

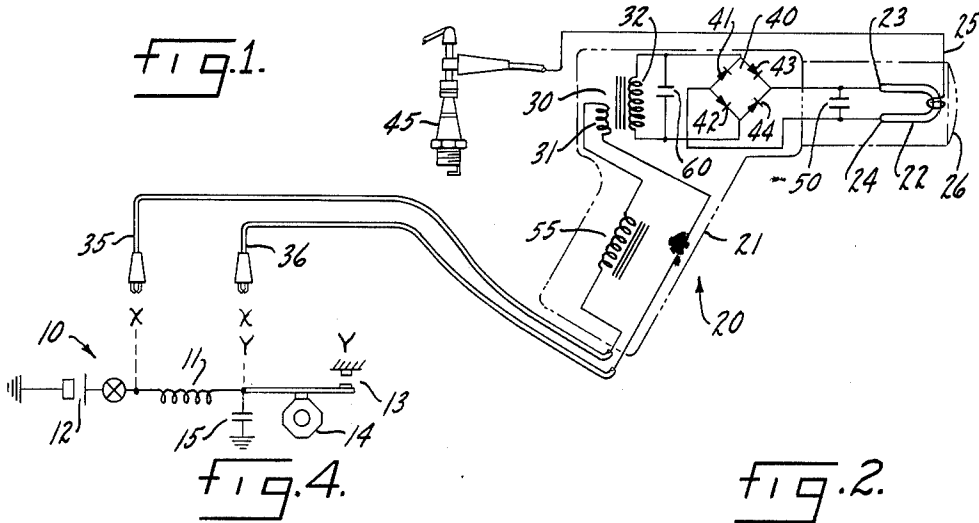
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V. C. WESTBERG

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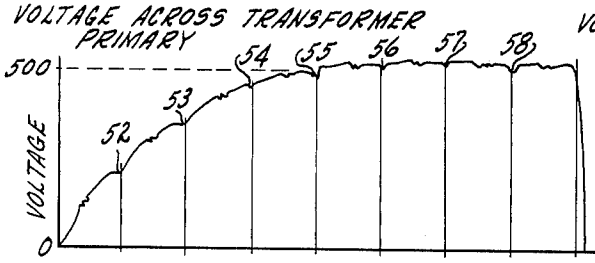
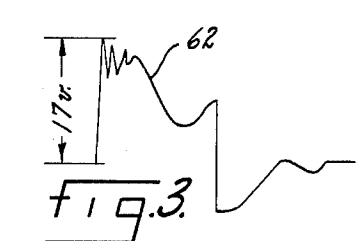
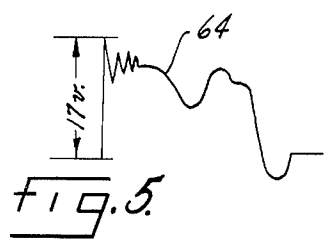
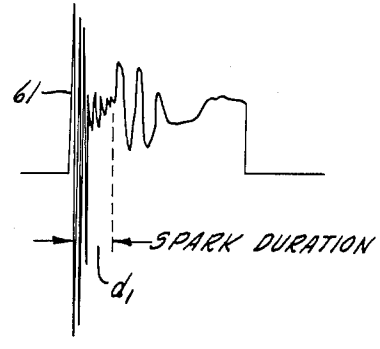
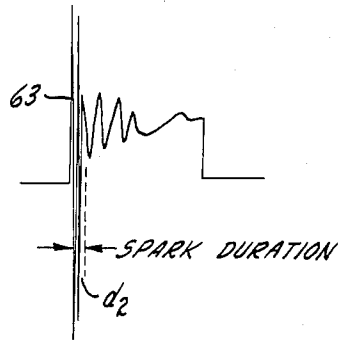
DEVICE FOR PRODUCING STROBOSCOPIC LIGHT FOR TIMING ENGINES

Filed July 11, 1962



VOLTAGE ACROSS BREAKER POINTS

VOLTAGE ACROSS IGNITION COIL



BUILDUP ACROSS CAPACITOR

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DEVICE FOR PRODUCING STROBOSCOPIC LIGHT FOR TIMING ENGINES

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3 Claims. (Cl. 315-241)

The present invention relates to stroboscopic means for timing automobile engines or the like.

It is an object of the present invention to provide a stroboscopic light source for timing automobile engines which produces a bright light but which does not depend upon A.-C. power lines or other auxiliary source of power for its energization. More specifically, it is an object to provide a stroboscopic device which is fed from the automobile ignition system and which may therefore be used at locations remote from the power lines but which has a light output which is much greater than that obtained in the usual "self-powered" stroboscopic units, permitting accurate readings under high level ambient light conditions, even outdoors in the presence of sunlight. Nevertheless it is an object to provide an automotive timing light which has minimum loading effect upon the ignition system and minimum effect upon the spark, and hence the operation, of the engine being timed. It is a related object to provide a stroboscopic timing light which is actuated by the regular breaker points but which does not have any deleterious effect upon the points during extended or repeated testing.

