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(54) **Safety system**

(57) A safety system (20) for limiting the inclination with respect to a given plane (π) of a device comprising at least one inclination sensor switch (21A,21B) comprising an ampoule body including electrical moving contacts (22A,22B) said at least one inclination sensor switch (21A,21B) has a first control terminal (TcA,TcB) where an electric test signal (testA,testB) is generated by the electrical moving contacts (22A,22B), by vibrations typical of normal operation of the device, the first control terminal (TcA,TcB) being connected to a control circuit (23A,23B), in turn connected to at least one safety redundant relay (SWA,SWB) suitable to generate a first alarm signal (alarm1) when the device exceeds a maximum angle of inclination (α), the electric signal (testA, testB) being further used to verify the correct operation of the at least one inclination sensor switch (21A,21B).

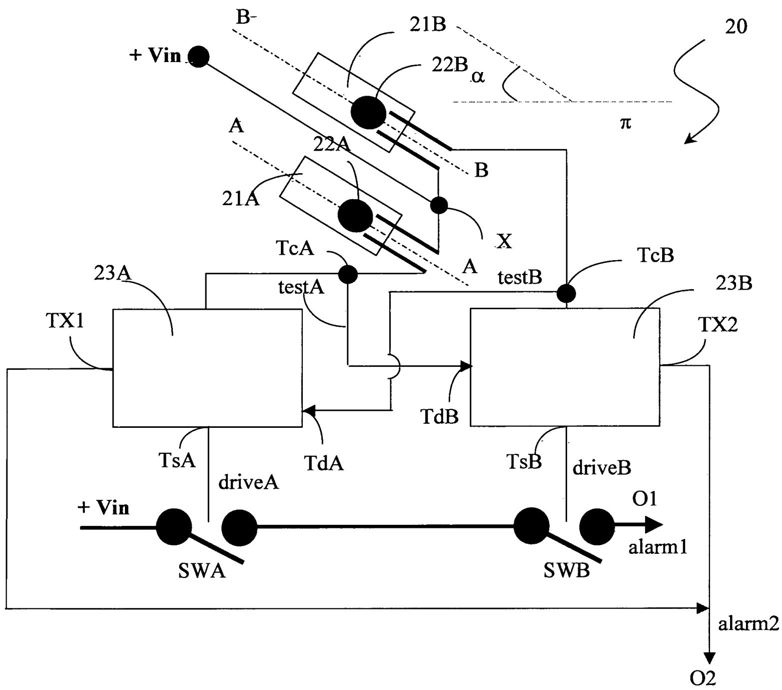

FIG. 5

EP 1 902 998 A1

Description

Field of Application

[0001] The present invention relates to a safety system for limiting the inclination of a safety system-bearing device with respect to a given plane.

[0002] More specifically, the invention relates to a system able to guarantee the opening of one or more electrical safety contacts when the inclination of the system and, therefore, of the device on board thereof, with respect to a given plane, exceeds one or more predetermined angles.

[0003] The invention relates in particular, but not exclusively, to a safety system for limiting the inclination of industrial plants, lifting and/or transportation systems for people and/or things, working vehicles in general and, in particular, to aerial platforms and the description hereunder refers to this field of application, with the sole purpose of simplifying the description.

Prior Art

[0004] As it is well-known in this field, lifting systems such as aerial platforms are equipped with specific safety systems, in particular inclination-switches which can block a maneuver in course or the total movement of the system when the inclination of the aerial platform exceeds one or more predetermined angles of inclination.

[0005] In particular, as illustrated in Figure 1, a lifting system of the known type, generally and schematically indicated with 1, comprises an aerial platform 2 and a base 3, said base 3 being such as to be mounted on tracks and stabilized by means of special feet or placed on a truck as illustrated in the Figure.

[0006] The aerial platform 2 is connected to the base 3 by means of an articulated arm 4.

[0007] The lifting system 1 further comprises a first 5 and a second safety circuit 6, mounted on board the aerial platform 2 and on the articulated arm 4 respectively.

[0008] In particular, the two safety circuits are such as to detect the inclination of the aerial platform (opportunely clockwise and anticlockwise) and of the articulated arm 4.

[0009] It can- immediately be understood how important it is to guarantee that the inclination of the aerial platform 2, with respect to a given plane, in particular a horizontal plane, does not exceed a maximum value where overturning of the aerial platform 2 is prevented, especially in the case where said aerial platform 2 comprises a cage where people or objects are carried and whose falling could be dangerous. Therefore, the first safety circuit 5 is used to block the inclination of the aerial platform 2 when its angle of inclination with respect to a horizontal plane π reaches a given first maximum value α. Opportunely, said safety circuit 5 controls the inclination of the aerial platform 2 in both a clockwise and an anticlockwise direction, said first maximum value α and a respective second maximum value β being preset, as illustrated graphically in Figure 1. In this case, it is known as a two-limit safety circuit.

[0010] Furthermore, the second safety circuit 6 controls the inclination of the articulated arm 4 and blocks its movement when the inclination of said arm exceeds a third maximum value γ, also preset, as illustrated graphically in Figure 1. In this case, it is known as a one-limit safety circuit. In particular, said third maximum value γ is chosen so as to guarantee that the articulated arm 4 does not collide with the top of the driver's cab of the truck which supports the base 3.

[0011] In substance, the first safety circuit 5 and the second safety circuit 6 ensure blocking of the inclination of the aerial platform 2 and of the articulated arm 4 before potentially dangerous situations arise. In particular, said first and second safety circuits 5, 6 essentially comprise sensor switches such as to detect their inclination with respect to a given plane, in particular the horizontal plane π.

[0012] The safety circuits illustrated block the lifting system 1 when the aerial platform 2 or the articulated arm 4 exceed the maximum values, indicated with α, β and γ, without actually controlling the hydraulic cylinder which normally acts on the orientation of said elements.

[0013] Likewise known is a safety circuit 5, inside a more complex electronic device, usually called automatic leveler 7, which is able to handle the orientation of the aerial platform 2 continuously, as schematically illustrated in Figure 2. In this case, an accelerometer (or a continuous inclination sensor) is used inside the leveler 7 to keep the aerial platform 2 horizontal during the movements of the lifting system 1, while the safety circuit 5, for detecting the inclination of the aerial platform 2 whereon it is boarded, constitutes the last safety step in case the electronic portion fails.

[0014] In particular, said safety circuit 5 acts on motor means 8, in particular a hydraulic cylinder, of the aerial platform 2 by means of a first driving signal Drive1 sent - on the basis of the control carried out by the first safety circuit 5 of the inclination of the aerial platform 2 - from the leveler 7 to a hydraulic valve 9 of the articulated arm 4, in turn supplying a second driving signal Drive2 for the motor means 8, as graphically illustrated in Figure 2.

[0015] It should be noted that said leveler 7, by means of an accelerometer (or another type of continuous inclination sensor) of an analog or digital control circuit, controls a hydraulic valve and an orientation cylinder; in this case too, the above-described safety system does not control the orientation but only blocks the machine.

[0016] Likewise known is the use of glass ampoules containing mercury as sensor switches for detecting inclination of the type illustrated in Figures 3 and 4,, generally indicated with 10 and 11 respectively. In said switches, since mercury is a liquid conductor, it is used as an element for electrical contact.

