 5 for driving an ignition controlling distributor 7. The timer shaft 5 is driven from the main shaft of the engine by suitably proportioned timing gears (not shown) and extending upwardly through the engine block 9 it is enclosed by a metallic housing 11 which projects upwardly from the engine and also provides bearing means for the shaft. A distributor cap 13 of insulating material, such as a phenolic condensation product, supports spaced inwardly projecting distributor contacts 15 and is provided with a radial flange 17 which is adapted to fit snugly down around a flange 19 of similar design projecting upwardly from the upper edge of the distributor housing 11 as shown more clearly in Fig. 2. A contact 21 also extends through the center of the distributor cap 13, having a ball contact 23 projecting downwardly for engaging the inner end of a contact arm 25 which is carried by a hub 27 of insulating material such as a phenolic condensation product and is upwardly displaced to provide a resilient engaging portion.

In order to automatically advance or retard the spark in accordance with the operation of the engine, the upper end of the timer shaft 5 is of smaller diameter and receives a sleeve 29 which is freely rotatable thereon. The sleeve 29 is driven from the timer shaft 5 through any well-known speed responsive mechanism for angularly shifting its position relative to the timer shaft in accordance with the speed of the engine. The speed responsive mechanism forms no part of my invention and any of the well-known mechanisms for this purpose may be utilized. As shown in Figs. 2, 3, 4 and 5, the speed responsive mechanism may comprise a disc 31 which is rigidly secured by a nut 33 on the smaller portion of the shaft 5, clamping the disc against the shoulder of the larger portion. The disc 31 carries a pair of arcuate shaped weights 35 which are pivotally supported on upwardly projecting pins 37. The rotatable sleeve 29 carries a disc 39 which is secured rigidly to an annular flange 41 thereon by screws 43 passing through an annular ring 45 and is provided with slots 47 through which extend upwardly projecting pins 49 from the pivoted weights 35. From the upper end of each pin 49 a biased spring 51 is tensioned to the end of a bracket 53 projecting radially outward from the sleeve 29 to which the brackets may be secured in any suitable manner as by welding. The pivoted weights 35 are thus continuously biased toward the shaft 5.

As the speed of rotation increases, the weights 35 are thrown outwardly by centrifugal force and the upwardly projecting pins 49 are accordingly moved outwardly along the slots 47, thereby relatively advancing the position of the disc 39 and thus the sleeve 29 and the elements controlled thereby.

For the purpose of regulating the phase position of the timer sleeve 29 more accurately in accordance with the operating conditions of the engine, a vacuum responsive brake is provided which may be of any well-known construction commonly used for this purpose. As shown, this may comprise a brake shoe 57 mounted on a piston member 59 which is slidably disposed within a tubular guide 61 which extends laterally from the side of the distributor housing 11. The tubular guide 61 comprises a cylinder for the slidable piston member 59 which is provided at its outermost end with a socket for receiving the end of a compression spring 63. The opposite end of the compression spring 63 engages an adjustable stop 65 which is mounted upon a threaded shaft 67 extending threadably through the end of a pipe fitting 69 which is threadably secured into the outer end of the tubular guide 61. The screw threaded shaft 67 carries a knurled knob 71 to facilitate adjusting the tension on the brake spring 63 for predetermining the characteristics of the automatic timing mechanism.

In order to apply a partial vacuum within the tubular guide 61 in accordance with the operation of the engine, a small tube 73 extends from the pipe fitting 69 to the intake manifold 75 of the engine. When the throttle is opened suddenly or the engine is pulling an unusually heavy load, such that the partial vacuum in the intake manifold 75 is decreased, the brake biasing spring 63 being then less opposed, pushes the brake shoe 57 toward the timer sleeve 29. When this movement has proceeded beyond a given point, the brake shoe 57 engages the outer edge of the disc 39 carried by the timer sleeve and applies a braking force thereon in accordance with the pressure in the intake manifold. The timer sleeve 29 is thus retarded relative to that position which it would have occupied as determined by the speed responsive mechanism alone, thereby retarding the spark and preventing labor knock and overheating and providing far more efficient operation of the engine.

In accordance with the present invention, and as shown more particularly in Figs. 2 and 6, the upper end of the timer sleeve 29 carries an inverted cup-shaped member 77 having circumferentially spaced apertures 79 and which comprises a light controlling shutter. The shutter 77 which may be of light aluminum construction is secured to a flange 80 on the hub 27 of insulating material which also carries the distributor contact arm 25 on the upper surface thereof. The shutter and the contact arm may be secured to the hub by rivets 81 or other suitable fastening means. For accurately receiving the distributor hub 27, the upper end of the timer sleeve 29 is tapered slightly to fit snugly into a corresponding tapered aperture in the hub. In order that the position of the hub may be accurately determined upon the end of the timer sleeve, it is provided with a metallic liner 83 having a radially projecting slot 85 which fits snugly down around a pin 87 projecting from the tapered end of the timer sleeve 29. By this arrangement the contact arm 25 and the light controlling shutter 77 are accurately centered in proper position when the hub 27 is inserted on the end of the timer sleeve 29.

