Aug. 26, 1969 R. ZECHNALL ET AL 3,463,134

LIGHT-OPERATED CONTROL APPARATUS FOR A COMBUSTION ENGINE

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FIG. 6

FIG. 1

INVENTORS
Richard ZECHNALL
Jörg ISSLER
Gerhard SÖHNER
Paul WÖRZ
BY Michael S. Striker,
their ATTORNEY

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FIG. 2

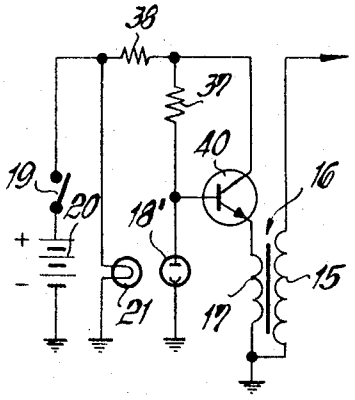
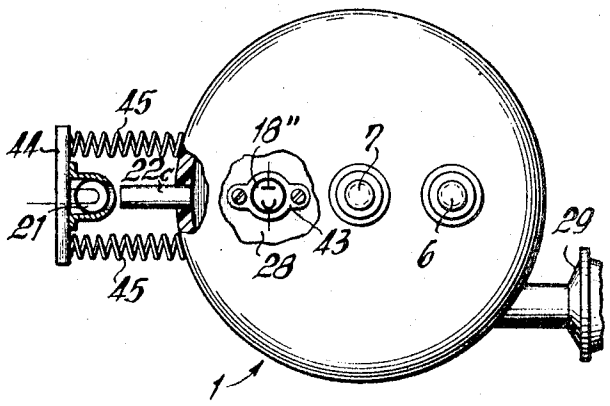


FIG. 5



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Paul WÖRZ
BY
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their ATTORNEY

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FIG. 3

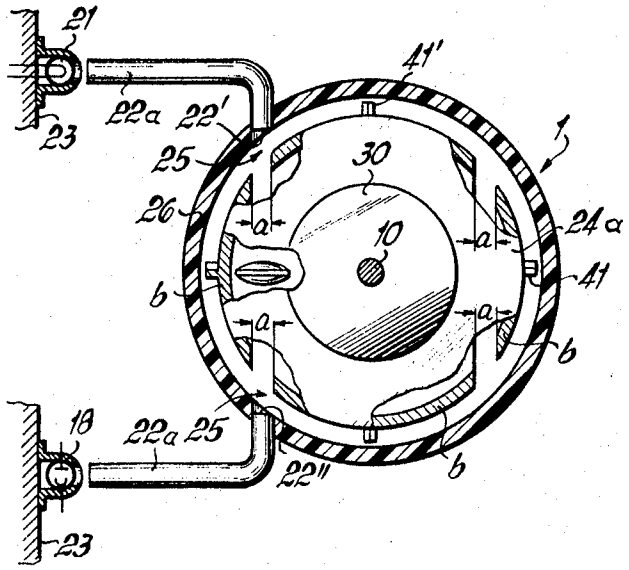
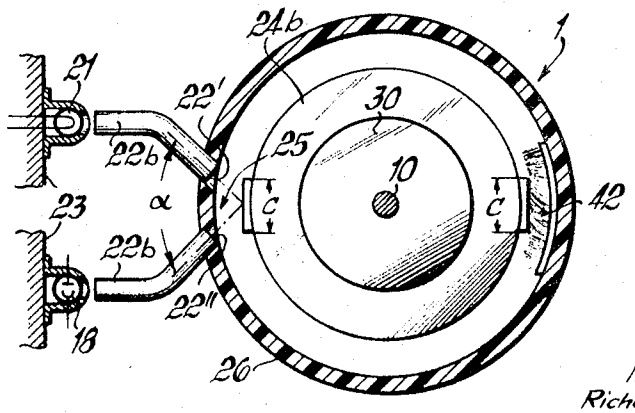


FIG. 4



INVENTORS
Richard ZECHNALL
Jörg ISSLER
Gerhard SÖHNER
Paul WÖRZ
BY
Michael S. Striker,
their ATTORNEY

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LIGHT-OPERATED CONTROL APPARATUS FOR A COMBUSTION ENGINE

Richard Zechnall, Stuttgart, Jörg Issler, Stuttgart-Sud, Gerhard Söhner, Geradstetten, and Paul Wörz, Stuttgart-West, Germany, assignors to Robert Bosch G.m.b.H., Stuttgart, Germany

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U.S. Cl. 123—146.5 16 Claims

ABSTRACT OF THE DISCLOSURE

Light operated control means for the ignition circuit of a combustion engine are located spaced from the engine and its distributor and connected by light guiding means to the distributor where a rotating actuator interrupts the path of light falling into a light sensitive means.

