

(19)



Europäisches Patentamt

European Patent Office

Office européen des brevets



(11)

EP 0 497 237 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
11.12.1996 Bulletin 1996/50

(51) Int Cl.⁶: **F02P 7/067**, F02P 3/045,
F02P 11/06, F02P 15/00,
F02P 17/00

(21) Application number: **92101247.2**

(22) Date of filing: **27.01.1992**

(54) Internal combustion engine stroke identification system

Einrichtung zur Detektion von Markierungselementen in einer inneren Brennkraftmaschine

Système de repérage de position angulaire dans un moteur à combustion interne

(84) Designated Contracting States:
DE ES FR GB

(30) Priority: **29.01.1991 IT TO910050**

(43) Date of publication of application:
05.08.1992 Bulletin 1992/32

(73) Proprietor: **MAGNETI MARELLI S.p.A.**
20145 Milano (IT)

(72) Inventors:
• **Serra, Gabriele**
I-40068 S. Lazzaro Di Savena (IT)
• **Bombarda, Giorgio**
I-40100 Bologna (IT)

(74) Representative: **Cerbaro, Elena et al**
c/o Studio Torta, Via Viotti 9
10121 Torino (IT)

(56) References cited:
EP-A- 0 013 846 **EP-A- 0 439 194**
EP-A- 0 443 175 **WO-A-88/02817**
DE-A- 3 307 833 **FR-A- 2 171 626**
FR-A- 2 374 528 **GB-A- 2 198 853**
US-A- 4 373 486

• **PATENT ABSTRACTS OF JAPAN vol. 9, no. 155**
(M-392)29 June 1985 & JP-A60 030 450 (NIPPON
DENSO K.K.) 16 February 1985

EP 0 497 237 B1

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

The present invention relates to a stroke identification system for internal combustion engines featuring electronic ignition and injection systems.

The electronic ignition and injection systems of internal combustion engines feature an electronic control system, which, on the basis of signals received from various sensors (engine speed and stroke, intake air pressure and temperature), determines the spark lead and computes the stroke and fuel injection time to the injectors. Such systems employ angle references fitted to the drive and camshaft to enable the control system to identify the stroke (induction, compression, expansion, exhaust) of each cylinder. On known identification systems, the angle references on the drive shaft are equal to the number of cylinders, and consist, for example, of equally-spaced teeth. A first sensor facing the references provides, every two references, for enabling an ignition command via the control system. Such systems require a stroke sensor capable of detecting the angular position of an auxiliary shaft rotating at half the speed of, but strictly in time with, the drive shaft, and which usually consists of the camshaft.

In the event of failure of the stroke or drive shaft speed sensor, the electronic ignition and injection system is totally disabled, thus arresting the engine until operation of the sensor is restored. European Patent Applications EP-A-0439193 and EP-A-0439194, entitled "Internal Combustion Engine Stroke Identification System" and "Perfected Internal Combustion Engine Stroke Identification System", filed by the present Applicant, relate to a system for overcoming startup or on-road failure of the stroke sensor.

The Japan Patent JP-A-60-030450 proposes a device for regulating the fuel injection timing. The purpose of this device is to prevent the occurrence of variations in product quality and any influence attributable to a secular change or the like, by conducting detection by detectors at both driving and driven sides of an actuator, while detecting the actual injection timing of fuel on the basis of phase difference calculated by a time lag being compensated by a reference value.

The European Patent EP-A-0 443 175 propose a device for the electronic injection and ignition in an internal combustion engine. This device uses angular position transducers, fitted to the camshaft and to the throwshaft, to determine the stroke of each cylinder.

It is an object of the present invention to provide an internal combustion engine stroke identification system designed to also overcome failure of the drive shaft speed sensor, and so provide, on the basis of the above patent applications, an overall system for overcoming failure of either one of the sensors.

