

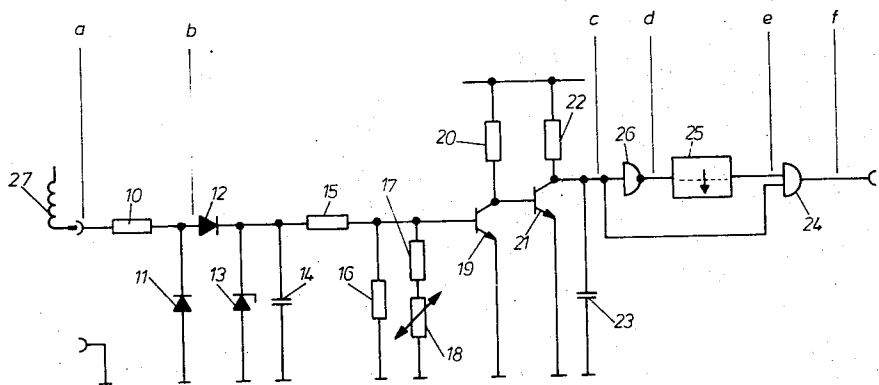
- [54] **ARRANGEMENT FOR DETERMINING THE TIMING OF IGNITION OF A CYLINDER OF AN INTERNAL COMBUSTION ENGINE**
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- [73] Assignee: **Robert Bosch GmbH**, Stuttgart, Germany
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- [52] **U.S. Cl.**.....**324/16 R**
- [51] **Int. Cl.**.....**G01m 15/00, F02p 17/00**
- [58] **Field of Search**.....**324/15-19; 73/116-119**

- [56] **References Cited**
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- Primary Examiner*—Michael J. Lynch
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[57] **ABSTRACT**

A signal is derived from the primary of the ignition coil. The signal is amplitude limited, has negative portions removed, and is smoothed and extended in time by a determined time interval. The trailing edge of the so-extended signal is steep since it results from cut off from a transistor. The leading edge of the pulse is used to trigger a multivibrator having a negative output signal. The multivibrator signal and the extended signal are applied to an AND gate where the output comprises the extended signal after subtraction of the negative pulse from the multivibrator. The resulting signal has a determined phase angle to the start of the spark and a rectangular shape with sharp leading and trailing edge.

14 Claims, 7 Drawing Figures



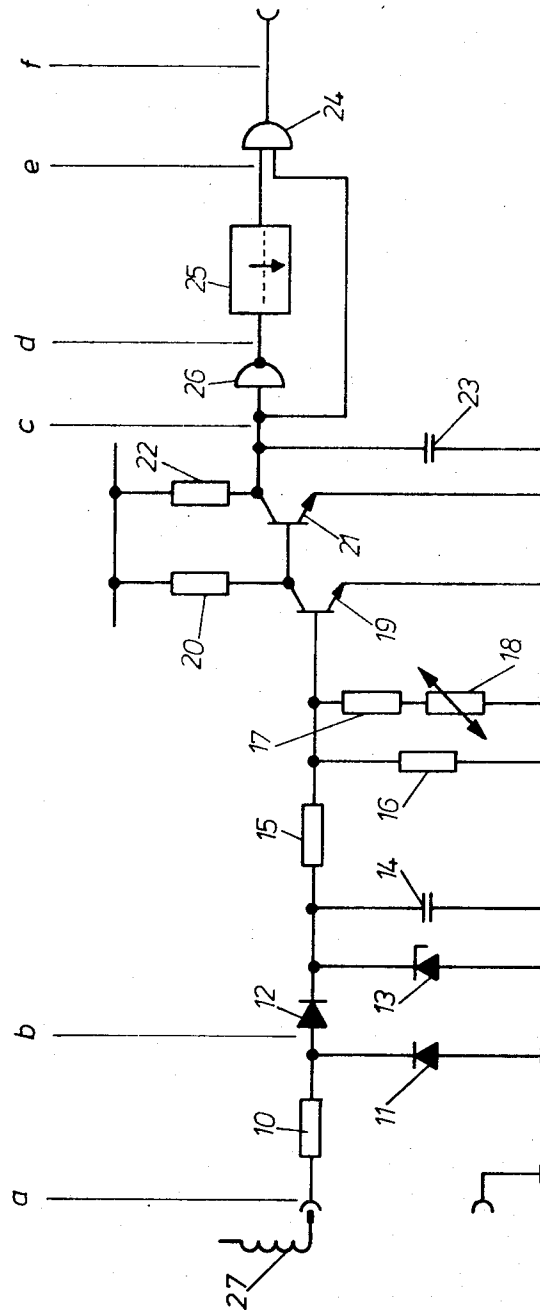


Fig.1

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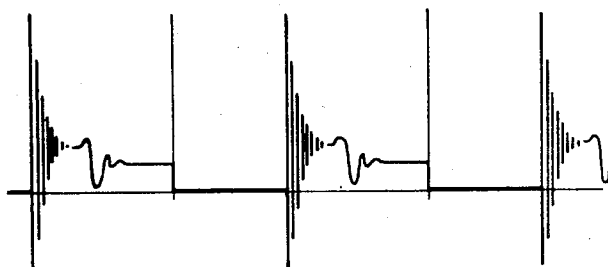