[0017] In particular, the sensor switch 10 illustrated in Figure 3 comprises a first and a second ampoule 12A, 12B comprising a first and a second drop of mercury 14A and 14B respectively, which are free- to move inside said ampoules and such as to come into contact with respective first T1A, T1B and second T2A, T2B contact terminals, said- second contact terminals T2A and T2B -being connected to -each other. The first contact terminal T1A of -the first ampoule 12A is connected to a voltage reference, in particular a supply voltage reference +Vin, while the first contact terminal- T1B of the second ampoule 12B is connected to an output terminal OUT of the sensor switch 10, where an output signal Vout signals that the inclination of the sensor switch 10 - and, therefore, of the aerial platform 2 or the articulated arm 4 whereon they are boarded - has exceeded the maximum values α or β, as indicated in the Figure. The ampoules and the drops of mercury contained therein substantially form an inclination sensor of the sensor switch 10 and, therefore, of a device whereon it is boarded.

[0018] On the contrary, the sensor switch 11 comprises a toroidal ampoule 13 comprising a region 15 of mercury. In particular, the sensor switch 11 comprises a first and a second contact terminal T3A and T3B near an upper level of said region 15 of mercury when the ampoule 13 - and, therefore, the sensor switch 11 and the aerial platform 2 or the articulated arm 4 whereon it is boarded - are in a horizontal position. Said contact terminals T3A and T3B are connected to a first OUT1 and to a second OUT2 output terminal of the sensor switch 11, which comprises a third contact terminal T3C, in contact with said region 15 of mercury, in an intermediate position between the first and the second contact terminal, T3A and T3B and connected to the supply voltage reference +Vin.

[0019] In particular, the sensor switch 11 also makes it possible to discriminate the inclination direction of the aerial platform 2 or of the articulated arm 4 whereon it is boarded. In this case too, the ampoule and the region of mercury contained therein, substantially form an inclination sensor of the sensor switch 11 and, therefore, of a device whereon it is boarded.

[0020] However, said sensor switches and safety circuits of the known type have two big drawbacks:

1) subjected to vibrations, they can cause unwanted temporary block of the lifting system 1; said vibrations, which are typical of the normal operation of the lifting system, cause the mercury contained in the sensor switches to move and, therefore, an unwanted block of the aerial platform 2, without any situation of real danger;

2) it is not possible to test their operation without taking the aerial platform 2 or the articulated arm 4 to values beyond their maximum inclination value, corresponding to conditions where the lifting system is blocked; this operation is not always possible and is sometimes dangerous since the aerial platform 2 and/or the articulated arm 4, forced to exceed the maximum inclination values during testing, risk overturning or damaging other parts of the lifting system 1.

[0021] The technical problem at the base of the present invention is to provide a safety system for limiting the inclination, with respect to a given plane, of a device bearing said safety system which is such as to ensure a safety block of the inclination of the device before potentially dangerous and/or harmful situations arise and to guarantee at the same time a correct and constant auto-test in order to overcome the limitations and drawbacks which still today affect the systems belonging to the prior art.

Summary of the invention

[0022] The solution at the basis of the present invention is to use the vibrations typical of the normal operation of a lifting system to perform the electrical test of the safety switches comprised in the safety system on board of said lifting system, in particular an aerial platform.

[0023] On the basis of said solution, the technical problem is solved by a safety system for limiting the inclination, with respect to a given plane, of a device bearing said safety system, of the type including at least one inclination sensor switch comprising an ampoule body, in turn including- a moving electrical contact and arranged at at least one maximum- angle of inclination of said device-with respect to said given plane, the -maximum angle of inclination corresponding to- one condition of correct operation of the device.

[0024] Advantageously, according to the invention, said at least one inclination sensor switch has a first control terminal where, from said moving electrical contacts, an electrical signal is generated corresponding to the vibrations typical of the normal operation of the device, the first control terminal being connected to a control circuit, in turn connected to at least one safety redundant relay suitable to generate, on a first output terminal of the safety system, a first alarm signal when the device exceeds a maximum angle of inclination.

[0025] Advantageously, said vibrations, by moving the moving contacts of the sensor switches, make it possible to -generate electrical signals which indicate correct operation of said switches.

[0026] More advantageously, said electrical signal is used by the control circuit to check if the inclination sensor switch is working correctly.

[0027] Further features and advantages of the safety system according to the present invention will become more apparent from the following detailed description of an exemplary but non-limiting embodiment thereof, as illustrated in the accompanying drawings.

Brief description of the drawings

[0028] In said drawings:

- Figure 1 schematically represents an aerial platform mounted on a truck realised according to the prior art;

- Figure 2 schematically represents an automatic leveler of an aerial platform which also incorporates a safety system realised according to the prior art;
- Figures 3 and 4 represent known embodiments of mercury-type sensor switches;
- Figure 5 schematically represents a safety system for limiting the inclination of a safety system-bearing-device with respect to a given -plane realised according to the invention;
- Figure 6 schematically represents a first alternative embodiment of the safety system in Figure 5; and
- Figure 7 schematically represents a second -alternative embodiment of the safety system in Figure 5.

Detailed description

[0029] With reference to said drawings, and in particular to Figure 5, a safety system for limiting the inclination of a safety system-bearing device with respect to a -given plane according to the present invention is schematically represented and generally indicated with 20.

[0030] Said safety system is such as to be used on board industrial plants, lifting and/or transportation systems for people and/or things, working vehicles in general and, in particular but not exclusively, to aerial servicing platforms.

[0031] Advantageously, according to the invention, as will become apparent from the following description, the proposed safety system 20 uses the vibrations typical of the normal operation of the lifting system whereon it is boarded, in particular an aerial platform thereof, for controlling the operation -of its components, in particular the sensor switches comprised in the safety system.

[0032] For this purpose, the safety system 20 comprises at least a first and a second sensor switch, 21A and 21B respectively, in particular inclination sensors, connected between a supply voltage +Vin and a first and a second control terminal, TcA and TcB respectively.

[0033] The first and second sensor switches 21A and 21B essentially comprise ampoule bodies having longitudinal axes of symmetry AA and BB, and containing respective moving contacts 22A and 22B, in particular formed by drops of a liquid conductor. It is also possible to use ball conductors as moving contacts, for example gold-coated balls, which can move inside the respective ampoule body.

[0034] Advantageously, according to the invention, said first 21A and second 21B sensor switches are mechanically mounted parallel to each other in such a way that their ampoule bodies have axes of symmetry AA and BB parallel to each other and forming an angle α to a given plane π, in particular a horizontal plane parallel to the ground on which the lifting system bearing the safety system 20 according to the invention is placed.

[0035] Suitably, said angle α is- a selected maximum angle equal to a value corresponding to a safe inclination of the lifting system, in particular an aerial platform bearing said safety system 20.

[0036] More advantageously, according to the invention, the sensor switches 21A and 21B have respective first terminals connected to each other at a circuit node X, connected to a voltage reference, in particular a supply voltage reference +Vin of the safety system 20, as well as respective second terminals connected to a first TcA and a second TcB control terminal.

[0037] Said first control terminal TcA is further connected to a first control circuit 23A having, in turn, a first driving terminal TsA which is such as to supply a first driving signal driveA to a first switch or safety redundant relay SWA, in series to a second safety redundant relay SWB between the supply voltage reference +Vin and the first output terminal O1 of the safety system 20, where a first alarm signal alarm 1 is supplied which is such as to signal a first alarm condition indicating that the device, in particular the aerial platform whereon the safety system 20 is boarded, has exceeded the maximum angle α.