According to the present invention, there is provided an internal combustion engine stroke identification system, comprising:

an electronic ignition system;
 an electronic injection system;
 a pulley fitted to the drive shaft of said engine, and defined by a toothed wheel having a number of first teeth and a gap defined by the absence of some of said first teeth;
 a first sensor for detecting said first teeth and, therefore, predetermined angular positions of said drive shaft;
 a second shaft rotating at half the speed of, but in time with, said drive shaft;

characterized by the fact of comprising:

a disk fitted to said second shaft, having equally-spaced interruptions and a first of which is identifiable by virtue of differing from the others;
 a second sensor for detecting said interruptions and, therefore, predetermined angular positions of said second shaft;
 first means for computing, upon startup of said engine, the actual relative angular position of said pulley and said disk, by simultaneously detecting said gap on said pulley and said first interruption on said disk; and for storing said actual angular position in a permanent memory;
 second means for computing the absolute angular position of said drive shaft, on the basis of the signals from said sensors, and enabling said electronic ignition and injection systems; and
 third means, which, in the absence of a signal from said first sensor, and on the basis of the signal from said second sensor and the signal processed by said first means, provides for computing a presumed angular position of said drive shaft, for enabling said ignition and injection systems.

A preferred, non-limiting embodiment of the present invention will be described by way of example with reference to the accompanying drawings, in which:

Fig.1 shows a schematic view of an electronic ignition and injection system for an internal combustion engine featuring the engine stroke identification system according to the present invention;
 Fig.2 shows a schematic view of a number of components in the Fig.1 system;
 Fig.3 shows an operating block diagram of the identification system according to the present invention;
 Fig.4 shows a longitudinal development of the Fig. 2 components.

Fig.1 shows, schematically, an electronic ignition and injection system for an internal combustion engine 101, conveniently a four-cylinder engine, shown partially in cross section. Said system comprises an electronic control system 102 having counters and memory maps relative to various operating conditions of engine 101,

in particular, a counter 103 and a permanent memory 104 as described later on. Control system 102 receives signals from an engine speed sensor 107 opposite a pulley 108 fitted to the drive shaft 111; an engine stroke sensor 112 opposite a disk 109 fitted to the camshaft 110 of a distributor (not shown); a sensor 114 for detecting the absolute pressure in intake manifold 115; a sensor 116 for detecting the air temperature in manifold 115; a sensor 117 for detecting the water temperature in the cooling jacket of engine 101; and a sensor 118 consisting of a potentiometer, for detecting the angular position of a throttle valve 121 located in manifold 115 and controlled by accelerator pedal 122. An additional air supply valve 123 is fitted parallel to valve 121. Shaft 110 rotates at half the speed of, but in time with, shaft 111.

Control system 102 is connected to a power battery 124 and to ground. On the basis of the signals received by control system 102, engine speed and air density are used for determining fuel supply as a function of the required strength. System 102 controls the opening time of injectors 127 housed in manifold 115 close to the intake valve of each cylinder, for controlling fuel supply to the various cylinders of engine 101; and controls fuel injection in relation to the stroke (induction, compression, expansion, exhaust) of engine 101. Injector 127 is supplied with fuel via a pressure regulator 128 sensitive to the pressure in manifold 115, and having a fuel inlet conduit 131 connected to a pump (not shown), and a return conduit 132 connected to a tank (not shown). System 102 is connected to an ignition pulse control unit 133 connected to the distributor.

As shown in Figs 2 and 4, pulley 108 consists of a toothed wheel having 60 minus 2 equally-spaced teeth 134 numbered 1 to 58 as of a gap formed by two missing teeth. Teeth 134 therefore present 58 gaps, one of which is three times the width of the others, i.e. extends over an angle of 18°. Sensor 107 is located facing the passage of teeth 134. Disk 109 presents two teeth 135 and a third tooth 136 at 120° to one another; teeth 135 both extending over an arc of 30°, and tooth 136 over an arc of 90°. Figs 4a, 4b and 4c show respective longitudinal developments of teeth 134 of pulley 108, teeth 135 and 136 of disk 109, and a further embodiment of disk 109.

In the embodiment described, sensor 112 is so positioned that, when the twentieth tooth 134 (114° arc as of the first tooth 134) is positioned facing speed sensor 107, sensor 112 faces the trailing edge of tooth 136 (Fig. 4a and 4b). The above angular position of pulley 108 and disk 109 in relation to sensors 107 and 112 corresponds to the top dead center position of cylinder 1. When sensor 112 is positioned facing the trailing edge of tooth 135 following tooth 136, i.e. when disk 109 is rotated 90°, sensor 107 faces the fiftieth tooth 134, i.e. pulley 108 has rotated 180°. This position of pulley 108 and disk 109 in relation to sensors 107 and 112 corresponds to the top dead center position of cylinder 3. The rotation direction of pulley 108 and disk 109 is, of course, as shown in Fig.2.