Fig. 2a

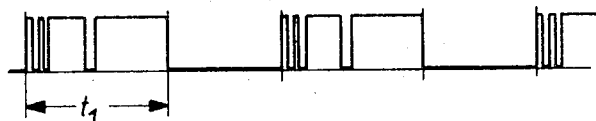


Fig. 2b

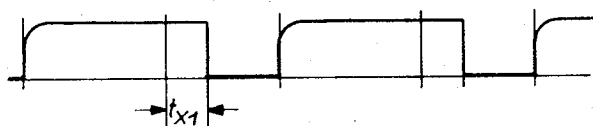


Fig. 2c

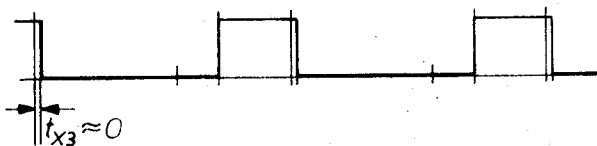


Fig. 2d

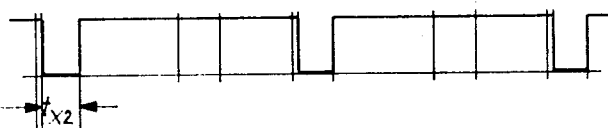


Fig. 2e

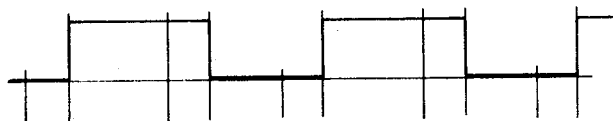


Fig. 2f

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ARRANGEMENT FOR DETERMINING THE TIMING OF IGNITION OF A CYLINDER OF AN INTERNAL COMBUSTION ENGINE

BACKGROUND OF THE INVENTION

This invention relates to an arrangement for furnishing a signal suitable for determining the timing of the interruptor switch in an ignition system in commercial vehicles.

In commercial vehicles, it is important to know the exact angle through which the shaft of the distributor travels while the interruptor switch is closed. This angle will herein be referred to as the angle of closure and its exact measurement is of greatest importance, since the energy available at the time of the spark depends greatly on this value. Further, it is desirable to measure the angles of closure of each cylinder and thereby derive an indication of the cam displacement in a multi-cylinder combustion engine.

SUMMARY OF THE INVENTION

It is an object of the present invention to furnish a signal indicative of the angle of closure as defined above. It is desirable that such a signal be a pulse having a flat, un-interrupted top, a steep leading and trailing edge, but not having any undesirable increase in pulse width over the actual open time of the interruptor switch.

This invention comprises an arrangement for an internal combustion engine having an interruptor switch and a distributor shaft, and means for timing the operation of said interruptor switch in dependence upon the angular position of said distributor shaft. The invention comprises first signal furnishing means furnishing a first signal starting upon opening of said interruptor switch and terminating upon reclosure of said interruptor switch. It further comprises smoothing means having an input connected to said first signal furnishing means and a smoothing output and furnishing a second signal at said smoothing output, said second signal starting at a time corresponding to the starting time of said first signal and terminating at a terminating time corresponding to the terminating time of said first signal increased by a predetermined time interval. Further comprised, are pulse forming means furnishing a first pulse having a pulse width corresponding to said predetermined time interval, upon activation. Circuit means are provided for activating said pulse furnishing means at a time corresponding to the starting time of said first signal. Finally, logic circuit means have a first input connected to said pulse furnishing means, a second input connected to said smoothing output, and having an output furnishing an output pulse having an output pulse width corresponding to the pulse width of said second signal decreased by said first pulse width. This output pulse constitutes the timing signal. It has a pulse width which corresponds to the opened time of the interruptor switch and a predetermined phase shift relative to the starting time of the first signal, that is relative to the opening of the interruptor switch.