[0038] Similarly, the second control terminal TcB is further connected to a second control circuit 23B having, in turn, a second driving terminal TsB which is such as to supply a second driving signal driveB to the second safety redundant relay SWB.

[0039] In particular, the safety redundant relays SWA and SWB can be used to block the lifting system comprising the device, in particular the aerial platform bearing the safety system 20 according to the invention, or only a particular maneuver which could cause an increase in the inclination of the platform.

[0040] It should be noted that the control circuits 23A and 23B are redundant circuits which may be either analog or digital, with or without a microprocessor. Only to simplify the description, reference will be made to redundant control circuits based on microprocessor.

[0041] Advantageously, according to the invention, the first and second control circuits 23A and 23B have further first and second test terminals TdA and TdB connected to the second TcB and to the first TcA control terminals respectively.

[0042] It should be noted that the moving contacts 22A and 22B of the sensor switches 21A and 21B are able to detect vibrations with infinitesimal amplitude compared to the oscillations caused by the normal operation of the lifting system, in particular an aerial platform comprising said safety system 20, so generating electric test signals testA and testB respectively at the control terminal TcA and TcB thanks to the electric contact made and interrupted by the movement of the moving contacts 22A and 22B inside the ampoule bodies of the sensor switches 21A and 21B.

[0043] Advantageously, according to the invention, said electric test signals testA and testB are used to test the operation of said switches and, suitably filtered with hardware or software filters inside the control circuits 23A and 23B, they control the safety redundant relays SWA and SWB. Advantageously according to the invention, said control circuits 23A and 23B are independent and redundant electronic systems and are such as to periodically control the state of the sensor switches 21A and 21B.

[0044] The control circuits 23A and 23B have further respective output terminals TX1 and TX2 connected to -each other at a second output terminal O2 of the safety system 20 where a second alarm signal alarm2 is supplied which is such as to signal a second alarm condition indicating a fault in the sensor switches 21A and 21B.

[0045] In other words, the safety system 20 illustrated in Figure 5 is such as to constitute a specific component which is able to ensure blocking of the lifting system, in particular the aerial platform whereon it is boarded, if the inclination of said aerial platform exceeds the maximum angle α. Therefore, said safety system 20 can be used, as described above with reference to the prior art, to produce a system for blocking the descent of an articulated arm which supports an aerial platform.

[0046] It is evident that it is possible to use a safety system 20 for each maximum angle of inclination of the aerial platform whereon said safety systems are boarded.

[0047] Furthermore, advantageously according to the invention, the proposed safety system 20 also implements an auto-test function. In fact, if one of the two control circuits, for example the first control circuit 23A, after suitably filtering the electric test signal testA coming from its sensor switch 21A and, therefore, after opening its safety redundant relay SWA so generating the first alarm signal alarm1 and blocking the machine or maneuver in course, does not receive at least one electric vibration front from the other sensor switch 21B and, therefore, from the corresponding electric test signal testB, it also generates the second alarm signal alarm2 indicating failure of the safety system 20 which, therefore, has to be replaced. The same is true for the opposite situation.

[0048] In substance, advantageously according to the invention, the first control circuit 23A controls whether or not the sensor switch 21B, connected to the second control circuit 23B, has- detected at least one vibration and vice versa, so guaranteeing continual correct performance of the safety system 20, without the need for dangerous test maneuvers as was the case with systems realised according to the prior art.

[0049] The safety system 20 according to the invention can easily be modified to provide a block mechanism which can detect both the clockwise inclination and the anticlockwise inclination of the device, in particular the aerial platform whereon it is boarded, as illustrated in Figure 6.

[0050] Therefore, the safety system 20 comprises, besides the first pair of sensor switches 21A and 21B, a second pair of sensor switches 21C and 21 D, also mechanically mounted parallel to each other in such a way that the respective ampoule bodies have axes of symmetry parallel to each other and forming a further maximum angle β to the plane π.

[0051] In this case, the maximum angle α is chosen equal to a value corresponding to a safe anticlockwise inclination of the lifting system, in particular an aerial platform bearing the safety system 20, and the further maximum angle β is chosen equal to a value corresponding to a safe clockwise inclination of said lifting system.

[0052] In detail, the sensor switches 21A and 21B of the first pair of switches are connected as illustrated in Figure 5 and the sensor switches 21C and 21D of the second pair of switches are connected symmetrically and dually.

[0053] In particular, the sensor switches 21C and 21 D of the second pair of switches have respective first terminals connected to each other at a further circuit node X1, connected to the supply voltage reference +Vin, as well as respective second terminals connected to a third TcC and to a fourth control terminal TcD.

[0054] Said third control terminal TcC is further connected to the first control circuit 23A having, in turn, a third driving terminal TsC such as to supply a third driving signal driveC to a third switch or safety redundant relay SWC, placed in series in a fourth safety redundant relay SWC between the supply voltage reference +Vin and a third output terminal 03 of the safety system 20 where a third alarm signal alarm3 is supplied which is such as to-signal a third alarm-condition indicating that the device, in particular the aerial platform whereon the safety system 20 is boarded, has exceeded the further maximum angle β.

[0055] In this case, the first alarm condition indicates that the safe clockwise inclination has been exceeded, while the third alarm condition indicates that the safe anticlockwise inclination has been exceeded.

[0056] In the same way, the fourth control terminal TcD is further connected to the second control circuit 23B having, in turn, a fourth driving terminal TsD such as to supply a fourth driving signal driveD to the fourth safety redundant relay SWD.

[0057] Advantageously according to the invention, the first and second control circuits 23A and 23B have further third and fourth test terminals TdC and TdD connected to the fourth and to the third control terminals, TcD and TcC respectively.

[0058] Therefore, the safety system 20 illustrated in Figure 6 is such as to constitute a specific component which can block the lifting system, in particular the aerial platform whereon it is boarded, if the inclination of said aerial platform exceeds the maximum angle α or β. Therefore, said safety system 20 can be used, as described above with reference to the prior art, to produce an inclination blocking system of an aerial platform.

[0059] Advantageously, the safety system 20 in Figure 6 is able to discriminate the clockwise inclination from the anticlockwise inclination and can be used to guarantee that when a device, in particular an aerial platform whereon it is boarded, goes beyond an acceptable- range of angles of inclination, any maneuvers which could lead to overturning will be blocked.

[0060] As explained above, the two _pairs of switches, 21A-21B and 21C-21D, detect vibrations caused- by normal operation of the lifting system to which the safety system 20 is associated and send electric test signals testA-D to the control circuits 23A and 23B. In particular, said electric test signals testA-D are digital signals (0 - switch off, 1 - switch on) and are used both to identify the state of the safety redundant relays SWA-SWD and to control correct operation of said switches.

[0061] For example, if the safety system 20 turns anticlockwise at a value greater than the maximum angle α, the sensor switches 21A and 21B of the first pair of switches open, so determining opening of the safety redundant relays SWA and SWB and, therefore, generating the first alarm signal alarm 1 (anticlockwise block). In practice, even if the sensor switches 21A and 21B of the first pair of switches are parallel to each other, the respective contacts will not open simultaneously. For sake of simplicity, suppose that the first sensor switch 21A is faster than the second sensor switch 21B; in this case, the first control circuit 23A disables its own safety redundant relay SWA before the second control circuit 23B disables its safety redundant relay SWB. In this case, suitable filter means, in particular a microprocessor, of the first control circuit 23A, after filtering the pulses coming from the first sensor switch 21A, disable its own safety redundant relay SWA, so blocking the maneuver and then immediately control if the second sensor switch 21B has detected vibrations.