BACKGROUND OF THE INVENTION

It is known to control auxiliary operations, such as the ignition, of a combustion engine by apparatus having a source of light and a light sensitive element.

Control arrangements of this type have been successfully used for the ignition means of combustion engines, and have the advantage that mechanical contact engagement is eliminated.

The ignition means of a combustion engine serves the purpose of igniting the compressed air-fuel mixture, which is accomplished by an igniting spark of the spark plug projecting into each cylinder of the engine. In order to initiate the igniting operation, the light emitted by a source and directed at a light sensitive switching element, is influenced by an actuator part driven by the engine.

In one known construction, in which the energy required for the ignition is inductively stored in an ignition coil, the light-sensitive element interrupts at the moment in which ignition is desired, the circuit of the primary winding of the ignition coil so that a high voltage impulse is produced in the secondary winding and supplied to the spark plug.

In capacitive ignition arrangements, in which the ignition energy is capacitively stored, the light-sensitive element effects at the moment at which ignition is desired, discharge of a previously charged capacitor through the primary winding of the ignition coil, so that a high voltage impulse is produced in the secondary winding for producing the desired spark at the spark plug.

The use of light operated control means for initiating an ignition operation has the advantage that the mechanically operated distributor contacts can be eliminated. Mechanical distributor contacts have the disadvantage that they are frequently scorched or soiled with oil, which results in malfunction, and that due to friction, bouncing back, and gradual deterioration of the contact pressure, the ignition is not always initiated at the exact moment at which it is desired.

The German Auslegeschrift 1,120,812 discloses the use of a source of light and of a light-sensitive switching element to replace a conventional mechanically operated distributor.

In the constructions of the prior art using light-operated control means in the ignition circuit of a combustion engine, the source of light and the light-sensitive electric switching element is directly mounted on the engine, and more particularly in the distributor housing of the same. The light-operated control means are subjected in this location to mechanical oscillations and

heat, so that they rapidly deteriorate. For example, if an incandescent filament lamp is used as a source of light, the oscillations of the distributor will soon cause breaking of the filament and consequent failure of the ignition. In the event that the light-sensitive electric element is a photodiode, or a phototransistor, the heat in the region of the engine and distributor will detrimentally influence the operations of these elements and of the entire electric ignition apparatus, since diodes and phototransistors are greatly influenced by heat.

Furthermore, in the prior art it is necessary to secure the source of light and the light-sensitive electric element by screws or like fastening means to the distributor housing, so that the oscillations of the same causes loosening of the threaded connections causing changes in the positions of the light-operated control means, which also jeopardizes the trouble-free operation of the ignition.

SUMMARY OF THE INVENTION

It is one object of the invention to provide a light-operated control means for controlling an auxiliary operation of an engine, for example, the ignition of the compressed fuel-air mixture of a combustion engine, which is arranged and constructed in such a manner that the apparatus is not subjected to heat and oscillations produced by the engine and parts of the same.

Another object of the invention is to provide a light-operated control means in which light emitted by a source is reliably guided to a light-sensitive element.

Another object of the invention is to arrange light-operated control means spaced from the distributor of a combustion engine, and to guide the light by light-guiding means into the region of the distributor where an actuator cyclically opens and closes the path of the light.

With these objects in view, the present invention relates to a light-operated control apparatus for controlling auxiliary operations of an engine, such as ignition or the injection of fuel.

One embodiment of the invention comprises a source of light and a light-sensitive means spaced from the engine, elongated light guiding means disposed between the source of light and the light-sensitive means, means for guiding light to the light-sensitive means along a path having a portion in the region of the engine, and actuating means moved by the engine across said portion of the path for cyclically varying the amount of light entering the light-sensitive means, and being spaced from the light-operated control means a predetermined distance.

Oscillations and heat produced by the engine and the actuating means, are not transmitted to the light-operated control means since the light-guiding means permits a substantial separation of the parts.