The top dead center position of all four cylinders occurs for every two turns of shaft 11, so that, at the second turn of shaft 11, when sensor 112 is positioned facing the leading edge of tooth 135 preceding tooth 136, sensor 107 faces the twentieth tooth 134. This position of pulley 108 and disk 109 in relation to sensors 107 and 112 corresponds to the top dead center position of cylinder 4. When disk 109 is rotated another 90° and pulley 108 another 180°, sensor 112 faces the leading edge of tooth 136 and sensor 107 faces the fiftieth tooth 134. This position of pulley 108 and disk 109 in relation to sensors 107 and 112 corresponds to the top dead center position of cylinder 2. In other words, disk 109 presents a number of equally-spaced interruptions equal to the number of cylinders. In the example shown, the interruptions are represented by the leading or trailing edge of a tooth, but may also be represented, as shown in Fig. 4c, by a first opening every 90° of disk 109. Fig. 4c also presents a second opening corresponding with the 2-toothed gap on pulley 108, to enable identification of a first opening in relation to the others. Instead of said second opening, a single opening differing from the others in length may be defined together with a first opening.

Counter 103 counts and memorises the number of teeth 134 over 720° rotation of shaft 111, commencing with the first tooth 134 with sensor 107 positioned facing the 2-toothed gap on pulley 108, and sensor 112 simultaneously facing tooth 136. At the end of tooth 136, counter 103 supplies the tooth 134 count to system 102 to enable it to determine the actual relative angular position of pulley 108 and disk 109, which does not normally correspond to the ideal angular position, due to errors caused by the mechanical connection of the various components of engine 101. System 102 compares the previously stored ideal position with the actual position to determine the mechanical error, which is memorized for processing the ignition and injection signals in the event of failure of sensor 107.

In the event of failure of stroke sensor 112, the electronic ignition system is totally disabled. European Patent Applications EP-A-0439193 and EP-A-0493194 entitled "Internal Combustion Engine Stroke Identification System" and "Perfected Internal Combustion Engine Stroke Identification System", and filed by the present Applicant, relate to a system for overcoming startup and on-road failure of the stroke sensor.

Operation of the stroke identification system according to the present invention will be described with reference to Fig.3. Block 151, to which the signal from sensor 107 is supplied, determines the presence of said signal, i.e. whether sensor 107 is operating normally or not. In the event of normal operation, block 151 goes on to block 152, whereas, in the event of failure of sensor 107, block 151 goes on to block 153. Blocks 152 and 153 are supplied with the signal from sensor 112. Block 152 checks the relative angular position of pulley 108 and disk 109, and supplies blocks 154 and 155 with a

signal corresponding to the absolute angular position of shaft 111 between 0 and 720°. Upon startup of engine 101, this signal is also supplied to block 156, which computes and stores in memory 104 the mechanical error of the stroke signal mentioned previously.

Blocks 157 and 158 are supplied with signals relative to quantities and operating conditions of engine 101, in this case, from sensors 114, 116, 117 and 118. Block 157 computes the spark lead, and is connected to block 154, which, on the basis of the signals supplied to it, enables electronic ignition via the distributor or by controlling a coil for each cylinder or each pair of cylinders. Block 158 computes injection time cylinder by cylinder, and supplies block 155 with an injection time signal, and a signal relative to the stroke of the cylinder to be injected, for enabling electronic injection accordingly. Blocks 154 and 157 represent an electronic ignition system, and blocks 155 and 158 an electronic injection system. Block 153 computes a presumed angular position of shaft 111 between 0 and 720°, on the basis of the signals received from sensor 112 and corrected in accordance with the stored mechanical error. The output signal from block 153 is sent to blocks 154 and 155, and, though obviously not as accurate as the output signal from block 152, nevertheless provides for enabling ignition and injection and running the vehicle.

The advantages of the present invention will be clear from the foregoing description.