[0062] In fact, since the sensor switches are highly sensitive, it is not possible that the second sensor switch 21B cannot detect at least one vibration before the filtered signal, therefore delayed, generated by the first control circuit 23A and corresponding to the signal generated by the first sensor switch 21A, causes the opening of its safety redundant relay SWA.

[0063] If the first control circuit 23A does not detect vibrations of the second sensor switch 21B, it generates the second alarm signal alarm2 which, transmitted to the second terminal O2 of the safety system 20, indicates a permanent failure condition of the system which must, therefore, be replaced.

[0064] The same mechanism arises if the safety system 20 (therefore the device, in particular the aerial platform whereon it is boarded) turns clockwise at an angle greater than the further maximum angle β. In this case, the third alarm signal alarm3 is generated by the sensor switches 21C and 21D of the second pair, and the third and fourth safety redundant relays SWC and SWD are opened (clockwise block).

[0065] It is evident that the safety system 20 in Figure 5 acts on the same principle as that above described, with the simplification due to the existence of only one maximum angle of inclination.

[0066] It is also possible to use the safety system 20 according to the invention as part or subsystem of a self-leveling device based on a continual inclination sensor, of the type illustrated in Figure 7.

[0067] In this case, the control circuits 23A and 23B of the safety system 20 comprise respective first and second orientation control terminals, ToA and ToB, suitably connected to the self-leveling device 25. Said device measures the angle of the system, in particular the aerial platform bearing the safety system 20, with respect to the plane π, in particular horizontal, and controls an actuator system 24, hydraulic or electric, in order to keep said aerial platform horizontal during movement of the lifting system comprising said aerial platform.

[0068] In this case, the self-leveling device 25 comprises circuits for continual measurement of the angle of inclination of the aerial platform, said measuring circuits supplying at least a first and a second measuring signal, measA and measB, to the orientation control terminals, ToA and ToB. Therefore, the self-leveling device 25, in particular the measuring circuits contained therein, by means of the control circuits 23A and 23B, drives the safety redundant relays SWA and SWB in collaboration with a first and a second sensor switch 21A and 21B, suitably mounted mechanically in such a way that the respective ampoule bodies have axes of symmetry forming a first and a second maximum angle, α and β, to the plane π and such as to generate electric test signals, testA and testC, as described above.

[0069] In this case, because of the presence of the measuring circuits, i.e. a continual sensor able to measure the angle of inclination of the device, in particular the aerial platform bearing the safety system 20, with respect to a horizontal plane π, it is sufficient to use only one inclination switch for each of the two maximum angles, α and β, thanks to the simultaneous control of the safety redundant relays SWA, SWB for the clockwise block and SWC, SWD for the anticlockwise block by the continual measuring circuits.

[0070] In this case, it is sufficient that the circuit 23A detects a signal measA of a few degrees of inclination anticlockwise, in the absence of vibration detection by the sensor switch 21A, for the second alarm signal alarm2 indicating faulty switch to be generated. With the same identical method, the circuit 23B can identify any fault in the second sensor switch 21B when a clockwise angle of inclination of a few degrees is detected by the signal measB. It should be noted that, advantageously according to the invention, even if one or both of the sensor switches 21A and 21B are faulty, the safety system 20 guarantees safe operation thanks to the presence of the continual measuring circuits of the self-leveling device 25 which open the safety redundant relays, signaling permanent failure of the safety system 20.

[0071] Therefore, the proposed safety system overcomes the drawbacks pointed out with regard to systems of the prior art and has numerous advantages, among which:

- the system is based on inclination sensor switches which are very sensitive to vibrations and uses said vibrations, typical of normal operation of a lifting system, to electrically test said switches during operation of said lifting system;

- the system makes it possible to test the sensor switches, in particular the inclination switches, without having to incline the device, in particular the aerial platform or the articulated arm whereon they are boarded, by simply using the vibrations of the lifting system to which it is connected, said vibrations acting on the switches, opening and closing the contacts dozens of times each second;

- the system can be controlled automatically when it is switched on and during its operation, without having to incline the device, in particular the aerial platform whereon it is boarded or other parts of the lifting system to which it is connected;

- the system can constitute a limiter which exclusively ensures blocking of the device, in particular the aerial platform whereon it is boarded and/or the lifting system to which it is connected, when the inclination of said device goes beyond a given range;

- the system can also form part of a more complex mechanism such as, for example, an electronic leveler for controlling the movement of the device, in particular the aerial platform whereon it is boarded and/or the lifting system to which it is connected;

- the system can use both analog and digital control circuits, with or without a microprocessor;

- the system comprises redundant elements which can guarantee control of said system and safety of the operation of the device, in particular the aerial platform whereon it is boarded;

- if a more complex self-leveling device is used with orientation controlled by means of electric or hydraulic actuators, the proposed safety system uses only one inclination switch for each maximum angle, so guaranteeing block of the lifting system to which it is associated, thanks to the simultaneous driving by the sensor switches contained therein and the measuring circuits already comprised in the self-leveling device;

- it is possible to provide a safety system for each maximum angle of inclination;

- the proposed safety system can block either the lifting system to which it is associated or simply the maneuver which could cause an increase in the inclination of the device-, in particular the aerial platform whereon it is boarded.

[0072] Naturally, in order to satisfy contingent and specific requirements, a person skilled in the art may apply to the above-described safety systems many modifications and variations, all of which, however, are included within the scope of protection of the invention as defined by the following claims.

Claims

1. Safety system (20) for limiting the inclination with respect to a given plane (π) of a device bearing said safety system of the type comprising at least one inclination sensor switch (21A, 21B) comprising an ampoule- body, in turn including an electrical moving contact (22A, 22B) and-arranged according to at least one maximum angle of inclination (α) of said device with respect to said given plane (π), said maximum angle of inclination (α) corresponding to a condition of correct operation of said device **characterized in that** said at least one inclination sensor switch (21A, 21B) has a first control terminal (TcA, TcB) where an electric test signal (testA, testB) is generated by said electrical moving contact (22A, 22B), by vibrations typical of normal operation of said device, said first control terminal (TcA, TcB) being connected to a control circuit (23A, 23B), in turn connected to at least one safety redundant relay (SWA, SWB) suitable to generate on a first output terminal (O1) of said safety system (20) a first alarm signal (alarm 1) when said device exceeds a maximum angle of inclination (α), said electric signal (testA, testB) being further used by said control circuit (23A, 23B) to verify the correct operation of said at least one inclination sensor switch (21A, 21B).

2. Safety system (20) according to claim 1, **characterized in that** it comprises at least a first and a second inclination sensor switch (21A, 21B) having respective ampoule bodies arranged parallel to each other according to said at least one maximum angle of inclination (α).

3. Safety system (20) according to claim 2, **characterized in that** it comprises a first and a second control circuit (23A, 23B) connected to a first and to a second control terminal (TcA, TcB) of said first and second inclination sensor switches (21A, 21B) and having further first and second test terminals (TdA, TdB) connected to said second and first control terminals (TcB, TcA) respectively, in such a way that said electric signals (testA, testB) generated by said electric moving contacts (22A, 22B) are used to test the operation of said inclination sensor switches (21A, 21B).

