

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
11 January 2007 (11.01.2007)

PCT

(10) International Publication Number
WO 2007/004936 A1

(51) International Patent Classification:
F02P 5/15 (2006.01) *F02P 11/02* (2006.01)
B27B 17/10 (2006.01) *F02P 11/04* (2006.01)
F02P 1/08 (2006.01) *F02P 5/02* (2006.01)

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SM, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(21) International Application Number:
PCT/SE2005/001100

(22) International Filing Date: 1 July 2005 (01.07.2005)

(25) Filing Language: English

(26) Publication Language: English

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(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

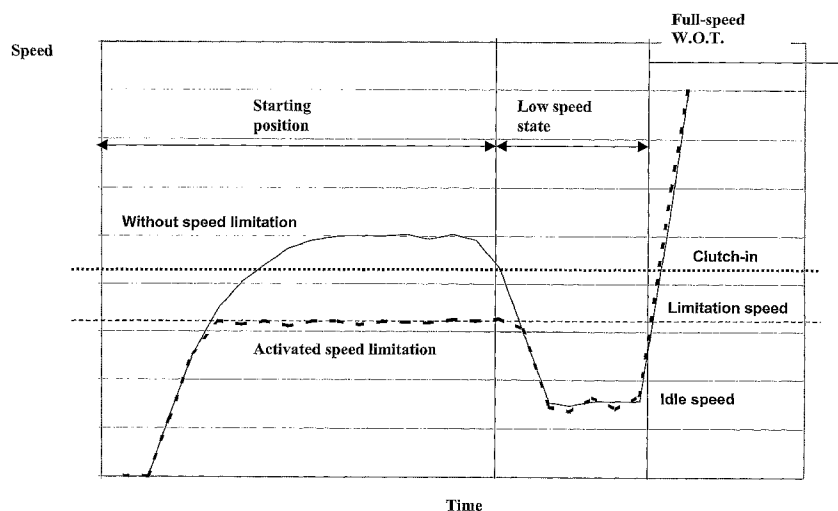
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Published:
— with international search report

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: START SAFETY IGNITION SYSTEM



(57) Abstract: The present invention relates to a method for controlling an ignition system of an internal combustion engine which has a primary firing pulse generator for charging a capacitor and an electronic switch for discharging the capacitor via an ignition coil to generate an ignition voltage. A microcomputer operates the switch to control the ignition timing of said generator, said microcomputer having speed detection means to directly or indirectly detect the rotational speed of the engine and a speed limitation control to limit the engine speed to a limitation speed below the clutch-in speed of a centrifugal clutch. In the present invention the speed limitation control is active or activated when starting the engine and being deactivated when said speed detection means detects a low speed state of the engine.

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START SAFETY IGNITION SYSTEM

TECHNICAL FIELD

The present invention relates to a method for controlling an ignition system of an internal combustion engine which has a primary firing pulse generator for charging a capacitor and an electronic switch for discharging the capacitor via an ignition coil to generate an ignition voltage. A microcomputer operates the switch to control the ignition timing of said generator, said microcomputer having speed detection means to directly or indirectly detect the rotational speed of the engine and a speed limitation control to limit the engine speed to a limitation speed below the clutch-in speed of a centrifugal clutch.

BACKGROUND

A multi-purpose, portable working machine such as a chain saw, cutting tool or grass trimmer with an internal combustion engine is well known. The machine has a working tool, such as a chain or cutting blade, which is brought to rotation by the operating engine. Since the tool is often near the worker, to secure an improved efficiency, there is a risk that the worker is can be accidentally hurt. Therefore, the machine is often equipped with a mechanical security brake for the tool together with other security arrangements such as two-hand grip for operations.

The machine is normally equipped with a centrifugal clutch which engages the tool when the engine exceeds a certain rotational speed. In normal operation, the clutch improves the safety since the tool does not rotate when the engine speed is reduced below the clutch-in speed. The risk for bodily injure is therefore reduced significantly.

The machine is normally started with the throttle valve positioned in a starting position in order to ensure an efficient start-up. Because of the valve position, more air flows into the motor causing the engine rotational speed to immediately increase above the clutch-in speed of the tool. Since the worker do not hold the machine in such a way so that the security arrangements works as they should, there is a disadvantage of a hazard of bodily injury to the worked due to the rotating tool.