The term "engine" is used in the present application to define any engine or motor and its auxiliary devices, for example, a combustion engine and a distributor. The term "light-guiding means" is used in the present application to define means for guiding light not only along a straight path, but also along a curved path or around corners. For example, the "light guiding means" may include preferably flexible rods consisting of light-guiding longitudinal fibers, and tubular elements having inner reflecting mirror surfaces.

In the preferred embodiments of the invention, the light-guiding means include two light-guiding elements having first ends located opposite the source of light and a light-sensitive means, respectively, and second confronting ends forming a gap through which a revolving portion of a rotating actuating means cyclically passes. The revolving portion may be impermeable to light, or reflecting depending on the construction and arrangement of the two light-guiding elements. It is also advantageous

to provide a lens in the gap between the light-guiding elements and to adjust the position of the lens when the position of light-guiding elements is adjusted.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is partly a circuit diagram, and partly an elevation, partially in section, illustrating one embodiment of the invention applied to the ignition system of a combustion engine;

FIG. 2 is a diagram illustrating a modified circuit which may be combined with the embodiment of the invention shown in FIG. 1;

FIG. 3 is a fragmentary cross sectional view illustrating a part of a second embodiment of the invention;

FIG. 4 is a fragmentary cross sectional view illustrating a part of a third embodiment of the invention;

FIG. 5 is a fragmentary plan view, partially in section, illustrating a fourth embodiment of the invention; and

FIG. 6 is a fragmentary sectional view of a detail taken on line VI—VI in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to the embodiment of FIGS. 1 and 6, a combustion engine includes a cylinder block **2**, and a distributor **1** whose housing **26** is secured by brackets **5** to the cylinder block **2**. The engine has two cylinders provided with grounded spark plugs **3** and **4** which are connected with stationary contacts **6** and **7** of the distributor. A contact arm **8** cooperates with stationary contacts **6** and **7** and is mouned on an insulator **9** carried by the distributor shaft **10** which is driven by shaft **12** of the engine, as schematically indicated by the dash-and-dot line **11**. Contact arm **8** alternately engages contacts **6** and **7** during rotation of shaft **10**, and is connected by a contact spring **13** and a slide contact **14** with a line leading to the secondary winding **15** of an ignition coil **16** which has a primary winding **17**. One pair of ends of windings **15** and **17** are grounded, and the other end of primary winding **17** is connected by a line to a light-sensitive electric switching means **18** which is also connected by a switch **19** to the positive terminal of a battery **20** whose negative terminal is grounded. Switch **19** also connects the positive terminal of the battery with one terminal of a source of light, shown to be a lamp **21** whose other terminal is grounded. The light-sensitive means **18** is a photodiode connected in series with primary winding **17**, main switch **19**, and the battery **20**. Instead of a photodiode, a phototransistor, and instead of an incandescent lamp **21**, a glow discharge lamp, or luminescent diode may be used.

When no light enters light-sensitive means **18**, it has a high resistance so that a small current flows through primary winding **17**. When switch **19** is closed, lamp **21** lights up, and if light is guided by light-guiding means **22** from lamp **21** into light-sensing means **18** by light guiding means **22** in a manner which will be described hereinafter, the resistance of light-sensitive means **18** drops so that a high current flows through the primary winding. When the flow of light is interrupted, as will be described hereinatfer, the resistance of light-sensitive means **18** is greatly increased so that the flow of current through primary winding **17** is reduced to an extent corresponding to an interruption so that a high voltage impulse is induced in the secondary winding **15** of the ignition coil **16** which is transmitted through contacts **13**, **14**, contact arm **8**, and one of the stationary distributor contacts **6** and **7** to either spark plug **3** or spark plug **4** so that the respective spark plug produces a spark for igniting the fuel-air mixture in the respective cylinder of the combustion engine.