The distributor housing 11 is provided with a disc-like partition member 89 which extends transversely across the housing under the rotatable shutter and rests upon a peripheral groove 91 in the inner surface of the upper edge of the distributor housing. A lamp socket 93 is disposed adjacent the underside of the partition 89 to which it is secured by a screw 95 with its lamp-receiving socket projecting upwardly through an aperture in the partition for supporting a light source such as a small incandescent electric light bulb 97 thereabove. The light bulb, which may be any small low voltage bulb having a concentrated filament, is disposed adjacent the circumferential wall of the shutter for projecting light through the spaced apertures 79 therein. Suitable reflecting means may be provided for concentrating the light of the bulb upon the apertured peripheral side wall of the shutter such as a silvered surface provided directly upon half of the incandescent bulb, or a separate reflector may be suitably mounted adjacent thereto. For energizing the light source 97, electrical conductors 101 extend from the lower portion of the socket 93 through an insulating conduit in the side of the distributor housing 11 to any suitable source of current. The outer wall of the distributor housing 11 is provided with a light projecting aperture 103 disposed in vertical alignment with the spaced apertures 79 in the light controlling shutter 77 which, as it rotates, projects light flashes therethrough.

A light sensitive device or photo-cell 105 is mounted adjacent the light transmitting window 103 for controlling the ignition system in response to the projected light flashes. In order to support the photo-cell 105 and to protect it from extraneous light and foreign matter, a casing 107 is secured to the outer surface of the distributor housing 11. The photo-cell casing 107 comprises a substantially L-shaped piece of sheet metal 109 having inwardly turned flanges 111 for receiving a sheet metal cover 113 which is secured thereto by screws 115 or other suitable fastening means, and which may be conveniently removed to provide access to the photo-cell 105 enclosed therein. For supporting the photo-cell 105 within the casing 107 a suitable socket 117 is secured to the bottom wall of the casing by screws 119 or other fastening means. The photo-cell casing 107 may be rigidly secured to a flattened portion 124 on the side of the distributor housing 11 as by screws 125 passing therethrough.

The electrical conductors 127 controlled by the photo-cell extend from the terminals 128 of the socket and pass downwardly through a suitable insulating sleeve 130 in the bottom of the casing 107 into an insulated cable which may also carry the conductors which energize the light bulb. As shown in Fig. 7, the photo-cell controlled conductors 127 extend to any suitable controlling means, such as an amplifier 129 for controlling the energization of the low-voltage winding 131 of the ignition coil 133 in accordance with the light impulses projected upon the photo-cell. Such an amplifier may be of any suitable design well-known in the industrial control art and forms no part of the present invention. From one end of the secondary or high-voltage winding 135 of the ignition coil 133 a connection 137 extends through the distributor arm 25 which selectively establishes connections to energize the

proper one of the spark plugs 3 through the respective spark plug cables 139 in accordance with the operation of the engine. The other end of the high-voltage winding may be grounded at 141 in the usual manner.

In operation the shutter member 77 on the timer shaft is rotated to carry its spaced apertures 79 successively past the light transmitting window in the wall of the distributor housing, thereby projecting properly timed light flashes upon the light sensitive device 105 which through the amplifier controls the source of high voltage or ignition coil 133 to provide properly timed igniting sparks for the spark plugs.

As the speed and load conditions vary, the speed responsive mechanism and the load responsive brake operate to vary the angular positions of the light intercepting shutter 77 relative to the instant position of the timer shaft 5, thereby providing a properly timed spark for all operating conditions. Since the rotating shutter 77 merely intercepts a light beam which does not apply a frictional drag thereon, the delicate speed and load responsive mechanisms are free to accurately adjust the proper timing of the ignition spark and provide more satisfactory operation of the engine. Also, the light beam controlled ignition system is unaffected by corrosion or wear and does not introduce detrimental inertia effects at high speeds. Other events in the operation of the engine may be controlled by substituting a corresponding electromagnetic device such as a valve for the ignition coil as will be readily understood.

By exchanging the lamp and photo-cell sockets 93 and 117 it is also possible to mount the light source 97 in the casing 107 outside of the distributor housing and the photo-cell 105 inside, as shown in Fig. 8. By providing a suitable focusing mirror 143 in the casing 107 adjacent the light source 97, the light may be more sharply focussed upon the rotating shutter 77 through the lens 121. The light transmitting apertures 79 in the shutter 77 may then be made smaller to provide for more accurately intercepting the sharply focussed beam of light as the shutter rotates.

In operating single-cylinder engines, it will be apparent that the light controlled system may be greatly simplified by omitting the shutter member 77 and projecting the light beam at a suitable position across the path of some movable member of the engine, also on two-cycle engines a light intercepting plate may be mounted directly upon the crank shaft or the crank may be directly utilized as the light intercepting member.