The patent document US 4553517 proposes a solution to this problem. In the document an arrangement is disclosed which intends to work in combination with the centrifugal clutch. It works in such a way that simultaneously with the locking of the throttle valve in starting position, a circuit as part of the ignition system is activated, which restricts the engine speed to a level below the clutch-in speed of the centrifugal clutch. The switch is deactivated when the throttle valve is no longer in start position thereby allowing the engine to operate normally. By this solution a security during start is enabled.

One problem with this solution is that it operated by a mechanical switch. This means that in case of failure of the switch the arrangement will either continuously be in a speed limiting stage or never activate the speed limitation during start. Another problem is the switch, to prevent failure, has to be reliable and thereby more expensive. A further problem is that the switch cooperates mechanically with the start position knob and consequently relies on the workers handling during start. The switch is activated when activating the start position knob, and if the machine is started with half or wide open throttle valve without activating the knob, the start security system will fail. Another problem is that a mechanical switch is much related to product related solutions. This means that a special technical design is used for each product category such as power cutters, chain saws or grass cutters. The object of the present invention is to solve the above-mentioned problems.

SUMMARY OF THE INVENTION

The present invention relates to a method for controlling an ignition system of an internal combustion engine which has a primary firing pulse generator for charging a capacitor and an electronic switch for discharging the capacitor via an ignition coil to generate an ignition voltage. A microcomputer operates the switch to control the ignition timing of said generator, said microcomputer having speed detection means to directly or indirectly detect the rotational speed of the engine and a speed limitation control to limit the engine speed to a limitation speed below the clutch-in speed of a centrifugal clutch.

In the present invention the speed limitation control is active or activated when starting the engine and being deactivated when said speed detection means detects a low speed state of the engine.

DESCRIPTION OF THE DRAWINGS

Fig. 1 shows a diagram about how the method operates at a starting period for the combustion engine.

Fig. 2 shows how the time of ignition is controlled in the speed limitation system.

Fig. 3 shows a flow chart about how the method operates at a starting period for the combustion engine.

DESCRIPTION OF AN ILLUSTRATIVE EMBODIMENT

The figures show an illustrative embodiment of a method for providing a speed limitation control in accordance with the invention. The illustrative embodiments shall not be interpreted as a limitation of the invention. Its purpose is to illustrate how the invention can be applied and to further illustrate the scope of the invention, as disclosed in claim 1. The illustrative embodiment relates to a microcomputer-controlled method for providing a speed limitation control in the combustion engine ignition system.

The illustrative embodiment discloses a method used in an ignition system of an internal combustion engine, which system has a primary firing pulse generator for charging a capacitor and an electronic switch for discharging the capacitor via an ignition coil to generate an ignition voltage. The ignition system comprises a microcomputer, which operates the switch to control the ignition timing of said generator.

The microcomputer the speed detection means further detects the rotational speed of the engine. Within the scope of the invention every speed detection means is considered, such as a direct or indirect control of the speed of the motor. A direct control could be via a magnetic Hall sensor for detecting the rotation of the shaft or an electric sensor for detecting the current generated by the primary firing pulse generator. An indirect detection of the rotational speed on the other hand could be the detection of the time of

ignition in relation to a stroke of the piston. This is for cases where the engine speed is controlled by varying the time angle of the ignition in relation to the top dead end of the piston.

In fig. 2 it is described how the time angle of ignition relates to the engines speed. The ignition will come earlier (ignition timing goes up) if the speed goes down to keep the speed as even as possible for a certain throttle position. In cases where the throttle valve is partly open, for instance if a starting knob is activated, the speed will be higher and the ignition will come later (ignition timing goes down). The speed will be kept as even as possible at a higher level due to the partly open valve. Since the speed is related to the ignition angle the microcomputer can look at the angle and see if the speed has gone down to a level below the clutch-in speed. Such a level corresponds to the low speed state, which will be described further below.

The microcomputer of the illustrative embodiment comprises a speed limitation control that is the essential feature of the present invention. This control makes sure to limit the engine speed to a limitation speed below the clutch-in speed of a centrifugal clutch. The intention is that this control will, when the worker starts the engine, strictly stop any attempt by the engine or the worker to bring up the speed so that the centrifugal clutch brings the cutting tool into rotation. An uncontrolled rotation of the cutting tool could be dangerous for the worker, and the speed limitation control will avoid the clutch-in at start.

In some known prior art a switch, coupled to the workers activation of a start knob or similar, is used to activate a periodical cut-off of the ignition at start to keep down the speed. However, such a system has certain drawbacks as described earlier. Therefore, the object is to provide a better, more reliable and safer system to introduce together with the ignition system.