In accordance with the invention, the source of light **21** and the light-sensitive means **18** of the above-described light-operated control means are mounted on a support **23** spaced from the distributor **1** and the cylinders of the combustion engine **2**, for example on the wall which separates the engine of a car from the driver's compartment. Consequently, neither heat nor oscillations produced by the combustion engine can detrimentally influence the sensitive elements **18** and **21**. Light-guiding means **22** guide the light emitted by the source of light **21** along a path having a portion in the region of the distributor **1** into the light-sensitive means **18**. In the embodiment of FIG. 1, two elongated light-guiding means **22** are provided. One light-guiding means ends in the wall of the distributor housing **26** and has an end **22'** forming a gap **25** with the confronting end **22''** of the other light-guiding means **22** which has a straight portion merging into a U-shaped portion. The end portion of the second light-guiding element **22** is secured by clamp **27** to a carrier plate **28** which is secured to the housing **26** and has a bearing for distributor shaft **10**.

It will be seen that the light-guiding means **22** form a U-shaped path for the light, interrupted by gap **25** in which a lens **31** is located to guide light from end **22'** into the end **22''**. The light-guiding means **22** may be composed of tubular elements having mirror reflecting inner surfaces, or may be light-guiding rods consisting of parallel longitudinally extending light-guiding fibers.

An actuating means **24** is secured to distributor shaft **10** and rotates with the same. Actuating means **24** has two light impermeable portions *b* separated by light permeable openings *a* between the same. When distributor shaft **10** rotates together with actuating means **24**, the portions *b* and the portions *a* alternately pass through gap **25** between the ends **22'** and **22''** so that the flow of light through light guiding means **22** is cyclically interrupted in synchronism with the engagement of contact arm **8** with stationary distributor contacts **6** and **7**. Since the combustion engine has two cylinders, two light impermeable portions *b*, and two light permeable window portions *a* are provided.

Whenever the flow of light is interrupted by revolving portions *b*, the resistance of light responsive element **18** is rapidly increased, the current in the primary winding **17** is reduced, and a high voltage impulse passes through the respective distributor contact **6** or **7** to spark plug **3** or **4**.

It is advantageous to provide a centrifugal governor **30** between distributor shaft **10** and the actuating means **24** for regulating automatically the timing of the ignition. The carrier plate **28** on which the second light-guiding element **22** is mounted is preferably automatically adjusted by a regulating device **29** which is connected to the suction inlet of the combustion engine and operated by negative pressure to automatically regulate the moment of ignition. Since the adjustment of the flexible end of the light-guiding element effects a displacement of the end **22''** relative to lens **31**, it is necessary to adjust the lens so that the light guided from the lamp **21** through the first light-guiding element **22** and passing through the end **22'** of the same, is focused by lens **31** onto the displaced end **22''** of the other light-guiding element **22**.

Lens **31** is mounted on a curved support member **32** provided with a gear segment **32'**, as best seen in FIG. 6. Gear segment **32'** meshes with a first portion of a pinion **34** whose second portion meshes with a gear segment **35** in the outer cylindrical surface of carrier plate **28**. Pinion **34** has a shaft portion mounted in a bearing of a support plate **33** projecting from the wall **26** of the distributor. When the negative pressure adjusting device **29** displaces carrier plate **28** with the end **22'** of the light-guiding ele-

ment to vary the moment at which gap **25** is crossed by the portion *b* of the actuating means, the angular position of lens **31** is also automatically adjusted so that the light passing through the end **22'** is reliably directed by lens **31** into the end **22''**, although the same is no longer exactly aligned with the end **22'**. Due to the displacement of the beam of light between lens **31** and end **22''** by the negative pressure control device **29**, the moment at which a portion *b* passes the light path is changed, so that the light reaching the light-sensitive means **18** is sooner or later interrupted whereby the moment of ignition, and the timing of the same relative to the rotation of shaft **12** and of distributor shaft **10** is varied.

Shielding walls **36** are provided in the distributor housing **26** to protect lens **31** and the ends of the light-guiding means **22** from dust.

In the above-described arrangement, the path of the light is interrupted by a portion *b* of the actuating means **24** at the moment in which ignition is desired. It is also possible to produce an ignition spark of the spark plugs **3**, **4** by blocking the path of the light for the greater part of a rotation, and to open the light path at the moment of ignition. In such an arrangement, the circumferential length of the portions *b* is substantially greater than the circumferential length of the window portions *a*, and the control circuit is modified as shown in FIG. 2. The light-operated control means include in addition to a photodiode **18'**, also a NPN transistor **40**, a resistor **37**, and a limiting resistor **38**. Switch **19** connects the battery **20** with lamp **21**, and also connects photodiode **18'** through resistors **37**, **38** with the positive terminal of the battery. The base collector path of transistor **40** is connected in parallel to resistor **37**, and the emitter of transistor **40** is connected to the primary winding **17**. A secondary winding **15** is connected to the stationary distributor contacts **6**, **7** and to the spark plugs, as described with reference to FIG. 1.