In particular, it provides for an engine stroke identification system designed to overcome failure of the drive shaft speed sensor, and which, combined with the system described in the aforementioned patent applications, provides for overcoming failure of either of sensors 107 and 112.

To those skilled in the art it will be clear that changes may be made to the system described and illustrated herein without, however, departing from the scope of the present invention.

In particular, changes may be made to the design of disk 109 in terms of both the design and number of interruptions, which, though obviously equally spaced, need not necessarily equal the number of cylinders.

Claims

1. An internal combustion engine stroke identification system, comprising:

an electronic ignition system (155 and 157);
 an electronic injection system (156 and 158);
 a pulley (108) fitted to the drive shaft (111) of said engine (101), and defined by a toothed wheel having a number of first teeth (134) and a gap defined by the absence of some of said first teeth (134);
 a first sensor (107) for detecting said first teeth (134) and, therefore, predetermined angular

positions of said drive shaft (111);

characterized by the fact of comprising:

a second shaft (110) rotating at half the speed of, but in time with, said drive shaft (111);
 a disk (109) fitted to said second shaft (110), having equally-spaced interruptions (135 and 136) a first of which is identifiable by virtue of differing from the others;
 a second sensor (112) for detecting said interruptions (135 and 136) and, therefore, predetermined angular positions of said second shaft (110);
 first means (156) for computing, upon startup of said engine (101), the actual relative angular position of said pulley (108) and said disk (109), by simultaneously detecting said gap on said pulley (108) and said first interruption (136) on said disk (109); and for storing said actual angular position in a permanent memory (104);
 second means (152) for computing the absolute angular position of said drive shaft (111), on the basis of the signals from said sensors (107 and 112), and enabling said electronic ignition system (155 and 157) and said electronic injection system (156 and 158); and
 third means (153), which, in the absence of a signal from said first sensor (107), and on the basis of the signal from said second sensor (112) and the signal processed by said first means (156), provides for computing a presumed angular position of said drive shaft (111), for enabling said ignition system (155 and 157) and said injection system (156 and 158).

2. An identification system as claimed in Claim 1, characterised by the fact that it comprises fourth means (151) for determining correct operation of said first sensor (107), and enabling said second means (152) in the event of correct operation, and said third means (153) in the event of failure of said first sensor (107).
3. An identification system as claimed in Claim 1 and/or 2, characterised by the fact that it comprises a counter (103) for counting and storing the number of said first teeth (134) over 720° rotation of said drive shaft (111); said count commencing from the first of said first teeth (134), with said first sensor (107) positioned facing said gap on said pulley (108) and said second sensor (112) simultaneously facing said first interruption (136).
4. An identification system as claimed in Claim 3, characterised by the fact that said pulley (108) consists of a toothed wheel having 60 minus 2 equally-

spaced first teeth (134); said gap being defined by the absence of two said first teeth (134).

5. An identification system as claimed in Claim 4, characterised by the fact that, for a four-cylinder engine, said disk (109) presents three second teeth (135 and 136) at 120° to one another, of which two extend over the same arc, and the third over a larger arc of 90°. 5
6. An identification system as claimed in Claim 4, characterised by the fact that, for a four-cylinder engine, said disk (109) presents a first opening every 90°, and a second opening close to one of said first openings for enabling this to be identified by said second sensor (112). 10 15
7. An identification system as claimed in Claim 4, characterised by the fact that, for a four-cylinder engine, said disk (109) presents four openings, one of which differs in extension from the others. 20
8. An identification system as claimed in Claim 4, characterised by the fact that, for a four-cylinder engine, said disk (109) presents three openings at 120° to one another, of which two extend over the same arc, and the third over a larger arc of 90°. 25

