(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 344 349 B1**

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **07.12.94** (51) Int. Cl.[5]: **F02P 11/06**, F02P 17/00

(21) Application number: **88108869.4**

(22) Date of filing: **03.06.88**

(54) Detecting misfiring in spark ignition engines.

(43) Date of publication of application:
06.12.89 Bulletin 89/49

(45) Publication of the grant of the patent:
07.12.94 Bulletin 94/49

(84) Designated Contracting States:
DE FR GB IT SE

(56) References cited:
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PATENT ABSTRACTS OF JAPAN, vol. 9, no. 139 (M-387)[1862], 14th June 1985 ; & JP-A-60 19 962

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EP 0 344 349 B1

Description

This invention relates to the detection of misfiring in spark ignition engines. In engines provided with catalytic converters it is particularly desirable to detect misfiring (for example due to worn spark plugs, defective ignition cable or the like) as soon as it begins to occur because it can lead to overheating or ruining of the catalyst due to the presence of unburnt fuel in the exhaust from the engine.

Previously the temperature of the catalyst itself has been used as an indication of misfiring. This means that the catalyst has already begun to overheat before misfiring is detected. It would therefore be preferable to detect misfiring before the catalyst overheats. The EP-A-20 069 describes an apparatus for testing an internal combustion engine ignition system, with a detected signal indicative of the voltage in the primary windings of the ignition coil. This signal is compared with a generated reference voltage having a predetermined magnitude and a predetermined duration. When the magnitude of a signal derived from the detected signal falls below the predetermined magnitude of the generated reference voltage after the end of the predetermined duration, a fault condition is indicated.

According to the present invention misfiring is detected from the voltage characteristic induced in the ignition coil when a spark occurs. When an ignition system is operating normally after sparking the secondary voltage is maintained at a certain level for a certain length of time until the ignition spark breaks down. When the system misfires the secondary and consequently the primary voltage may decay immediately from an initially high voltage or the spark may break down very quickly. Thus the shape of the voltage characteristic can be used to detect misfiring.

The present invention provides a method of detecting misfiring in an internal combustion engine comprising detecting a signal indicative of the voltage induced in the primary winding of the ignition coil, generating a reference voltage representing normal firing and comparing the detected voltage with the reference voltage. The reference voltage is a pulse having a predetermined magnitude and a predetermined duration and the detected voltage is compared to the reference voltage so as to detect when the magnitude of the detected voltage falls below said predetermined magnitude before the end of the duration.

An embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings in which:

Figure 1 is a diagram showing the circuit components used in the present invention;

Figure 2 shows the voltage versus time at various points in the circuit of Figure 1 during normal engine operation; and

Figure 3 shows the voltage versus time at various points in the circuit of Figure 1 when the engine misfires.

Referring firstly to Figure 1, the circuit comprises a transistor T1 whose base is connected to the terminal KL 15 of the ignition coil via resistor R1 and diode D1. The collector of the transistor T1 is connected to ground via resistors R2 and R3. The emitter is connected to a terminal KL 1. The terminals KL1 and KL15 are the primary terminals of the ignition coil with KL15 on the battery side such that the voltage at KL15 is the battery voltage supplied via the ignition lock. The junction between resistors R2 and R3 is connected to a first input of a comparator 10 via line L1. Signals supplied to the comparator 10 are smoothed by a capacitor C1 connected between L1 and ground and limited by a diode D2 connected between L1 and ground. Voltage pulses to be described below are supplied to a second input of comparator 10 via a second line L2. A voltage divider formed by resistors R4 and R3 connected between a 5 volt supply rail and earth ensures that a certain minimum voltage is always supplied via line L1 to the first input of the comparator 10. In the illustrated embodiment R4 and R3 form a voltage divider with the ratio of R4 to R3 being about 10 so that a minimum of 1/2 volt is supplied to the first input of the comparator 10. The first input of the comparator mentioned above is preferably the non-inverting input and the second input is preferably the non-inverting input.