4. Safety system (20) according to claim 3, **characterized in that** said first and second control circuits

-(23A, 23B) have respective output terminals (TX1, TX2) connected to each other at a second output terminal (02) of said safety system (20) for generating a second alarm signal (alarm2) corresponding to a failure of said sensor switches (21A, 21B).

5. Safety system (20) according to claim 4, **characterized in that** said ampoule bodies have longitudinal axes of symmetry (AA, BB) in the direction of their greater extension, arranged parallel to each other according to said at least one maximum angle of inclination (α).

6. Safety system (20) according to claim 5, **characterized in that** said first and second inclination sensor switches (21A, 21B) have respective first terminals connected to each other at a circuit node (X), in turn connected to a supply voltage reference (+Vin), and respective second terminals connected to a first and a second control terminal (TcA, TcB) of respective first and second control circuits (23A, 23B), in turn having at least a first and a second driving terminal (TsA, TsB) such as to supply respective first and second driving signals (driveA, driveB) to at least a first and a second safety redundant relay (SWA, SWB), in turn connected in series to each other between said supply voltage reference (+Vin) and said first output terminal (01) of said safety system (20) for generating said first alarm signal (alarm 1) .

7. Safety system (20) according to claim 6, **characterized in that** said safety redundant relays (SWA, SWB) completely block a lifting system comprising said device.

8. Safety system (20) according to claim 6, **characterized in that** said safety redundant relays (SWA, SWB) block a particular maneuver of a lifting system comprising said device which could cause an increase in the inclination of said device.

9. Safety system (20) according to claim 1, **characterized in that** it comprises at least one first and -one second pair of inclination sensor switches (21A, 21B; 21C, 21D)_ having respective ampoule bodies arranged according to- said at least one maximum angle of inclination (α) and further maximum angle- of inclination (β) with respect to a given plane (π), said maximum angle of inclination (α) being equal to a safe anticlockwise inclination of said device and said further maximum angle of inclination (β) being equal to a safe clockwise inclination of said device respectively.

10. Safety system (20) according to claim 9, **characterized in that** it comprises a first and a second control circuit (23A, 23B) connected to a first and to a second control terminal (TcA, TcB) of a first and a second inclination sensor switch (21A, 21B) of said first pair of switches and to a third and to a fourth control terminal (TcC, TcD) of a third and a fourth inclination sensor switch (21C, 21D) of said second pair of switches, said first and second control circuits (23A, 23B) having further first and second test terminals (TdA, TdB) connected to said second and first control terminals (TcB, TcA) respectively, as well as further third and fourth test terminals (TdC, TdD) connected to said fourth and third control terminals (TcD, TcC) respectively, in such a way that the electric signals (testA, testB, testC, testD), generated by the electric moving contacts (22A, 22B, 22C, 22D) of said sensor switches (21A, 21B, 21C, 21D), are used to test the operation of said inclination sensor switches (21A, 21B, 21C, 21D).

11. Safety system (20) according to claim 10, **characterized in that** said first and second control circuits (23A, 23B) have respective output terminals (TX1, TX2) connected to each other at a second output terminal (O2) of said safety system (20) for generating a second alarm signal (alarm2) corresponding to a failure of said sensor switches (21A, 21B, 21C, 21D).

12. Safety system (20) according to claim 11, **characterized in that** said first and second inclination sensor switches (21A, 21B) of said first pair of switches have respective first terminals connected to each other at -a circuit node (X), in turn connected to a supply voltage reference (+Vin), and respective second terminals connected to said first and second control terminals (TcA, TcB) of said first and second control circuits (23A, 23B), in turn having at least a first and a second driving terminal (TsA, TsB), such as to supply respective first and second driving signals (driveA, driveB) to at least a first and a second safety redundant relay (SWA, SWB), in turn connected in series to each other between said supply voltage reference (+Vin) and said first output terminal (O1) of said safety system (20) for generating said first alarm signal (alarm1) when said device exceeds said maximum angle of inclination (α).

13. Safety system (20) according to claim 12, **characterized in that** said third and fourth inclination sensor switches (21C, 21D) of said second pair of switches have respective first terminals connected to each other at a further circuit node (X1), in turn connected to said supply voltage reference (+Vin), and respective second terminals connected to said third and fourth control terminals (TcC, TcD) of said first and second control circuits (23A, 23B), in turn having at least a third and a fourth driving terminal (TsC, TsD) such as to supply respective third and fourth driving signals (driveC, driveD) to at least a third and a fourth safety redundant relay (SWC, SWD), in turn connected in series to each other between said supply voltage reference (+Vin) and a third output terminal (03) of said safety system (20) for generating a third alarm signal (alarm3) when said device exceeds said further maximum angle of inclination (β).

14. Safety system (20) according to claim 13, **characterized in that** said safety redundant relays (SWA, SWB, SWC, SWD) completely block a lifting system comprising said device.

15. Safety system (20) according to claim 13, **characterized in that** said safety redundant relays (SWA, SWB, SWC, SWD) block a particular maneuver of a lifting system comprising said device which could cause an increase in the inclination of said device.

16. Safety system (20) for limiting the inclination with respect to a given plane (π) of a device bearing said safety system included in a self-leveling device (25) for controlling an actuator system (24) of said device bearing said safety system (20) of the type comprising at least one-inclination sensor switch (21A, 21B) comprising an ampoule body including electric moving contacts (22A, 22B) and arranged along at least one maximum inclination angle (α) of said device with respect to said given plane (π), said maximum angle of inclination (α) corresponding to a condition of correct operation of said device **characterized in that** said at least one inclination sensor switch (21A, 21B) has a first control terminal (TcA, TcB) where an electric signal (testA, testB) is generated by said electric moving contacts (22A, 22B) by vibrations typical of normal operation of said device, said first control terminal (TcA, TcB) being connected to a control circuit (23A, 23B), connected to at least one safety redundant relay (SWA, SWB) such as to generate on a first output terminal (O1) of said safety system (20) a first alarm signal (alarm1) when said device exceeds a maximum angle of inclination (α).

17. Safety system (20) according to claim 16, **characterized in that** it comprises at least a first and a second inclination sensor switch (21A, 21B) having respective ampoule bodies arranged according to said at least one maximum angle of inclination (α) and a further maximum angle of inclination (β) with respect to said given plane (π), said maximum angle of inclination (α) being equal to a safe anticlockwise inclination of said device and said further maximum angle of inclination (β) being equal to a safe clockwise inclination of said device respectively.

18. Safety system (20) according to claim 17, **characterized in that** it comprises a first and a second control circuit (23A, 23B) connected to a first and to a second control terminal (TcA, TcB) of said first and second inclination sensor switches (21A, 21B) and having further first and second orientation control terminals (ToA, ToB) connected to said self-leveling device (25) and receiving from it a first and a second measuring signal (measA, measB) of the angle of inclination of said device.