As disclosed in the characterizing part of the patent claim the main scope of the invention is to have a control method where the speed limitation control is active or activated when starting the engine and being deactivated when said speed detection means detects a low speed state of the engine. See fig. 1 and 3. This means that when the worker starts the engine the microcomputer system is immediately activated and will directly or after a short period activates the speed limitation control. Furthermore, if

a low speed state is detected, which corresponds to an engine speed below the limitation speed, the speed limitation control is deactivated by the microcomputer.

The low speed state corresponds to an operation state of the engine where the rotational speed of the engine is below the limitation speed. To have a margin, see fig. 1, due to possible variations in clutch-in speed, the limitation speed is distanced from the clutch-in speed. This gives a safer system in order to keep out of the clutch-in speed variations. For most engines this low speed state relates to a throttle valve being in its most closed position. The pre-defined requirement of a low speed state for deactivation means that the worker, after have started the engine, in most cases has to grip it with both hands, thereby being safe away from the cutting tool. Without doing so, he will not be able to deactivate the speed limitation control since he has to press the handle throttle control to deactivate the start position of the throttle valve which brings the speed down to idle level.

In cases where the motor has a direct fuel injection system, there is no throttle valve to define the idle level. However, it should be realized by the person skilled in the art that a low speed state for any combustion engine is included within the scope of the invention.

The activation of the speed limitation control will stop any attempt by the engine or the worker to bring up the speed so that the centrifugal clutch brings the cutting tool into rotation. It is only dependent on the starting of the engine and cannot be stopped by the worker. This means that the activation is not related to any requirement despite the fact that the engine is started. The reason for this is to avoid a failure of the speed limitation system. For instance the varying speed at start could, if the activation was dependent on the speed control, result in that there is no activation.

Starting the engine means any starting, either with choke (cold engine), normal start (warm engine), start with a wide-open throttle or start by pumping the choke. To avoid that some few lost ignitions or a tool that get stuck will be misunderstood by the microcomputer as a turn-off of the engine, it could be preferable to have a short time period at start before activating the speed limitation control. This period should be so short that it does not cause any failure of the speed limitation control for a normal start.

The deactivation on the other hand will occur when the engine reaches the low speed state. This means that the microcomputer will detect that the speed goes down below the clutch-in speed of the centrifugal clutch. As earlier mentioned this low speed state also correspond to an earlier angle time for the ignition, which information can also be used to detect the low speed state.

To have a margin, see fig. 1, due to possible variations in clutch-in speed, the limitation speed is distanced from the clutch-in speed. This gives a safer system in order to keep out of the clutch-in speed variations. Moreover, the low speed state has to last for a certain time period before the speed limitation control is deactivated. Preferably, the system will create an average of the speed for a period of 30-100 cycles before deactivating. The reason for this is to avoid deactivation by mistake, for instance by speed variations at start due to properties of the air/fuel mixing, or if the worker pumping the choke or the handle throttle valve control. It may also be possible to include a time period at the beginning of the start of the engine, within which deactivation is not allowed. This adds safety since the engine speed varies a lot at the first cycles of ignition.

The requirement with an average speed to detect the low speed state means that the worker has to allow the engine to go down to the idle speed for a period of time, which in second turn means he will have more control of the machine and probably be safely away from the cutting tool.

The limitation of the speed could be solved in different ways. One way is to switch of the ignition for some cycles. This is an easy way but may cause higher emission at start. Another way, which has also been discussed above and in fig. 2 is to control the timing of the ignition. A third way is to use a direct injection system, where the fuel injection is controlled. Either of these three ways will have the affect of an instant speed limitation, which is of course necessary.

CLAIMS

1. Method for controlling an ignition system of an internal combustion engine having a primary firing pulse generator for charging a capacitor and an electronic switch for discharging the capacitor via an ignition coil to generate an ignition voltage, a microcomputer operating the switch to control the ignition timing of said generator, said microcomputer having speed detection means to directly or indirectly detect the rotational speed of the engine and a speed limitation control to limit the engine speed to a limitation speed below the clutch-in speed of a centrifugal clutch,

characterized in

that the speed limitation control is active or activated when starting the engine and being deactivated when said speed detection means detects a low speed state of the engine.

2. Method according to any of the preceding claims wherein the indirect detection of the rotational speed corresponds to a detection of the time of ignition in relation to a stroke of the piston.