It will be seen that I have provided an ignition system which may be controlled by a beam of light interrupted in accordance with the operations of the engine, thereby eliminating errors caused by varying wear, friction, corrosion and inertia effects of mechanically engaging parts.

Aside from the specific embodiments of the invention herein shown and described, it will be understood that numerous details of the construction may be altered or omitted without departing from the spirit and scope of the invention as disclosed and claimed, and that I do not desire to limit the invention to the exact constructions herein set forth.

I claim as my invention:

1. In combination a multi-cylinder internal combustion engine, a spark plug for each cylinder thereof, a light responsive device, a source of electrical energy controlled thereby for producing a high-voltage current, means for projecting light upon said device, means movable in accordance with the operation of said engine comprising a shutter for interrupting the projected light to produce impulses of high-voltage current accordingly, and associated distributor means for selectively delivering the high-voltage current impulses to the respective spark plugs in accordance with the operation of the engine.

2. In combination an internal combustion engine, a light responsive device, a source of energy controlled thereby, means for projecting a beam of light upon said light responsive device, shutter means movable in accordance with the operation of said engine for interrupting said beam of light, and means for focusing said light beam sharply upon said shutter means.

3. In combination an internal combustion engine, a light responsive device, a source of energy controlled thereby, means for projecting light upon said light responsive device, and means movable in accordance with the operation of said engine comprising a shutter for interrupting the projected light to control the source of energy accordingly.

4. In combination, an internal combustion engine, a spark plug for igniting a combustible charge in said engine, a light responsive device, a source of electrical energy controlled by said device for applying high-voltage impulses to said spark plug, means for projecting light upon said light responsive device, shutter means for intercepting the projected light, and driving means for actuating said shutter means in accordance with the operation of said engine to provide properly timed high-voltage impulses for said spark plug.

5. In combination, an internal combustion engine, a timer shaft operated by said engine, a light responsive device, means for projecting light thereon, a shutter mounted on said timer shaft for intercepting the light projected to said light responsive device, and means controlled by said light responsive device for controlling events in the operation of said engine.

6. In combination, an internal combustion engine, a timer shaft operated by the engine, a shutter of substantially cylindrical conformation mounted on said shaft, apertures in the side walls of said shutter, a light sensitive device, a light source for projecting light on said device, means for mounting said device and said light source in spaced relation separated by the side walls of said shutter, and means controlled by said light responsive device for controlling events in the operation of said engine.

7. In combination, an internal combustion engine, a timer shaft operated by the engine, a shutter of substantially cylindrical conformation mounted on said shaft, apertures in the side walls of said shutter, a housing for enclosing said timer shaft and shutter, an aperture in the side wall of said housing in alignment with the apertures in said shutter, means for supporting an electric light bulb within the side walls of said cylindrical shutter in alignment with said apertures, a photo-cell casing having an aperture, means for securing said casing on the outside of said housing with its aperture aligned with the aperture in the housing, and means for supporting a photo-cell in said casing in aligned relation with the apertures.

8. In combination, an internal combustion engine, a spark plug for igniting a combustible charge in said engine, a light responsive device, a source of electrical energy controlled by said

device for applying high-voltage impulses to said spark plug, means for projecting light upon said light responsive device, shutter means for intercepting the projected light, and driving means comprising phase adjusting means for driving said shutter means and adjusting the instant position thereof relative to said engine in accordance with the speed and load operating conditions of said engine to provide properly timed high voltage impulses for said spark plug under all operating conditions.

9. In combination, an internal combustion engine, a spark plug for igniting a combustible charge in said engine, a source of electrical energy, a circuit energizable from said source for applying high-voltage impulses to said spark plug, control means actuated in accordance with the motion of said engine and comprising phase adjusting means responsive to operating conditions, energy projecting means, energy receiving means for controlling the energization of said circuit, and a movable member for controlling the transfer of energy between said projecting means and said receiving means, said member disposed for operation by said control means in spaced friction-free relation to the stationary portions of the system whereby said phase adjusting means operates freely to respond accurately to variable operating conditions to provide accurately timed igniting sparks.

10. In combination, an internal combustion engine, operating means for controlling an event in the operation of said engine, a source of electrical energy, control means actuated in accordance with the motion of said engine, said control means comprising automatic phase adjusting means responsive to operating conditions, energy projecting means, energy receiving means, means controlled by said energy receiving means for energizing said operating means from said source of electrical energy, and a movable member for controlling the transfer of energy between said projecting means and said receiving means, said member disposed for operation by said control means in spaced friction-free relation from the stationary portions of the system, whereby the automatic phase adjusting means operates freely to respond accurately to variable operating conditions.

11. In combination, an internal combustion engine, operating means for controlling an event in the operation of said engine, a source of electrical energy, control means actuated in accordance with the motion of said engine, energy projecting means, energy receiving means, means controlled by said energy receiving means for energizing said operating means from said source of electrical energy, and a movable member for controlling the transfer of energy between said projecting means and said receiving means, said member disposed for operation by said control means in spaced friction-free relation from the stationary portions of the system.

FREDERICK T. HICKS.