As mentioned above, misfiring can be detected by examining the shape of the voltage characteristic. The circuit shown in Figure 1 is intended to examine the shape of the primary voltage characteristic. The voltages induced in the primary winding are then applied to the circuit of Figure 1 across terminals K1 and K15. The transistor T1 together with components D1, R1, R2, R3 detects changes in the voltage induced in the primary and applies them to the comparator 10. The pupose of the components R2 and D2 is to protect the comparator 10.

In operation of the circuit, voltage changes detected by the transistor T1 are fed to the comparator 10 via resistors R2 and R3 which constitute a voltage divider. In the event of a spark a voltage pulse is fed to the other input of the comparator. The comparator switches between two levels depending on which of its inputs is highest.

The voltage induced in the primary in response to spark production is hereinafter referred to as "the spark duration signal". Figure 2(a) shows a typical spark duration signal occurring during normal operation of the engine. The primary voltage initially increases to a maximum, drops after spark firing at the spark plug to a value which is proportional to the so-called "spark burning voltage" and decays in a damped oscillation after breakdown of the ignition spark.

For normal operation of the engine the spark must be maintained for a predetermined length of time which is greater than or equal to a "minimum spark duration". If the spark breaks down too quickly the result is misfiring.

Figure 3(a) illustrates the type of spark duration signal which occurs when there is no spark firing. The primary voltage decays immediately in a damped oscillation. The amplitude characteristic and frequency of the oscillation depend on the stored energy and also the values of R, L and C of the ignition circuit.

Figures 2(b) and 3(b) each show the smoothed spark duration signal as applied to the input of comparator 10. The smoothed voltages decay to the 5 voltage level supplied via the voltage divider comprising resistors R4 and R3. The comparator, in this embodiment produces a HIGH output when the voltage at the non-inverting input is greater than the voltage at the inverting input. Thus when there is no voltage induced in the primary of the ignition coil and no voltage at the inverting input, the output of the comparator is at HIGH.

The voltage pulses supplied to the inverting input of the comparator are generated in response to the ignition point. Figures 2(c) and 3(c) each show one such pulse. Each pulse begins at a delay time after the ignition point. The magnitude of the pulses is selected such that during spark maintenance the output from the comparator is at a high level. This is illustrated in Figure 2(d) which shows the output from the comparator during normal operation.

The duration of the pulses is selected to correspond to the minimum spark duration. Thus, if the spark is not maintained for the minimum spark duration the output from the comparator 10 will switch to a LOW level until the end of the generated pulse as illustrated in Figure 3(d). Thus LOW at the output from the comparator 10 indicates misfiring.

In a microprocessor controlled ignition system, the pulses may be generated by the microcomputer, in a simple transistorised ignition system they may be generated by a monoflop stage or the like.

The detection of misfiring can be used in a number of ways. An optical or acoustic signal can be provided as a warning to the driver. The fuel injection to selected cylinders may be cut out in response to the LOW signal at the comparator. The LOW signal may also be used to switch over to an emergency running program to limit the catalyst temperature.

The circuit arrangement described above has a number of advantages including the following:

1. low hardware expenditure;
2. fast fault detection since the cause (misfiring) and not the effect (excessive catalyst temperature) is detected;
3. the system is suitable for vehicles with or without (excess air factor) control;
4. unlike the methods of the prior art, the fault detection is cylinder-selective, allowing
    a) cylinder-selective engine intervention, for example disconnection of the injection valve of a cylinder with defective ignition
    b) diagnosis of the fault cause.

Claims

1. A method of detecting misfiring in an internal combustion engine comprising detecting a signal indicative of the voltage in the primary winding of the ignition coil, generating, in response to ignition, a reference voltage pulse, representing normal firing, having a predetermined magnitude and a predetermined duration and comparing the detected voltage signal with the reference voltage pulse to detect when the magnitude of the detected signal falls below said predetermined magnitude of the reference voltage pulse before the end of the predetermined duration thereby indicating misfiring in the engine.

2. A method as claimed in claim 1, in which the detected signal is derived from the primary winding of the ignition coil.

3. A method as claimed in claim 1, in which the primary voltage and the reference voltage are compared in a comparator (10).