3. Method according to claim 2 wherein the detection of time of ignition is based on the microcomputers control to operate the engine in a preset value for its rotational speed.

4. Method according to claim 3 wherein the preset value is for the run at the engines rotational idle speed.

5. Method according to any of the preceding claims wherein the low speed state corresponds to a rotational speed of the engine below the limitation speed.

6. Method according to claim 5 wherein the start limitation control is deactivated when the low speed state have been kept for defined time period.

7. Method according to claim 6 wherein the low speed state corresponds to a throttle valve positioned at its most closed position.

8. Method according to any of the claims 6 - 7 wherein the low speed state corresponds to a time of ignition which is earlier in relation to the top dead center of the piston than a preset threshold value.

9. Method according to any of the preceding claims wherein the speed limitation control limits the speed through the operation of said switch via selectively activating or deactivating the ignition at different strokes of the piston.

10. Method according to any of the preceding claims wherein the speed limitation control limits the speed through the operation of said switch via selecting the time of ignition in relation to a stroke of the piston.

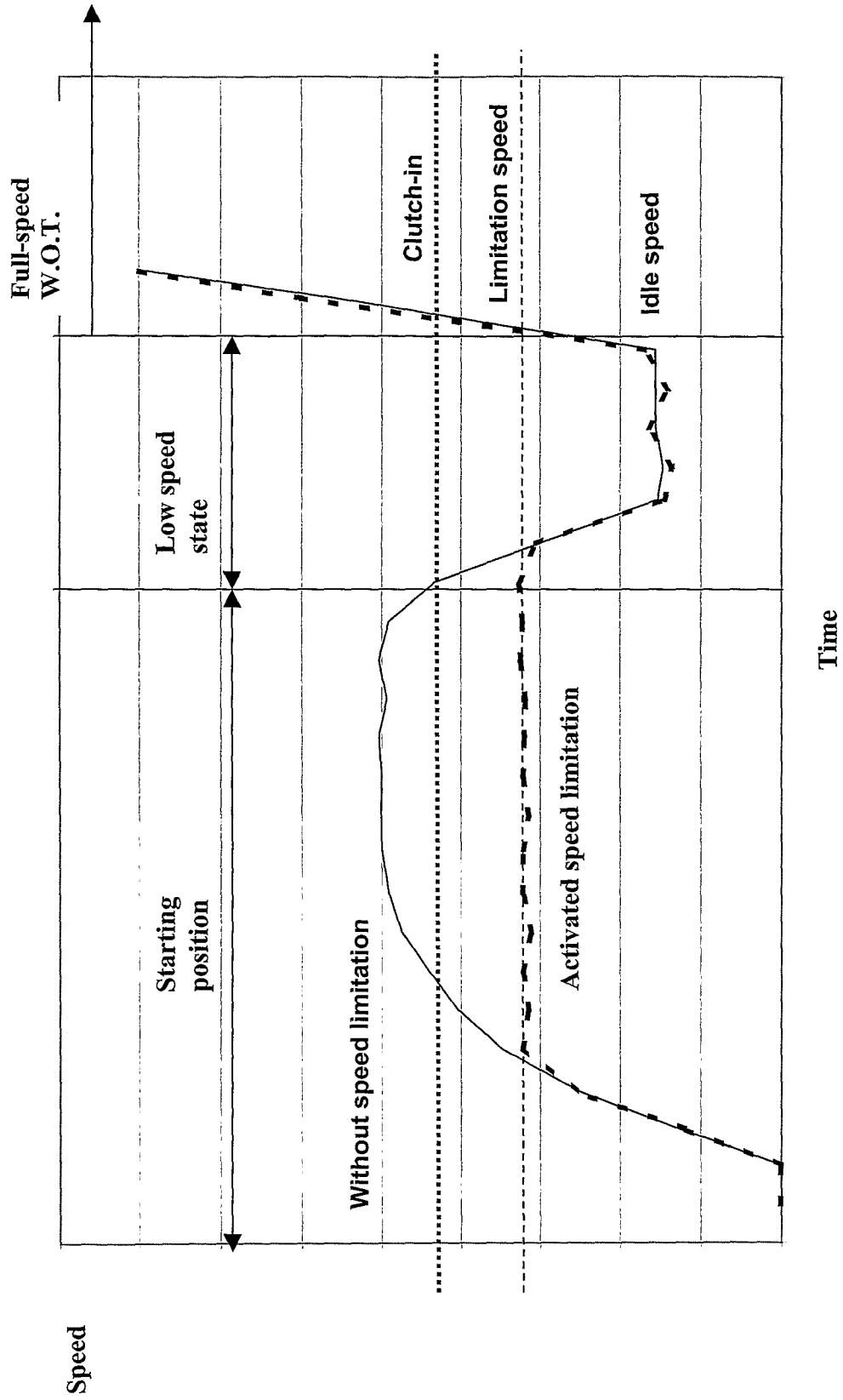


FIG 1

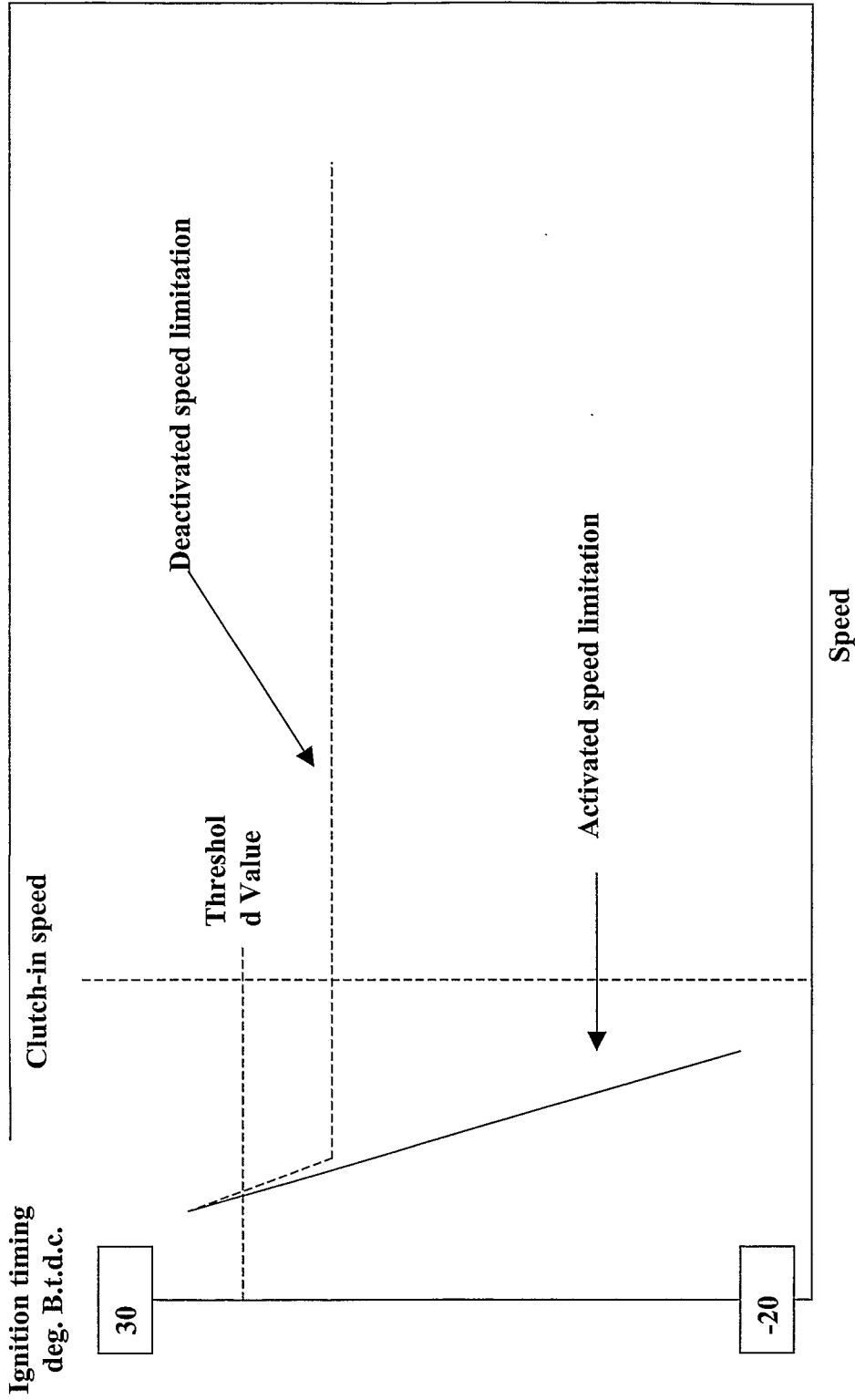


FIG 2

**Speed limitation control
Speed detection/ Ignition detection**

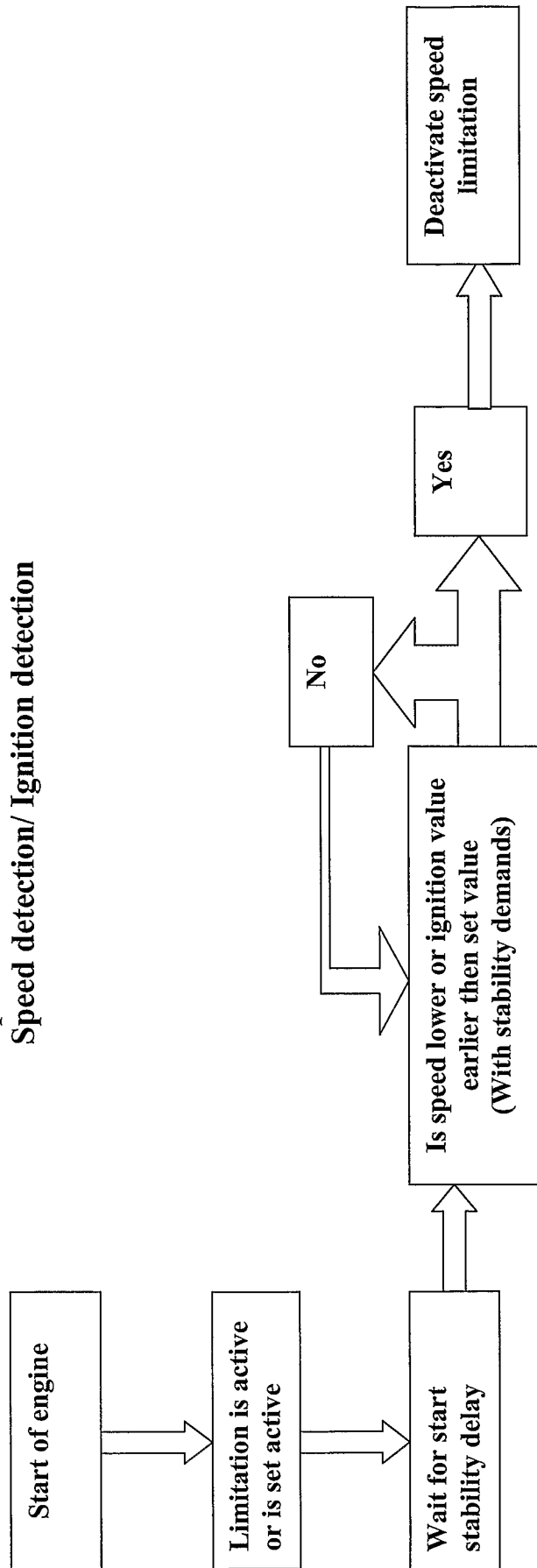


FIG 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2005/001100

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: B27B, F02P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4553517 A (BO C ANDERSSON), 19 November 1985 (19.11.1985), see whole document --	1-10
A	US 5050553 A (WERNER ERHARD), 24 Sept 1991 (24.09.1991), column 2, line 13 - column 4, line 4 --	1-10
A	US 4610231 A (HIROSHI NAKATA ET AL), 9 Sept 1986 (09.09.1986), claim 1 --	1-10
A	EP 1496249 A1 (LIDA DENKI KOGYO CO., LTD.), 12 January 2005 (12.01.2005), [0029]-[0041] -- -----	1-10

Further documents are listed in the continuation of Box C. See patent family annex.

<p>* Special categories of cited documents:</p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier application or patent but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p>	<p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone</p> <p>"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art</p> <p>"&" document member of the same patent family</p>
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Date of the actual completion of the international search 1 February 2006	Date of mailing of the international search report 06-02-2006
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Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Fredrik Wahlin/MN Telephone No. +46 8 782 25 00
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/ SE2005/001100

INTERNATIONAL PATENT CLASSIFICATION (IPC):

F02P 5/15 (2006.01)
B27B 17/10 (2006.01)
F02P 1/08 (2006.01)
F02P 11/02 (2006.01)
F02P 11/04 (2006.01)
F02P 5/02 (2006.01)

INTERNATIONAL SEARCH REPORT

Information on patent family members

26/11/2005

International application No.

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