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 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 shows a circuit diagram of an arrangement of this invention; and

FIGS. 2a-2f are diagrams showing the pulses at various points of the circuit of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the invention will now be discussed with reference to the drawing.

The primary winding of an ignition coil 27 is connected to the first terminal of a resistance 10, whose second terminal is connected to the cathode of a diode 11 and an anode of a diode 12. The cathode of diode 12 is connected to the cathode of a Zener diode 13. The anodes of diodes 11 and 13 are connected to ground potential. The cathode of diode 12 is further connected to a capacitor 14 whose other terminal is also connected to ground and to a resistance 15 at whose other terminal is connected a parallel circuit comprising, in its first arm, a resistance 16 and in its second arm a resistance 17 series-connected to a variable resistance 18 which is a negative temperature coefficient resistor. Further, resistance 15 is connected to the base of a transistor 19. The emitter of transistor 19 is connected to ground, while its collector is connected to the positive side of the supply (first voltage terminal) via a resistance 20. The collector of transistor 19 (second amplifier means) is further connected to the base of a transistor 21 (first amplifier means). The emitter of transistor 21 is connected to ground potential (second voltage terminal). The collector of transistor 21 is connected to the positive side of the supply via a resistor 22 and to ground via a capacitor 23 herein called a delay capacitor. Similarly, resistor 22 is herein referred to as delay resistance means. The collector of transistor 21 is further connected to the input of an inverter 26 whose output is connected to trigger a monostable multivibrator 25 (pulse furnishing means) into the unstable state. The output of monostable multivibrator 25 is connected to the first input of logic circuit means, here an AND gate 24. The second input of AND gate 24 is directly connected to the collector of transistor 21.

The above arrangement operates as follows: The first signal is shown in line a of FIG. 2. It is furnished at the point labeled a in FIG. 1 and is derived from the primary circuit of the ignition coil. The signal resulting from diodes 11, 12, 13, as well as resistance 10 when operating upon the signal shown in line a is shown in line b of FIG. 2. Specifically, diode 11 serves to remove the negative spikes shown in the signal on line a of FIG. 2, while Zener diode 13 limits the maximum positive amplitude to a value corresponding to the break-down voltage of said Zener diode. This break-down voltage must be such that the positive voltage is limited to a voltage under the battery voltage of the vehicle. In this manner, capacitor 14 is always charged to the same voltage. The condenser charges with a time constant $t_1 = R_{10} \cdot C_{14}$. The discharge is with a time constant equal to:

$$t_2 \approx C_{14} \{ R_{15} + [R_{16} // (R_{17} + R_{18})] // R_e \}.$$

R_e is the input resistance of transistor 19. If the charging time constant t_1 is equal to a greater than $3t_2$, the capacitor 14 serves to smooth the signal so that the

signal at the collector of transistor 19 has a smooth top and has a pulse width which is increased by the amount labeled t_{x1} in line *c* of FIG. 2. This increase in pulse width results from the fact that transistor 21 remains blocked for the time t_{x1} , since transistor 19 remains conductive until the voltage at its base (as determined by the discharge of capacitor 14) reaches a cut-off value.

It should be noted here that the break-down voltage of Zener diode 13, as well as the characteristics of the other semi-conductors vary somewhat in dependence upon temperature. The function of negative temperature coefficient resistor 18 is to afford a compensation for this variation, by suitable adjustment of the time constant t_2 .

The output pulse at the collector of transistor 21 is shown in line *c*, as mentioned above. This pulse thus contains information about the angular rotation of the distributor switch while the interruptor switch is open, or, alternatively, the distance between consecutive pulses indicates how far the shaft travels between sequential interruptor switch activations. The total pulse width of the pulse is $t_1 + t_{x1}$. This output signal is applied via an inverter (whose output is shown in line *d* of FIG. 2) to the input of a monostable multivibrator 25. It switches the monostable multivibrator to its unstable state. The output of the monostable multivibrator has a constant pulse width. It is shown in line *e* of FIG. 2. It is seen that this is a negative pulse of pulse width t_{x2} . It is applied directly to one input of AND gate 24 whose second input is directly connected to the collector of transistor 21. The AND gate thus forms the difference between the elongated pulse shown in line *c* and the output pulse of the multivibrator, namely the negative pulse of width t_{x2} shown in line *e* of FIG. 2. Capacitor 23, which is connected from the collector of transistor 21 to ground serves to delay the leading edge of the signal at the collector of the transistor with a delay corresponding to the time constant $t_3 = C_{23} \cdot R_{22}$. This is necessary so that the time delay generated in multivibrator 25 is compensated for. If this were not the case, AND gate 24 would furnish a short pulse immediately upon application of the signal shown in line *c* to its input terminal.