Patentansprüche 30

1. Takt-Identifikationssystem einer Verbrennungskraftmaschine, mit:

einem elektronischen Zündsystem (155 und 157); 35

einem elektronischen Einspritzsystem (156 und 158);

einer Riemenscheibe (108), die mit der Antriebswelle (111) der Maschine (101) verbunden ist und durch ein mit Zähnen versehenes Rad gebildet ist, das eine Anzahl von ersten Zähnen (134) und einen durch das Fehlen von einigen der ersten Zähne (134) bestimmten Zwischenraum aufweist; 40

einem ersten Sensor (107), um die ersten Zähne (134) und auf diese Weise vorbestimmte Winkelstellungen der Antriebswelle (111) zu erfassen; 45

dadurch gekennzeichnet, daß es enthält:

eine zweite Welle (110), die sich mit der halben Geschwindigkeit der Antriebswelle (111), jedoch mit dieser gekoppelt, dreht; 55

eine Scheibe (109), die an der zweiten Welle (110) befestigt ist und gleichmäßig beabstandete Unterbrechungen (135 und 136) aufweist,

von denen eine erste identifizierbar ist, da sie sich von den anderen unterscheidet;

einen zweiten Sensor (112), um die Unterbrechungen (135 und 136) und auf diese Weise vorbestimmte Winkelstellungen der zweiten Welle (110) zu erfassen;

erste Mittel (156), um beim Starten der Maschine (101) die momentane Winkelstellung der Riemenscheibe (108) und der Scheibe (109) relativ zueinander zu berechnen, indem gleichzeitig der Zwischenraum auf der Riemenscheibe (108) und die erste Unterbrechung (136) auf der Scheibe (109) erfaßt werden, und um die momentane Winkelstellung in einem Permanentspeicher (104) zu speichern;

zweite Mittel (152), um die absolute Winkelstellung der Antriebswelle (111) auf der Basis der Signale von den Sensoren (107 und 112) zu berechnen und um das elektronische Zündsystem (155 und 157) und das elektronische Einspritzsystem (156 und 158) freizugeben; und

dritte Mittel (153), die beim Fehlen eines Signals von dem ersten Sensor (107) und auf der Basis des Signals von dem zweiten Sensor (112) und des von den ersten Mitteln (156) verarbeiteten Signals eine angenommene Winkelstellung der Antriebswelle (111) berechnen, um das Zündsystem (155 und 157) und das Einspritzsystem (156 und 158) freizugeben.

2. Identifikationssystem nach Anspruch 1, dadurch gekennzeichnet, daß es vierte Mittel (151) zum Bestimmen eines korrekten Betriebs des ersten Sensors (107) und zum Freigeben der zweiten Mittel (152) im Falle eines korrekten Betriebs sowie der dritten Mittel (153) im Falle eines versagens des ersten Sensors (107) aufweist.

3. Identifikationssystem nach Anspruch 1 und/oder Anspruch 2, dadurch gekennzeichnet, daß es einen Zähler (103) zum Zählen und Speichern der Anzahl der ersten Zähne (134) über eine Drehung der Antriebswelle (111) von 720° aufweist, wobei das Zählen bei dem ersten der ersten Zähne (134) beginnt, wobei der erste Sensor (107) dem Zwischenraum auf der Riemenscheibe (108) gegenüberliegend angeordnet ist und der zweite Sensor (112) gleichzeitig gegenüber der ersten Unterbrechung (136) liegt. 50

4. Identifikationssystem nach Anspruch 3, dadurch gekennzeichnet, daß die Riemenscheibe (108) aus einem mit Zähnen versehenen Rad besteht, das 60 minus 2 gleichmäßig beabstandete erste Zähne (134) aufweist, wobei der Zwischenraum durch das Fehlen von zwei der ersten Zähne (134) gebildet ist.

5. Identificationssystem nach Anspruch 4, dadurch gekennzeichnet, daß die Scheibe (109) bei einer Maschine mit vier Zylindern drei gegeneinander um 120° versetzte zweite Zähne (135 und 136) aufweist, von denen sich zwei über den gleichen Bogen erstrecken und der dritte über einen größeren Bogen von 90° erstreckt.
6. Identificationssystem nach Anspruch 4, dadurch gekennzeichnet, daß bei einer Maschine mit vier Zylindern die Scheibe (109) alle 90° eine erste Öffnung und in der Nähe von einer der ersten Öffnungen eine zweite Öffnung aufweist, so daß dies von dem zweiten Sensor (112) identifiziert werden kann.
7. Identificationssystem nach Anspruch 4, dadurch gekennzeichnet, daß die Scheibe (109) bei einer Maschine mit vier Zylindern vier Öffnungen aufweist, wobei sich die Erstreckung von einer Öffnung von derjenigen der anderen Öffnungen unterscheidet.
8. Identificationssystem nach Anspruch 4, dadurch gekennzeichnet, daß die Scheibe (109) bei einer Maschine mit vier Zylindern drei gegeneinander um 120° versetzte Öffnungen aufweist, von denen sich zwei über den gleichen Bogen erstrecken und die dritte über einen größeren Bogen von 90° erstreckt.