It is another object of the invention to provide a stroboscopic timing device which is easily connected to the engine and in which the energizing leads may be connected to the ignition system of all voltages in common use and without regard to polarity and therefore without risk of damage upon making an incorrect connection. In this connection it is an object to provide a stroboscopic timing device which may be employed with equal advantage on grounded-negative and grounded-positive systems. It is a related object to provide a stroboscopic timing device for automotive engines which is flexible in use, which may be employed with all automotive ignition systems, and which may be alternatively connected, for supply, to different portions of the ignition system at the choice of the user.

It is one of the important objects of the present device to provide means for building up the supply voltage at a rate which is coordinated with the firing or triggering impulse thereby insuring that voltage is built up gradually to a reliably high level for firing only once during each complete ignition cycle of the engine. Conversely, it is an object to provide a stroboscopic device which insures that the voltage will not be built up to a level which is so high as to jeopardize the electrical components, particularly where the triggering circuit is inadvertently left unconnected.

Finally, it is an object to provide a stroboscopic timing device which is completely portable, requiring only the automotive ignition system for supply and triggering, which may be made highly compact with all of the parts built into a pistol-shaped housing, which uses low cost, readily available components and which, being free of the moving parts or contact points, has a long and reliable useful life.

Other objects and advantages of the invention will become apparent upon reading the attached detailed description and upon reference to the drawings in which:

FIGURE 1 is a pictorial, semi-schematic diagram showing a timing light constructed in accordance with the present invention.

FIG. 2 is a plot of the voltage across the primary of the ignition coil.

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FIG. 3 shows the voltage across the transformer primary where the unit is connected in parallel with the ignition coil.

FIG. 4 shows the voltage wave across the breaker points.

FIG. 5 shows the voltage wave across the transformer primary where the device is energized by the voltage across the breaker points.

FIG. 6 shows the build-up of voltage across the storage capacitor in a single, complete ignition cycle.

While the invention has been described in connection with the preferred embodiment, it will be understood that I do not intend to be limited to the embodiment shown but intend to cover the various alternative and equivalent arrangements included within the spirit and scope of the appended claims.

Referring to the drawing, the common form of automotive ignition system indicated at 10 includes an ignition coil 11, only the primary of which is shown, supplied from a storage battery 12 and turned on and off by a cam driven breaker switch having breaker points 13 cycled by a cam 14. The usual condenser 15 connects the ungrounded point to ground.

A stroboscopic timing device constructed in accordance with the present invention, and indicated at 20 in the drawing, may be housed in a pistol-shaped housing 21, having a flash tube 22 at its front end. This flash tube has a pair of supply terminals 23, 24 as well as a triggering terminal 25. The tube does not per se constitute part of the present invention and tubes of this kind may be secured from a number of commercial manufacturers. I prefer to employ an F-55 tube which is filled with xenon gas giving a blue-white flash manufactured by the Kemlight Laboratories of Chicago, Illinois, and described in their engineering data sheet, "Kemlight Strobic F-55 Series Flash Tubes." A collimating lens 26 is employed adjacent the tube 22 for the purpose of forming the light into a coherent beam.

For the purpose of providing the direct voltage for application to the input or supply terminals 23, 24 of the tube, a step-up transformer 30 is used having a primary winding 31 and a secondary winding 32. The primary winding is connected, through a pair of leads 35, 36, to the primary coil 11 of the ignition system 10 for periodic energization upon opening and closing of the breaker points. Alternative connections are provided as covered in a later paragraph. For the present, it will suffice to say that voltage impulses are received by the primary winding 31 and stepped up to a higher voltage level in the secondary winding 32, the ratio being on the order of 35:1. The high voltage is then rectified by a bridge rectifier 40 having diodes 41-44 connected as shown and with the output of the bridge being connected to the supply terminals 23, 24 of the flash tube.

In carrying out the present invention the triggering terminal 25 of the flash tube is connected to one of the spark plugs, for example, the "number one" plug indicated at 45, and a storage capacitor is provided in parallel with the supply terminals 23, 24 of the tube capable of charging to substantially full voltage during each complete ignition cycle and prior to the successive firings of the spark plug 45. In the present instance the storage capacitor, indicated at 50, has a capacitance on the order of two to three microfarads. The build-up of voltage across the storage capacitor during a typical cycle is set forth in FIG. 6. Here it will be noted that the first actuation of the contact points incident to the firing of spark plug number two causes the voltage across the capacitor to be built up to point 52. Successive breaker point operations cause progressive build-up as indicated at 53-58, with the voltage becoming asymptotic to the

horizontal. When spark plug 45 fires, which is "number one" in the series, the discharge path within the tube 22 is broken down by field ionization so that the energy of the capacitor 50 is discharged through the tube causing an intense flash of light.