Patentansprüche

1. Verfahren zum Erfassen von Fehlzündungen in einem Verbrennungsmotor mit Erfassen eines Signals, das die Spannung in der Primärwicklung der Zündspule zeigt, Generieren eines Referenz-Spannungsimpulses bei Zündung der normale Zündung darstellt und eine festgelegte Amplitude und eine festgelegte Dauer hat, sowie Vergleichen des erfaßten Spannungssignals mit dem Referenz-Spannungsimpuls, um den Fall festzustellen, daß die Amplitude des erfaßten Signals unter die erwähnte, festgelegte Amplitude des Referenz-Spannungsimpulses vor Ablauf der festgelegten Zeit sinkt, so daß Fehlzündungen im Motor aufgezeigt werden.

2. Verfahren nach Anspruch 1 dadurch gekennzeichnet, daß das erfaßte Signal von der Primärwicklung der Zündspule abgeleitet wird.

3. Verfahren nach Anspruch 1 dadurch gekennzeichnet, daß die Primärspannung und die Referenzspannung in einem Komparator (10) verglichen werden.

Revendications

1. Procédé de détection d'un défaut d'allumage dans un moteur à comoustion interne comprenant la détection d'un signal qui indique la tension dans l'enroulement primaire de la bobine d'allumage, engendrant, en réponse à l'allumage, une impulsion de tension détectée à l'impulsion de tension de référence pour détecter le moment où l'amplitude du signal détecté tombe en dessous de l'amplitude prédéterminée de l'impulsion de tension de référence avant la fin de la durée prédéterminée indiquant ce faisant, le défaut d'allumage dans le moteur.

2. Procédé tel que revendiqué dans la revendication 1, dans lequel le signal détecté est dérivé de l'enroulement primaire de la bobine d'allumage.

3. Procédé tel que revendiqué dans la revendication 1, dans lequel la tension primaire et la tension de référence sont comparées dans un comparateur (10).

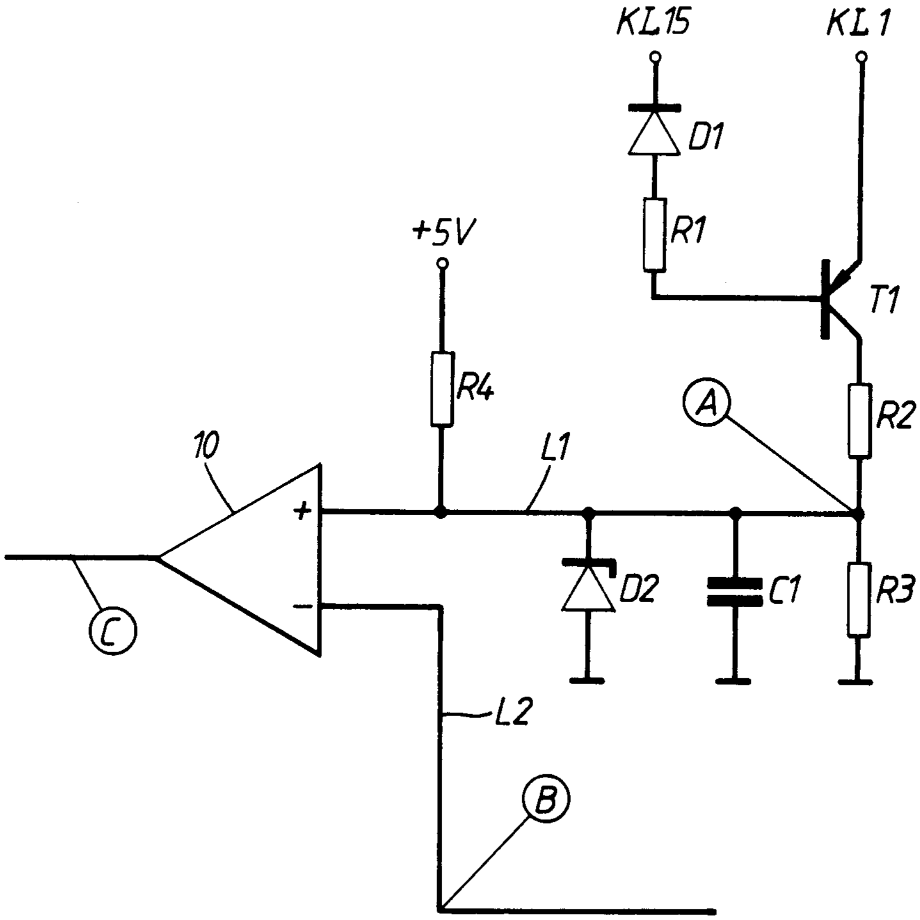

FIG. 1.