Revendications

1. Système de repérage de position angulaire dans un moteur à combustion interne, comprenant :
- un système d'allumage électronique (155 et 157) ;
 - un système d'injection électronique (156 et 158) ;
 - une poulie (108) montée sur l'arbre de commande (111) du moteur (101), et définie par une roue dentée comportant un certain nombre de premières dents (134) et un espace défini par l'absence de certaines de ces premières dents (134) ;
 - un premier capteur (107) pour détecter les premières dents (134) et par conséquent, les positions angulaires prédéterminées de cet arbre de commande (111) ;
- caractérisé par le fait de comprendre :
- un second arbre (110) en rotation à la moitié de la vitesse de, mais en synchronisation avec, l'arbre de commande (111) ;
 - un disque (109) monté sur le second arbre (110), comportant des interruptions espacées de façon égale (135 et 136) dont une première

interruption est identifiable du fait d'être différente des autres ;

un second capteur (112) pour détecter les interruptions (135 et 136) et, par conséquent, les positions angulaires prédéterminées du second arbre (110) ;

des premiers moyens (156) pour calculer, lors du démarrage du moteur (101), la position angulaire relative réelle de la poulie (108) et du disque (109), en détectant simultanément l'espace sur la poulie (108) et la première interruption (136) sur le disque (109) ; et pour stocker cette position angulaire réelle dans une mémoire permanente (104) ;

des seconds moyens (152) pour calculer la position angulaire absolue de l'arbre de commande (111), en fonction des signaux provenant des capteurs (107 et 112), et validant ou mettant en circuit le système d'allumage électronique (155 et 157) et le système d'injection électronique (156 et 158) ; et

des troisièmes moyens (153) qui, en l'absence d'un signal provenant du premier capteur (107), et en fonction du signal provenant du second capteur (112) et du signal traité par les premiers moyens (156), assurent le calcul de la position angulaire présumée de l'arbre de commande (111) pour valider ou mettre en circuit le système d'allumage (155 et 157) et le système d'injection (156 et 158).

2. Système de repérage selon la revendication 1, caractérisé par le fait qu'il comprend quatre moyens (151) pour déterminer le fonctionnement correct du premier capteur (107) et mettre en circuit les seconds moyens (152) dans le cas d'un fonctionnement normal et les troisièmes moyens (153) dans le cas de panne du premier capteur (107).
3. Système de repérage selon la revendication 1 et/ou 2, caractérisé par le fait de comprendre un compteur (103) pour compter et mémoriser le nombre de premières dents (134) au-dessus de la rotation 720° de l'arbre de commande (111) ; le comptage commençant à partir de la première de ces premières dents (134), avec le premier capteur (107) positionné en face de l'espace sur la poulie (108) et le second capteur (112) faisant simultanément face à la première interruption (136).
4. Système de repérage selon la revendication 3, caractérisé par le fait que la poulie (108) consiste en une roue dentée ayant 60 moins 2 premières dents espacées de façon égale (134) ; l'espacement étant défini par l'absence de deux de ces premières dents (134).
5. Système de repérage selon la revendication 4, ca-

ractérisé par le fait que pour un moteur à quatre cylindres, le disque (109) présente trois secondes dents (135 et 136) à 120° l'une de l'autre, dont deux dents s'étendent sur le même arc, et la troisième dent sur un arc plus grand de 90° .

5

6. Système de repérage selon la revendication 4, caractérisé par le fait que, pour un moteur à quatre cylindres, le disque (109) présente une première ouverture tous les 90° , et une seconde ouverture proche de l'une des premières ouvertures pour permettre son identification par le second capteur (112).