19. Safety system (20) according to claim 18, **characterized in that** said first and second control circuits (23A, 23B) have respective output terminals (TX1, TX2) connected to each other at a second output terminal (02) of said safety- system (20) for generating a second alarm signal (alarm2) corresponding to a failure of said sensor switches (21A, 21B)

20. Safety system (20) according to claim 19, **characterized in that** said first and second inclination sensor switches (21A, 21B) have respective first terminals connected to each other at a circuit node (X), in turn connected to a supply voltage reference (+Vin), and respective second terminals connected to a first and a second control terminal (TcA, TcB) of respective first and second control circuits (23A, 23B), in turn having at least a first and a second driving terminal (TsA, TsB), such as to supply respective first and second driving signals (driveA, driveB) to at least a first and a second safety redundant relay (SWA, SWB), in turn connected in series to each other between said supply voltage reference (+Vin) and said first output terminal (O1) of said safety system (20) for generating said first alarm signal (alarml), said respective first and second driving signals (driveA, driveB) being generated on the basis of electric signals generated by said sensor switches (21A, 21B) at said first and second control terminals (TcA, TcB) and of said first and second measuring signals (measA, measB) supplied by said self-leveling device (25) at said first and second orientation control terminals (ToA, ToB).

21. Safety system (20) according to claim 20, **characterized in that** said first and second control circuits (23A, 23B) have at least a third and a fourth driving terminal (TsC, TsD) such as to supply respective third and fourth driving signals (driveC, driveD) to at least a third and a fourth safety redundant relay (SWC, SWD), in turn connected in series to each other between said supply voltage reference (+Vin) and a third output terminal (03) of said safety system (20) for generating a third alarm signal (alarm3) when said device exceeds said further maximum angle of inclination (β), said respective third and fourth driving signals (driveC, driveD) being generated on the basis of electric signals generated by said sensor switches (21A, 21B) at said first and second control terminals (TcA, TcB) and of said first and second measuring signals (measA, measB) supplied by said self-leveling device (25) at said first and second orientation control terminals (ToA, ToB).

22. Safety system (20) according to claim 21, **characterized in that** said safety redundant relays (SWA, SWB, SWC, SWD) completely block a lifting system comprising said device.

23. Safety system (20) according to claim 22, **characterized in that** said safety redundant relays (SWA, SWB, SWC, SWD) block a particular maneuver of a lifting system comprising said device which could cause an increase in the inclination of said device.

24. Safety system (20) according to any of the previous claims wherein said device is an aerial platform of a lifting system.

25. Safety system (20) according to claim 24 wherein said given plane (π) is a horizontal plane parallel to the ground where the lifting system is placed.

26. Use of the vibrations typical of the operation of a lifting system for testing the sensor switches contained in a safety system on board of an aerial platform of said lifting system.