When switch **19** is closed, and the path of light formed by light-guiding means **22** and lens **31** is interrupted in the gap **25** by a light-impermeable portion of actuating means **24**, the photodiode **18'** has such a high resistance that the base of transistor **40** has a positive potential in relation to the emitter so that the emitter collector path becomes conductive and a current flows through primary winding **17**. In the ignition moment, a window portion of the actuating means **24** passes through gap **25** and opens the path of the light so that the light entering photodiode **18'** reduces the resistance of the same to such an extent that the base of transistor **40** has a negative potential in relation to the emitter. Consequently, the emitter collector path, and thereby the current flowing through primary winding **17** is interrupted so that the high voltage impulse is induced in secondary winding **15** which causes an igniting spark on one of the spark plugs **3** or **4**, depending on the position of contact arm **8**.

FIG. 3 illustrates modified parts of an embodiment which otherwise corresponds to the embodiment described with reference to FIG. 1. The source of light **21** is farther spaced from the light-sensitive means **18**, and light-guiding elements **22***a* have angular ends mounted in the wall **26** of the distributor housing so that the end faces **22'** and **22''** are aligned along a chord of the cylindrical distributor wall and of the cylindrical wall *b* of actuating means **24***a* which rotates with the distributor shaft **10**. In order to permit the passage of light between the ends **22'** and **22'**, the cylindrical wall *b* has pairs of openings *a* aligned along two chords. Light can pass from end **22'** and through gaps **25** into end **22''** only when the openings *a* of a pair of openings are aligned, as shown in FIG. 3. Since the ignition system is assumed to be used with a two-cylinder combustion engine, and the ignition impulse is to be given by opening the path of the light between the source of light **21** and the light-sensitive means **18**, four openings *a* and four wall portions *b* are provided. During each revolution of actuating means **24***a*, the path of the light is twice opened and twice closed so that in each of the two cylinders, an igniting spark is produced at the respective spark plug **3** or **4**, as described with reference to FIG. 1.

A lens **31** is advantageously provided to focus and direct the light rays from end **22'** into end **22''**, since the distance between the ends **22'**, **22''** is comparatively great.

The actuating means **24***a* shown in the embodiment of FIG. 3 are provided with vanes **41** disposed close to the inner surface of the distributor wall and produce an air current during rotation of the actuating means with the distributor shaft **10**. If the light-guiding means **22***a* are fiber rods, dust is blown off the end faces **22'**, **22''**. If the light-guiding elements **22***a* are tubular and have inner mirror reflecting surfaces, the air current enters the tubular light-guiding element and blows dust out of the same, while simultaneously cooling the lamp **21** and the light responsive means **18**.

FIG. 4 illustrates modified parts of another embodiment which otherwise corresponds to the embodiment shown in FIG. 1. The light-guiding elements **22***b* have portions symmetrically slanted at an angle α and mounted in bores of the cylindrical wall of the housing **26**. The actuating means **24***b* has opposite light-reflecting portions *c* which are disposed to reflect light coming from the end **22'** of the first light-guiding element into the end **22''** of the second light-guiding element. The light-reflecting portions may be constructed as mirrors, or as prisms, and the portions of actuating means **24***b* between the reflecting portions *c* may be either nonreflecting, or windows. The ignition system controlled by the embodiment of FIG. 4 is again designed for a two-cylinder combustion engine, as described with reference to FIG. 1, and each of the reflecting portions *c* is correlated with one of the spark plugs **3** or **4** and assumes the operative position shown in FIG. 4 for the left reflecting portion *c* at the moment at which an ignition spark is desired while contact arm **8** engages the respective stationary distributor contact **6** or **7**, as described with reference to FIG. 1. When no reflecting surface is located in the gap **25**, the light beam projected from the end **22'** of the first light-guiding element **22***b* cannot enter the end **22''** of the second light guiding element **22***b* so that no light enters light-sensitive means **18**.

If the embodiment of FIG. 4 is to be modified to effect ignition at the moment in which the light entering light-sensitive means **18** is interrupted, the portions *c* are made of a nonreflecting material, or with a surface layer consisting of such a material, while the wide circumferential portions between the portions *c* have to be made with a light-reflecting surface.