For the purpose of protecting the diodes 41-44, particularly where the triggering lead is left unconnected, a capacitor 60 is connected in parallel with the transformer secondary winding. In a practical case this capacitor may have a capacitance of 0.1 mfd. and a voltage rating of, say, 400 volts D.-C. The capacitor tends to shunt out any transient peaks which might otherwise exceed the inverse voltage rating of the diodes. The diodes are preferably of the silicon type capable of passing one-half ampere and having a voltage rating of about 600 volts.

It is one of the features of the present circuit that exciting voltage may be secured by two alternative connections to the ignition system. To minimize the effect upon the regular ignition, i.e., to insure complete and positive opening of the coil primary circuit when the points open, the leads 35, 36 are preferably connected in parallel with the primary winding 11 of the ignition transformer, i.e., across the points X—X in FIG. 1. Thus each time the breaker points 13 cycle an impulse is applied to the primary winding 31 of the transformer 30. While the current drawn by the timing device must pass through the breaker points 13, it is found that this additional load is a minor one and the wear upon the breaker points is negligible even in the face of extended or repeated operation.

Where it is desired to minimize current which must flow through the breaker points, dependence may be placed upon the residual or stored energy in the ignition transformer by connecting the timing device across the breaker points, i.e., across the points Y—Y in FIG. 1. Using such connection the transformer primary is shorted during the dwell but open to receive the voltage existing across the points when the latter are open. For the purpose of preventing loss or shorting out of the high frequency components, on the order of 10 kc./sec., which exist across the winding 11 when the points open and which primarily contribute to the spark means are employed providing additional inductive resistance in the circuit of the primary winding; thus, an isolating and current-reducing inductance 55 is preferably included in series with the transformer winding 31. The inductance 55 preferably has a reactance on the order of 1.3 millihenries. The residual voltage which is non-useful as far as the creation of a spark is concerned, being of a lower frequency on the order of two kc./sec. is more readily passed by the inductance 55 and is utilized, with a high degree of efficiency, across the primary winding 31 of the step-up transformer. Where the input connection is made across points X—X instead of across points Y—Y, the inductive reactance may have a value lower than that given above but the total impedance should nevertheless be sufficiently high to insure that battery current is not shunted away from the ignition coil. Moreover, it is desirable for the voltage to be built up progressively over the ignition cycle; thus, adjusting the reactance serves as a convenient means for varying the shape of the voltage build-up wave (FIG. 6).

The gradual build-up of the voltage across the capacitor means that the energy used in flashing the tube is subtracted from the ignition system in small amounts spread over a large portion of the total engine cycle and without imposing any substantial loading upon the firing of individual spark plugs. Moreover, since the voltage across the capacitor 50 and hence across the tube 22 is low during a large initial portion of the cycle, the likelihood of double firing as a result of voltages which may be induced in the triggering line by the firing of other spark plugs is minimized.

The voltage waves secured in the alternative forms

of supply connection are quite similar and may be understood by comparing FIGS. 2, 3 with FIGS. 4, 5. Thus referring to FIG. 2 which shows the voltage 61 across the ignition coil primary using the X—X connection, the ten kilocycle component gives a spark duration $d-1$, the remainder of the energy of the wave being residual. The resulting voltage across the primary winding 31 and on the downstream side of the series inductance 55 is shown at 62, having a peak value of approximately 17 volts. It is the voltage wave 62 which, stepped up by transformation, produces the voltage impulse which is rectified, with the energy thereof stored in the storage capacitor 50. Where the alternative connection is made to points Y—Y, the voltage appears as indicated at 63 giving a somewhat shorter spark duration $d-2$ as shown in FIG. 4. The resulting voltage impulse across the primary of the step-up transformer 31 appears as indicated at 64 in FIG. 5. The similarity between the wave 62 in FIG. 3 and 64 in FIG. 5 is apparent. Both make use of the residual energy in the ignition coil. In both the peak voltage, 17 volts, is appreciably higher than the battery voltage of 12 volts. The alternative connections make it possible for the operator to use either one or the other depending upon individual preference and depending upon which gives the better result in a particular application.