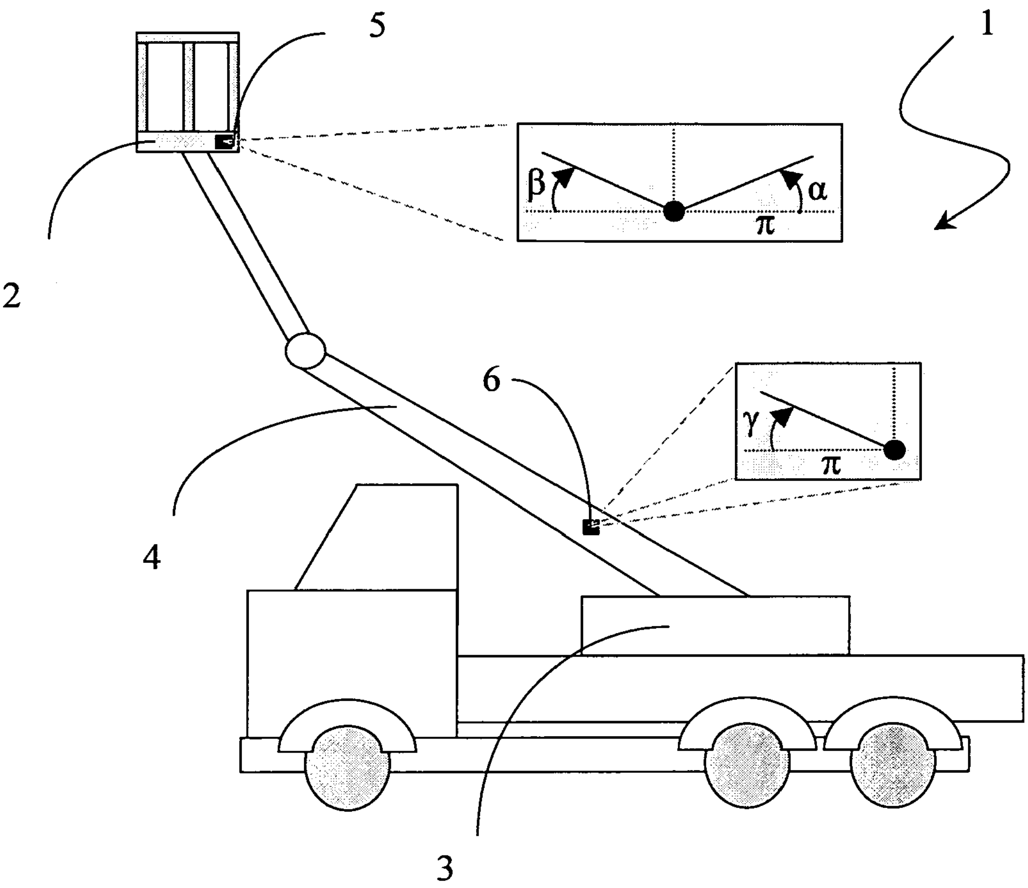

FIG. 1
PRIOR ART

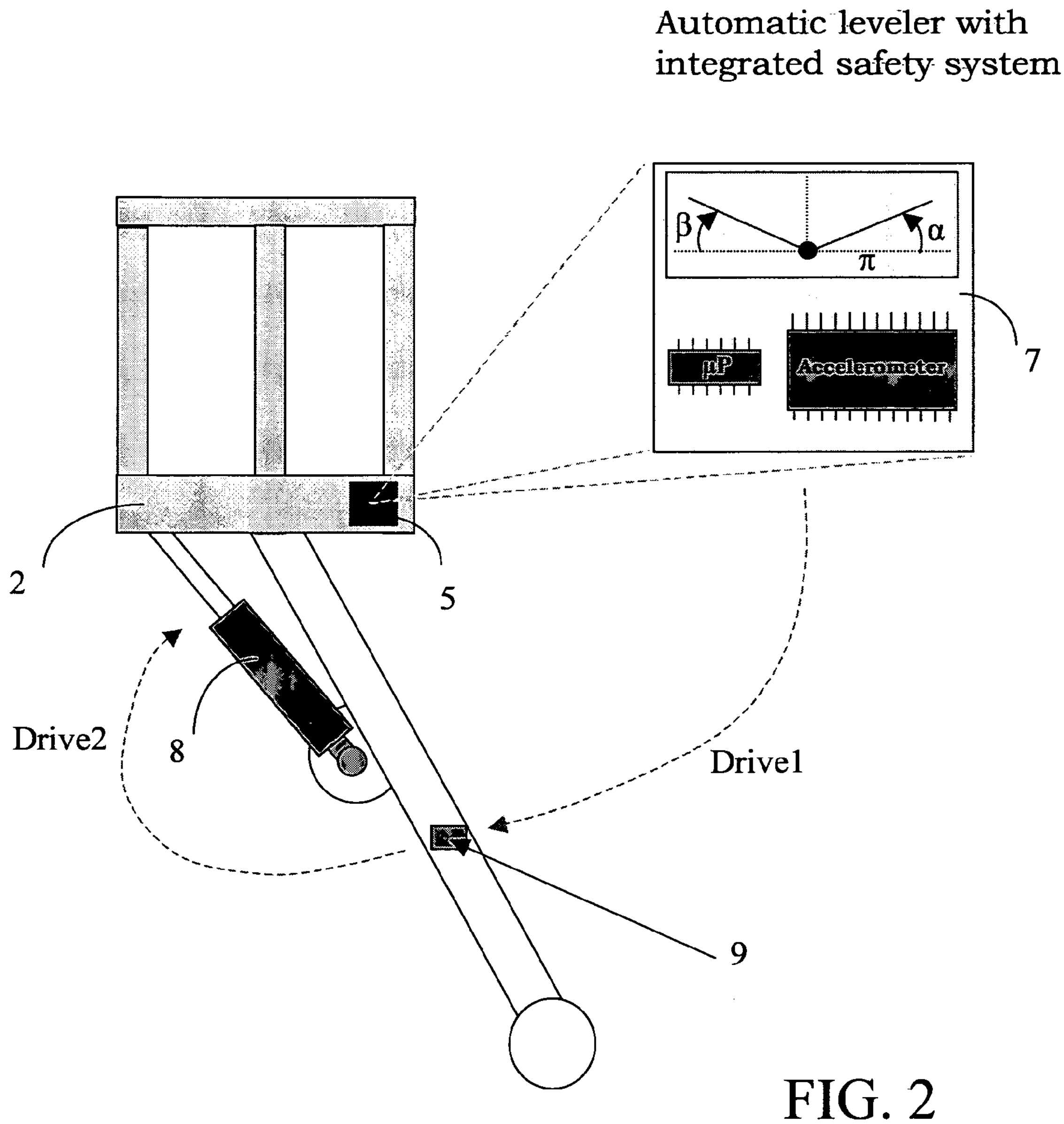

FIG. 2
PRIOR ART

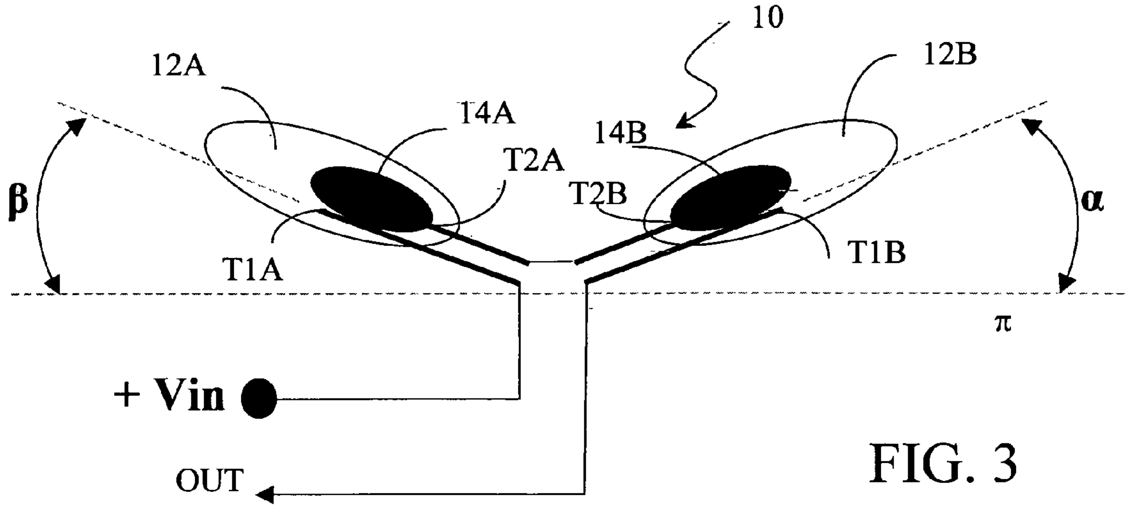

FIG. 3
PRIOR ART

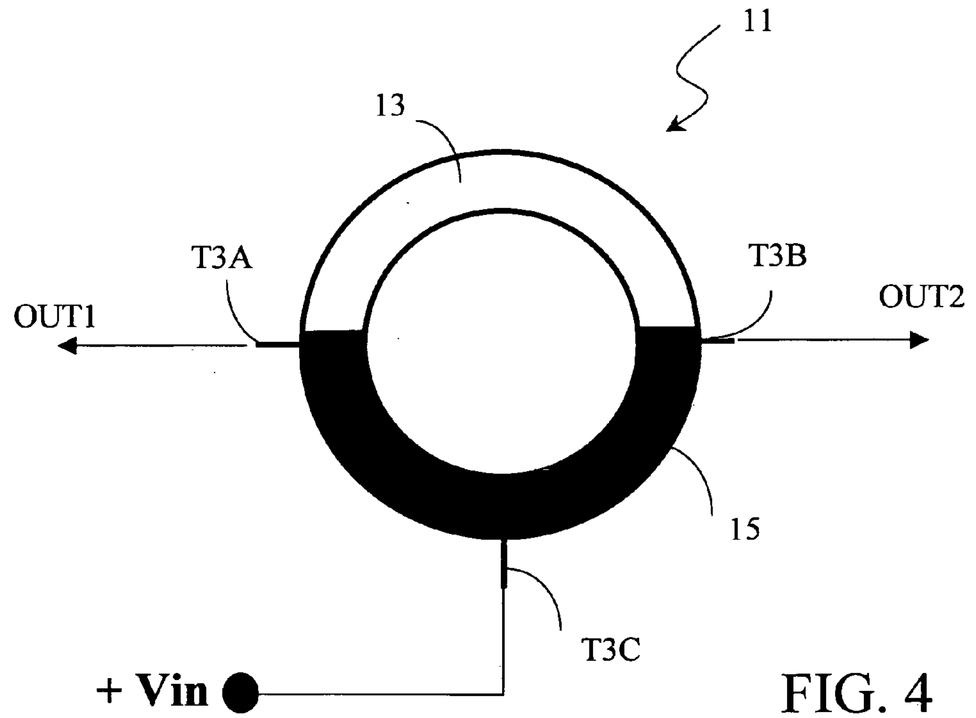

FIG. 4
PRIOR ART

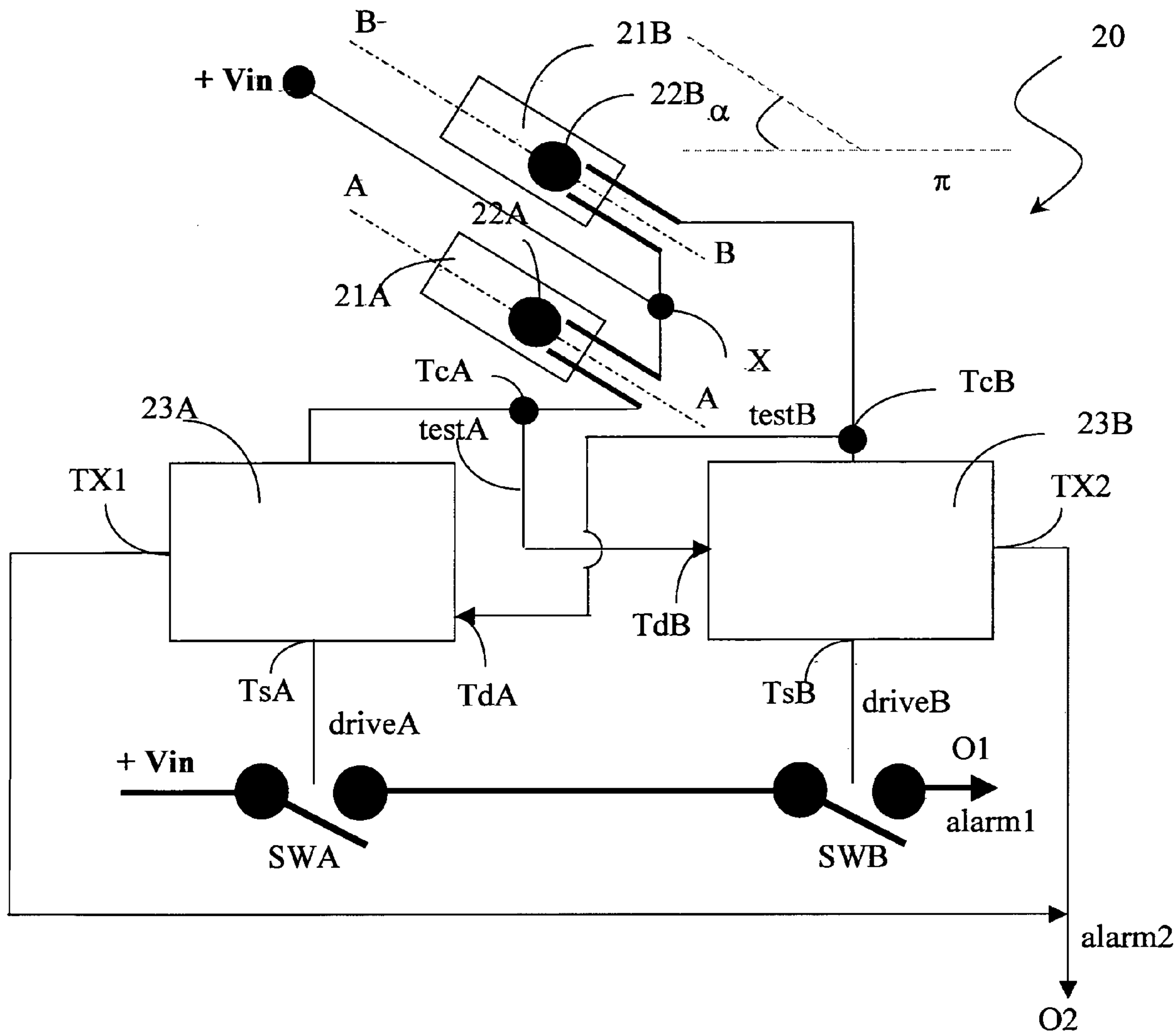
B-
21B
20
+ Vin
22B
α
π
A
22A
B
21A
X
TcA
A
TcB
23A
testA
testB
23B
TX1