FIG. 4 shows cleaning means in the form of a brush **42** secured to the inner surface of the distributor wall **26** and positioned so that the reflecting surfaces of the revolving portions *c* are wiped off and cleaned by brush **42** during each revolution of actuating means **24***b*. It is advantageous to provide cleaning brushes, not shown, also on the rotating actuating means **24***b* to wipe off the end face **22'**, **22''** if light-guiding fiber rods are used as light-guiding elements **22***b*. Such brushes may be secured to the actuating means anywhere between the light reflecting portions *c*.

FIG. 5 illustrates a modified portion of another embodiment of the invention which otherwise corresponds to the arrangement shown in FIG. 1. The light-sensitive means **18''** which must be a heat-resistant type, is mounted on the stationary carrier plate **28** with a heat insulating elastic dampening member **43** interposed so that light-sensitive means **18''** is not subjected to oscillations and heat produced by the combustion engine. The lamp **21** is mounted spaced from the combustion engine and distributor **1** on a supporting structure including a support plate **44** and a pair of springs **45** secured to the outer surface of the distributor housing wall **26**. A light-guiding means **22***c* guides the light emitted by a source

of light 21 along a straight path toward the light-sensitive means 18", and is supported in a bore of housing wall 26. The inner end of light-guiding means 22c forms a gap with light-sensitive means 18" through which revolving portions of actuating means 24, not shown in FIG. 5, pass during rotation. In FIG. 5, a portion of the top wall of the distributor 1 is broken out to permit a view at the light-sensitive means 18" which is located in the interior of the distributor housing. Support plate 44 may be made of metal and grounded and connected to one terminal of lamp 21. Springs 45 prevent the transmission of oscillation to lamp 21, and the spacing between lamp 21 and the distributor can be suitably selected, since the transmission of light to the light-sensitive means 18" from the lamp 21 is asured by the light-guiding means 22c. Since no oscillations are transmitted to the lamp 21, it can be constructed as an incandescent filament lamp.

In a modified construction, not shown, the lamp 21 is resiliently mounted on the carrier plate 28 in the place of the light-sensitive means 18" of FIG. 5, and light-sensitive means 18" is mounted on a spring-supported plate, as shown for lamp 21 in the construction of FIG. 5. The light-guiding means 22c assures an accurate guidance of light emitted by lamp 21 into the light-sensitive means 18".

The ignition circuits shown in FIGS. 1 and 2 represent an induction ignition system, but it will be understood that a capacitive ignition system can also be used with all embodiments of the invention. The discharge of a capacitor and the correlated production of an igniting spark is obtained by means of a source of light and a light-sensitive means, connected by light guiding means, as explained above.

Instead of the mechanically controlled distributor including distributor arm 8 and stationary distributor contacts 6 and 7, a distributor having switching elements operated by light rays may be used. The actuating means 24 is not necessarily mounted on the distributor shaft 10, but may be driven directly from the shaft of the combustion engine and combined with the flywheel of the same, or the flywheel may be constructed with light-permeable and light-impermeable portions and serve as actuating means 24.

The precisely timed control impulse produced by the arrangement of the invention, may be used for controlling other auxiliary operations of a combustion engine instead of the ignition. For example, the fuel injection may be timed by impulses produced when the path of light between a source of light and a light-sensitive means is opened or closed by an actuating means in synchronism with the piston movements of a combustion engine.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of light-operated control apparatus, differing from the types described above.

While the invention has been illustrated and described as embodied in a control apparatus for controlling the ignition timing of a combustion engine by means of light-operated control means which are spaced from the engine to prevent the transmission of oscillations and heat, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims:

1. Light-operated control apparatus for a combustion engine, comprising, in combination, light-operated control means for controlling an auxiliary operation of said combustion engine, and including a source of light and light-sensitive electrical means responsive to light variations, at least a part of said light-operated control means mounted independently from and being spaced a predetermined distance from said combustion engine so that oscillations and heat produced by said combustion engine are not transmitted to said source of light or to said light-sensitive electrical means; elongated light-guiding means disposed between said source of light and said light-sensitive electrical means for conducting light by repeated total reflection, and guiding the rays of light emitted by said source of light to said light-sensitive electrical means along a predetermined path having a portion in the region of said combustion engine; actuating means moved by said combustion engine across said portion of said path for cyclically varying the amount of light entering the light-sensitive electrical means; and an electrical control circuit connected to said light-sensitive electrical means for influencing the auxiliary operation of said combustion engine when the amount of light entering said light-sensitive electrical means varies.