It is one of the features of the present timing light that it may be employed in either 6 volt or 12 volt systems without requiring either switching or circuit adjustment. Thus it is found that when the device is employed with a 6 volt ignition system the voltage produced across the storage capacitor 50 is only about 10 to 15% less than that which is attained in a 12 volt system and in any event is at a sufficiently high level as to produce a reliable high intensity burst of illumination from the tube upon triggering. This shows that the energy for the device is derived mainly from the energy stored in the field of flux in the ignition coil and which is released at the time the points are opened, which energy is the same in 6 and 12 volt systems, and that only a minor portion of the energy is supplied by direct D.-C. flow from the battery. Moreover, the operator need not keep track of the polarity of the supply leads 35, 36. These may both be of the same color and may be interchanged with one another without affecting the operation of the device in any way. Thus there is no risk of damage upon reversing the connections and instructions to the operator may be minimized.

The present device produces a light output which is equal to that obtained when supplying the charging circuit from the 60 cycle A.-C. supply line, or special vibration type supply, yet the device is independent of the regular supply lines enabling use in remote locations. It is even possible to take readings with the vehicle in motion.

While the operation has been described in connection with an eight cylinder engine, and while gradual buildup of voltage across the tube is desirable it will be noted in FIG. 6 that buildup of voltage is caused to occur primarily during the first four charging intervals so that reliable firing, with high intensity light output, is achieved even in the case of four or six cylinder engines. Regardless of the number of cylinders, the circuit is so arranged that charging occurs during the main portion of the total engine cycle with discharge, or firing, at the end of the cycle and with the operation being repeated over and over again as long as the connections are made and as long as the engine is in operation. Because of the frequent discharge there is no possibility of unwanted voltage buildup which might endanger one or more of the components, for example, the rectifying diodes. However, even if the operator should inadvertently forget to connect the triggering circuit, the provision of the capacitor 60 insures against any transient voltage being applied to the diodes which might exceed their inverse voltage rating.

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It will be apparent that the parts which have been used in the present circuit are readily available and inherently inexpensive so that the timing light notwithstanding its numerous advantages may be manufactured and sold at reasonable cost. Because of the lack of contacts or moving parts, reliable operation may be secured over long periods of time.

In the following claims the term "breaker points" refers generally to the switch, or switching device, which actually controls the flow of current from the battery to the primary of the ignition coil.

I claim as my invention:

1. In a device for producing stroboscopic light for timing an engine having a spark ignition system including a battery and ignition coil, the latter having in its primary circuit breaker points shunted by a condenser, the combination comprising a step-up transformer having a primary and secondary, a rectifier connected to the secondary for producing a high voltage D.-C. output, a flash tube having supply terminals and a triggering terminal with the supply terminals being connected to the output of the rectifier, means for connecting the transformer primary to the ignition coil primary for periodic energization of the transformer by release of energy stored in the coil as the breaker points are opened, a storage capacitor connected in parallel with the supply terminals of the flash tube for progressive buildup of voltage thereacross upon successive closure of the ignition points during a complete firing cycle of the engine, and means for connecting the triggering terminal of the flash tube to one of the spark plugs for firing of the tube once during said cycle coordinated with the buildup of voltage across the storage capacitor to a predetermined level.

2. In a device for producing stroboscopic light for timing an engine having spark ignition including a battery and ignition coil, the latter having in its primary circuit breaker points shunted by a condenser, the combination comprising a step-up transformer having a primary and secondary, means for connecting the transformer primary to the ignition coil primary for periodic energization thereof by release of energy stored in the coil upon opening of the breaker points, a rectifier connected across the secondary of said transformer and having output terminals, a flash tube having supply terminals and a triggering terminal with the supply terminals being connected to the output terminals of the rectifier and with the triggering terminal being connected to one of the spark plugs

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for periodic firing of the tube, a storage capacitor connected across the output of the rectifier, the primary winding having an inductance winding in series therewith for reducing the loading effect of the primary winding upon the high frequency components of the ignition wave.

3. In a device for producing stroboscopic light for timing an engine having a spark ignition system including a battery and ignition coil, the latter having in its primary circuit breaker points shunted by a condenser, the combination comprising a step-up transformer having a primary winding and a secondary winding, a rectifier connected to the secondary winding for producing a high voltage D.-C. output upon flowing of pulses of current in the primary winding, a flash tube having supply terminals and a triggering terminal, the supply terminals being connected to the output of the rectifier and the triggering terminal having means for connection to one of the spark plugs for initiating the flash, a storage capacitor connected across the supply terminals of the flash tube, means for connecting the primary winding of the transformer to the primary winding of the ignition coil so that the primary winding of the transformer is subjected to current impulses from the primary winding of the ignition coil upon opening of the breaker points and by reason of the release of the field energy stored in the ignition coil in addition to the direct component of current which flows directly from the battery, and means providing additional inductive reactance in the primary circuit of the transformer to reduce the loading effect of the transformer upon the high frequency components of the current from the ignition coil primary at the time that the points are open and the spark is taking place so that voltage is built up across the storage capacitor in step with the firing of the remaining spark plugs gradually to a maximum condition.

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