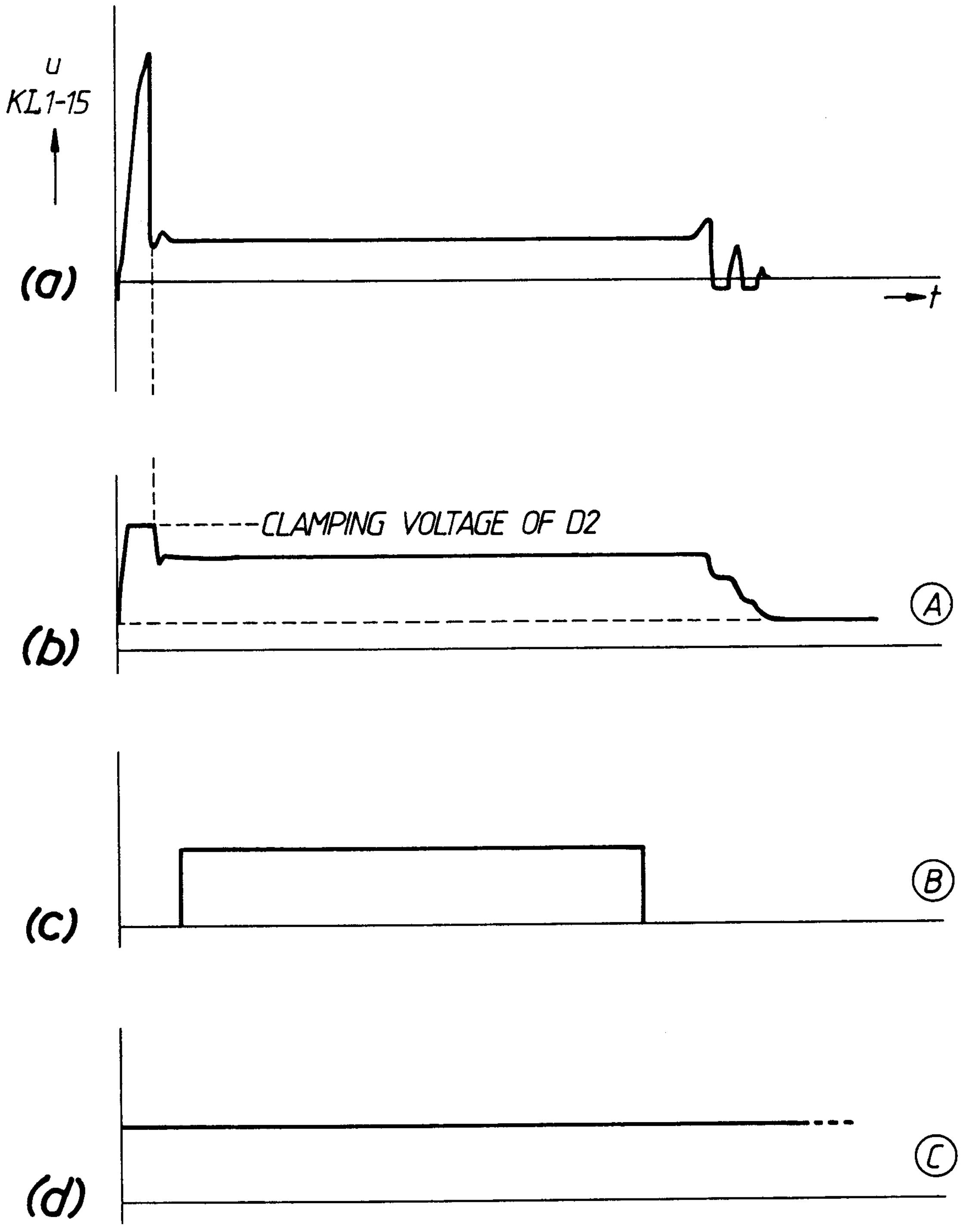

FIG.2.