10

7. Système de repérage selon la revendication 4, caractérisé par le fait que, pour un moteur à quatre cylindres, le disque (109) présente quatre ouvertures, dont l'une diffère dans sa grandeur par rapport aux autres.

15

20

8. Système de repérage selon la revendication 4, caractérisé par le fait que, pour un moteur à quatre cylindres, le disque (109) présente trois ouvertures à 120° l'une de l'autre dont deux s'étendent sur le même arc, et la troisième sur un arc plus grand de 90° .

25

30

35

40

45

50

55

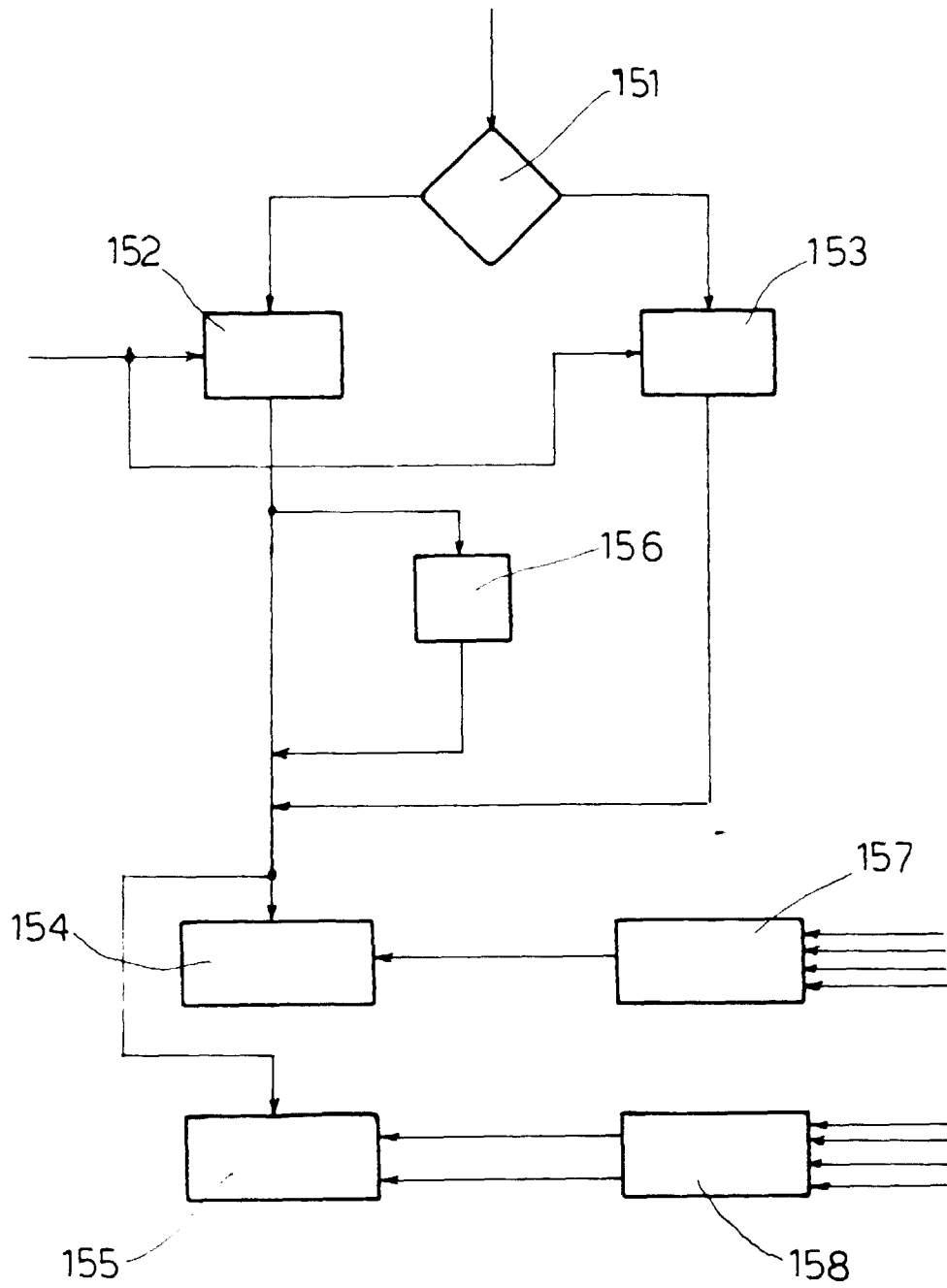


Fig.3

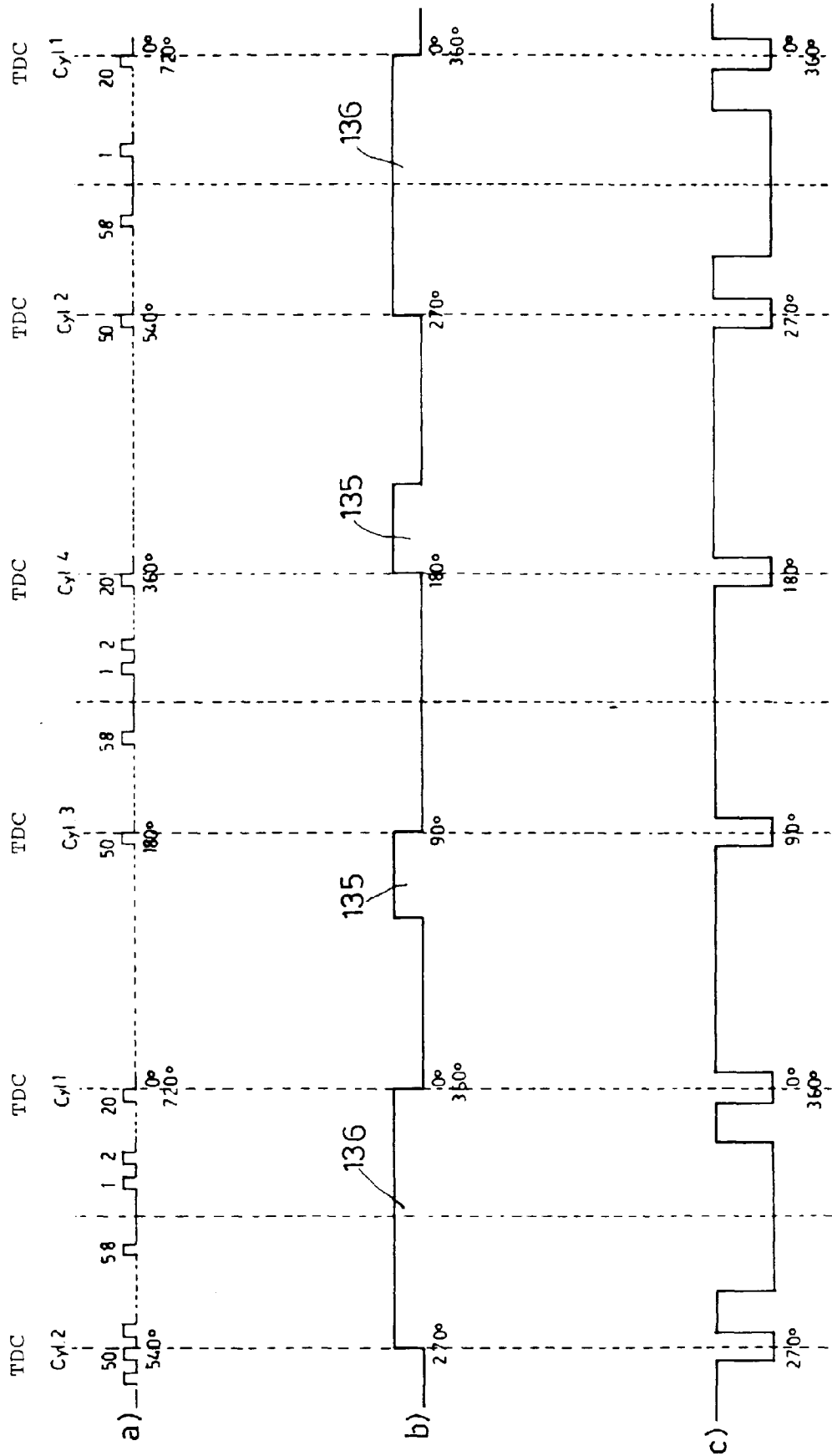


Fig. 4