2. Control apparatus as claimed in claim 1 wherein said actuating means crosses said portion of said path at a point located between said source of light and a light entrance end of said light-guiding means.

3. Control apparatus as claimed in claim 1 wherein said actuating means crosses said portion of said path at a point located between the light exit end of said light-guiding electrical means and said light-sensitive means.

4. Control apparatus as claimed in claim 1 wherein said light-guiding means include two light-guiding elements, said elements having first ends located opposite said source of light and said light-sensitive electrical means, respectively, and second ends forming a gap; and wherein said actuating means passes cyclically through said gap so as to be spaced from said light-operated control means a distance determined by the selected length of said light-guiding elements.

5. Control apparatus as claimed in claim 1 wherein said engine includes means for rotating said actuating means; and wherein said actuating means includes at least one light permeable portion and at least one light impermeable portion cyclically passing across said portion of said path for opening and closing the same for the passage of light.

6. Control apparatus as claimed in claim 1 wherein said light-guiding means include two light-guiding elements, said elements having first ends located opposite said source of light and said light-sensitive electrical means, respectively, and second ends forming a gap; and wherein said actuating means has reflecting portion which cyclically passes through said gap for reflecting light from one of said light-guiding elements into the other; and wherein said actuating means is spaced from said light-operated means a distance determined by the selected length of said light-guiding elements.

7. Control apparatus as claimed in claim 1 wherein said light-guiding means include two light-guiding elements, said elements having first ends located opposite said source of light and said light-sensitive electrical means, respectively, and second ends forming a gap; including at least one lens located in said gap; and wherein said actuating means passes cyclically through said gap so as to be spaced from said light-operated means a distance determined by the selected length of said light-guiding elements.

8. Control apparatus as claimed in claim 1 comprising automatic adjusting means controlled by said engine for adjusting the position of said light-guiding means so that the moment at which said light-operated control means controls said auxiliary operation is adjusted.

9. Control apparatus as claimed in claim 8 comprising at least one lens located in said path; means for supporting said lens for movement; and wherein said automatic adjustment means also adjusts the position of said lens.

10. Control apparatus as claimed in claim 1 including cleaning means for automatically cleaning said light-guiding means and carried by said actuating means.

11. Control apparatus as claimed in claim 1 wherein said actuating means include a reflecting portion; and including stationary cleaning means for cleaning said reflecting portion.

12. Control apparatus as claimed in claim 1 wherein said light-guiding means include tubular means having a reflecting inner surface; and wherein said actuating means include means for producing an air current directed into said tubular means.

13. Control apparatus as claimed in claim 1 including shielding means for protecting at least said light-guiding means from dust.

14. Control apparatus as claimed in claim 1 wherein said engine comprises ignition means having an electric circuit, and a rotary distributor shaft; wherein said light-operated control means include switch means located in said circuit; and wherein said actuating means is mounted on said distributor shaft.

15. Control apparatus as claimed in claim 13 comprising a distributor housing; and resilient means for supporting at least a part of said light-operated control means on said housing spaced from the same so that heat and oscillations are not transmitted from said housing to said part of said light-operated control means.

16. Control apparatus as claimed in claim 1 wherein said combustion engine including a distributor and igniting means; comprising supporting means for said source of light and for said light-sensitive electrical means spaced from said distributor; wherein said light-guiding means include two light-guiding elements forming a gap in the region of said distributor and having ends, respectively, located adjacent said source of light and said light-sensitive means; wherein said actuating means rotates in timed relation with said engine and has at least one revolving portion passing through said portion of said gap; wherein said light-sensitive electrical means is adapted to vary its resistance under the influence of light; and a circuit including means connected to said light-responsive means, and through said distributor, to said igniting means for producing a spark in the latter when the resistance of said light-sensitive means varies.

References Cited

UNITED STATES PATENTS

2,084,267	6/1937	Hicks.	
3,163,700	12/1964	Williamson	88—22.5

LAURENCE M. GOODRIDGE, Primary Examiner

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88—22.5; 184—6; 200—19.