The delay time is indicated by t_{x3} in line *d* of FIG. 2 and is substantially equal to zero. The output pulse of AND gate 24, if t_{x1} is made equal to t_{x2} , is thus a signal whose pulse width corresponds to the angle of rotation of the distributor shaft while the interruptor switch is opened, and which has a time delay relative to the opening of the interruptor switch which is equal to $t_{x2} + t_{x3}$. It has a rectangular shape with a sharp leading and trailing edge, and is thus particularly suitable for use in a measuring instrument or data processing arrangement. The displacement between cams on the distributor shaft can be determined by furnishing signals such as the above for each cylinder and then deriving average values from such signals.

While the invention has been illustrated and described as embodied in specific smoothing and logic circuits, it is not intended to be limited to the details shown, since various modifications, structural and circuit 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.

I claim:

1. In a vehicular ignition system having an interruptor switch, a shaft, and means timing the operation of said interruptor switch in dependence upon the angular position of said shaft, an arrangement for furnishing a timing signal indicative of the angle of rotation of said shaft while said interruptor switch is open, comprising, in combination, first signal furnishing means furnishing a first signal upon opening of said interruptor switch and terminating upon reclosure of said interruptor switch; smoothing circuit means connected to said first signal furnishing means and furnishing a second signal at a smoothing output, said second signal starting at a starting time corresponding to the starting time of said first signal, and terminating at a terminating time corresponding to the terminating time of said first signal increased by a predetermined time interval; pulse furnishing means furnishing a first pulse having a first pulse width corresponding to said predetermined time interval upon activation; means activating said pulse furnishing means at a time corresponding to said starting time of said first signal; and logic circuit means having a first input connected to said pulse furnishing means and a second input connected to said smoothing output, said logic circuit means furnishing an output pulse having an output pulse width corresponding to the width of said second signal decreased by said first pulse width.

2. An arrangement as set forth in claim 1, wherein said ignition system comprises an ignition coil connected to said interruptor switch, said ignition coil having a primary winding and a secondary winding; and wherein said first signal furnishing means comprise connecting means connecting said primary winding to said smoothing means.

3. An arrangement as set forth in claim 1, wherein said smoothing means comprise an input receiving said first signal; first capacitor means; charging resistance means connecting said first capacitor means to said input; a voltage source having a first and second voltage terminal; discharge resistance means connecting said capacitor to said second voltage terminal; first amplifier means having a first control electrode and a first output circuit; and means connecting said first control electrode to said discharge resistance means.

4. An arrangement as set forth in claim 3, wherein said pulse furnishing means comprise a monostable multivibrator; and wherein said means activating said pulse furnishing means comprise additional connecting means connecting the input of said monostable multivibrator means to said first output circuit.

5. An arrangement as set forth in claim 4, wherein said means connecting said first control electrode to said discharge resistance means comprise second am-

plifier means having a second amplifier output circuit connected to said first control electrode, and a second amplifier control electrode connected to said discharge resistance means.

6. An arrangement as set forth in claim 5, further comprising negative temperature coefficient resistance means connected to said second amplifier control electrode.

7. An arrangement as set forth in claim 5, further comprising delay circuit means connected to said second amplifier output circuit.

8. An arrangement as set forth in claim 7, wherein said delay circuit means comprise a delay capacitor; and delay resistance means connected in series with said delay capacitor.

9. An arrangement as set forth in claim 7, wherein said additional connecting means comprise inverter means.

10. An arrangement as set forth in claim 9, wherein said logic circuit means comprise an AND gate.

11. An arrangement as set forth in claim 10, wherein said first and second amplifier means respectively comprise first and second transistor means, said first and second transistor means respectively having a first and second emitter-collector circuit and a first and second

base.

12. An arrangement as set forth in claim 11, wherein said delay capacitor has a first terminal connected to said collector of said first transistor and a second terminal connected to said voltage terminal; and wherein said delay resistance means is connected between said collector of said first said transistor and said first voltage terminal.

13. An arrangement as set forth in claim 12, further comprising first diode means having an anode connected to said second voltage terminal and a cathode connected to said charging resistance means; second diode means having an anode connected to said charging resistance means and a cathode; Zener diode means having an anode connected to said second voltage terminal and a cathode connected to said cathode of said second diode means.

14. An arrangement as set forth in claim 13, wherein said discharge resistance means comprise a first resistor connected between said cathode of said Zener diode and said base of said second transistor means; and second discharge resistance means connected between said base of said second transistor means and said second voltage terminal.

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