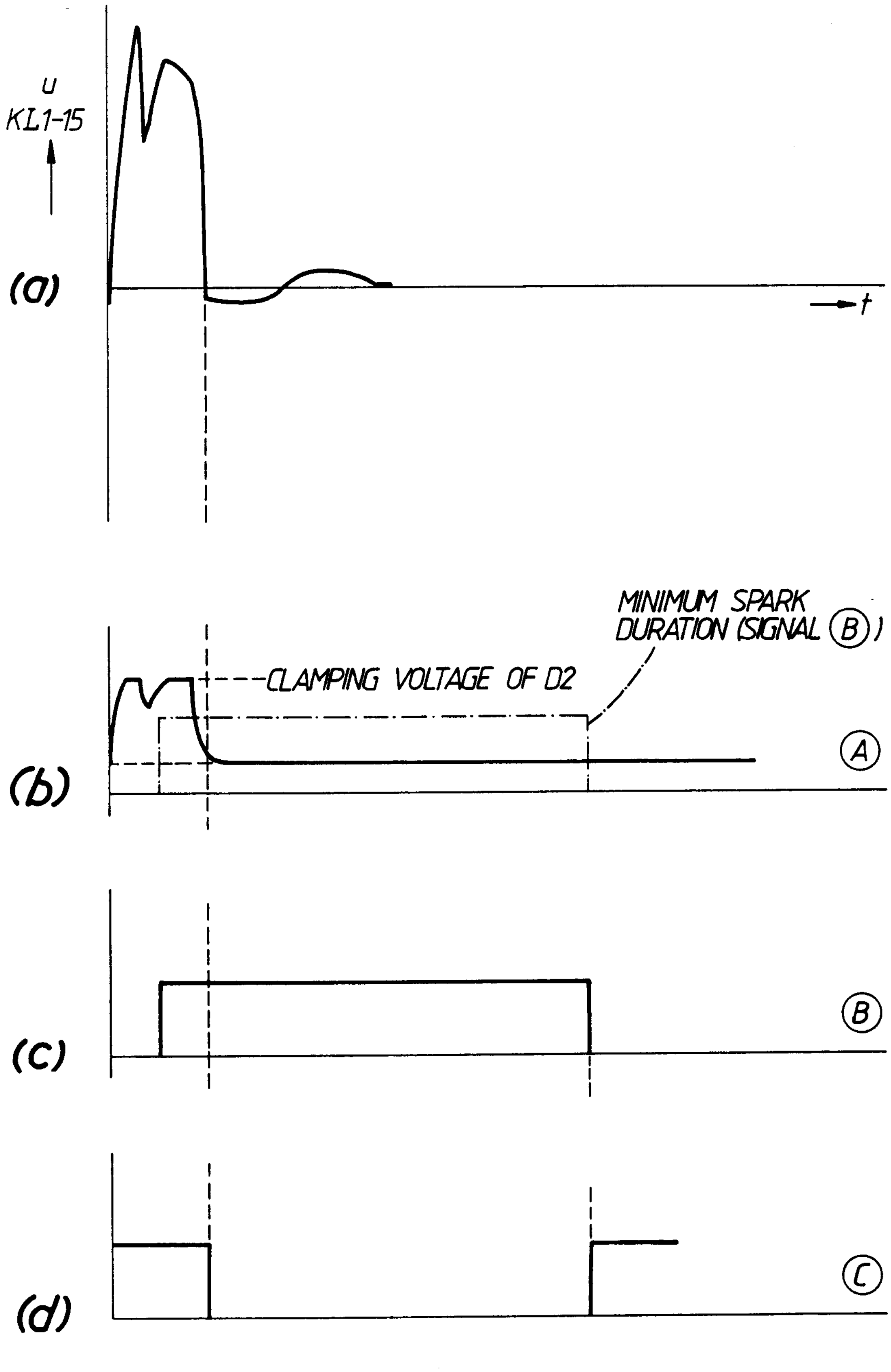
u
KL1-15
(a)
t
MINIMUM SPARK
DURATION (SIGNAL B)
CLAMPING VOLTAGE OF D2
A
(b)
B
(c)
C
(d)

FIG. 3.