TX2
TdB
TdA
TsA
TsB
driveA
driveB
+ Vin
O1
alarm1
SWA
SWB
alarm2
O2

FIG. 5

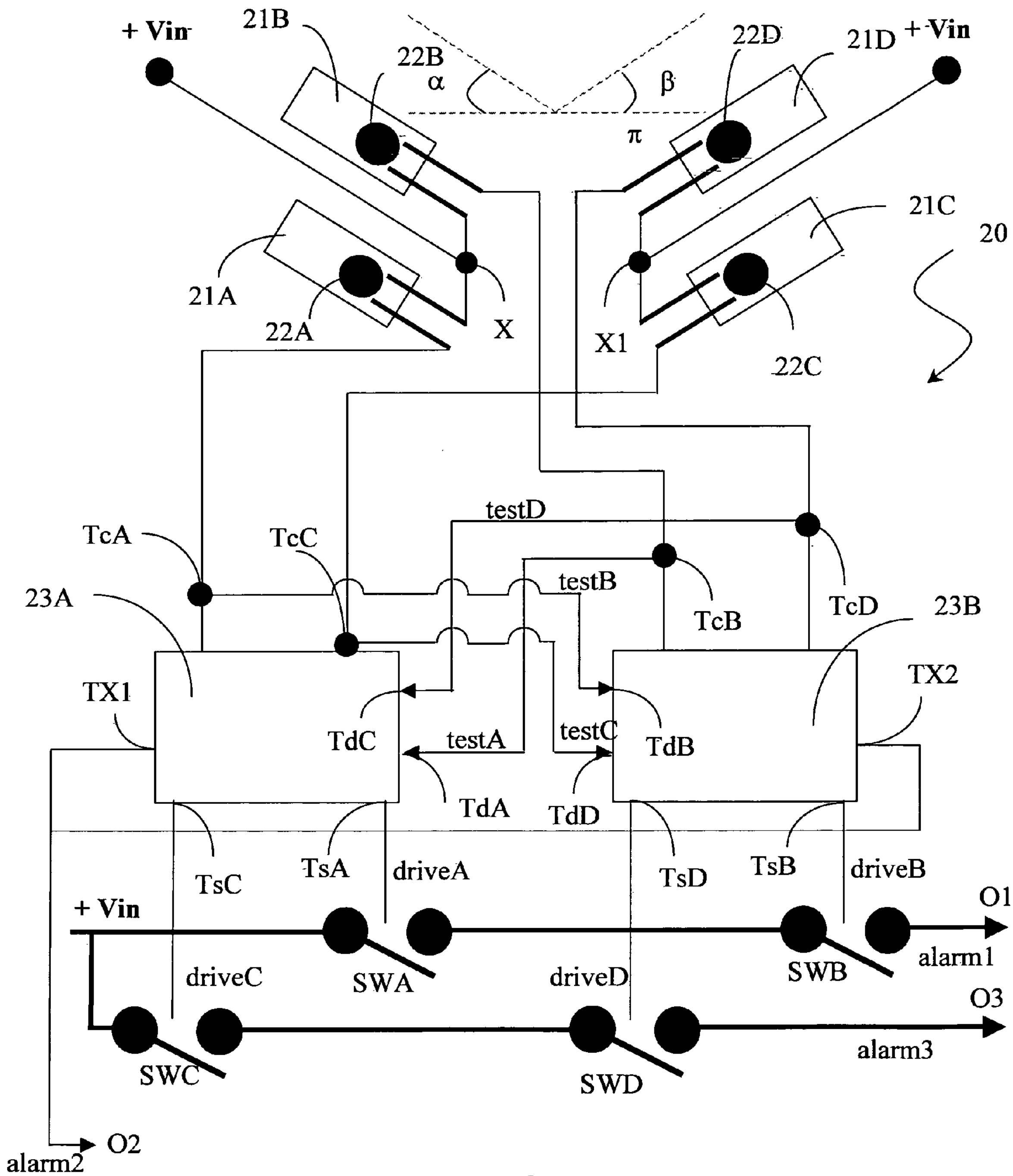
+ Vin
21B
22B
α
β
22D
21D
+ Vin
π
21C
20
21A
22A
X
X1
22C
testD
TcA
TcC
testB
23A
TcB
TcD
23B
TX1
TX2
TdC
testA
testC
TdB
TdA
TdD
TsC
TsA
driveA
TsD
TsB
driveB
+ Vin
O1
alarm1
driveC
SWA
driveD
SWB
O3
alarm3
SWC
SWD
O2
alarm2

FIG. 6

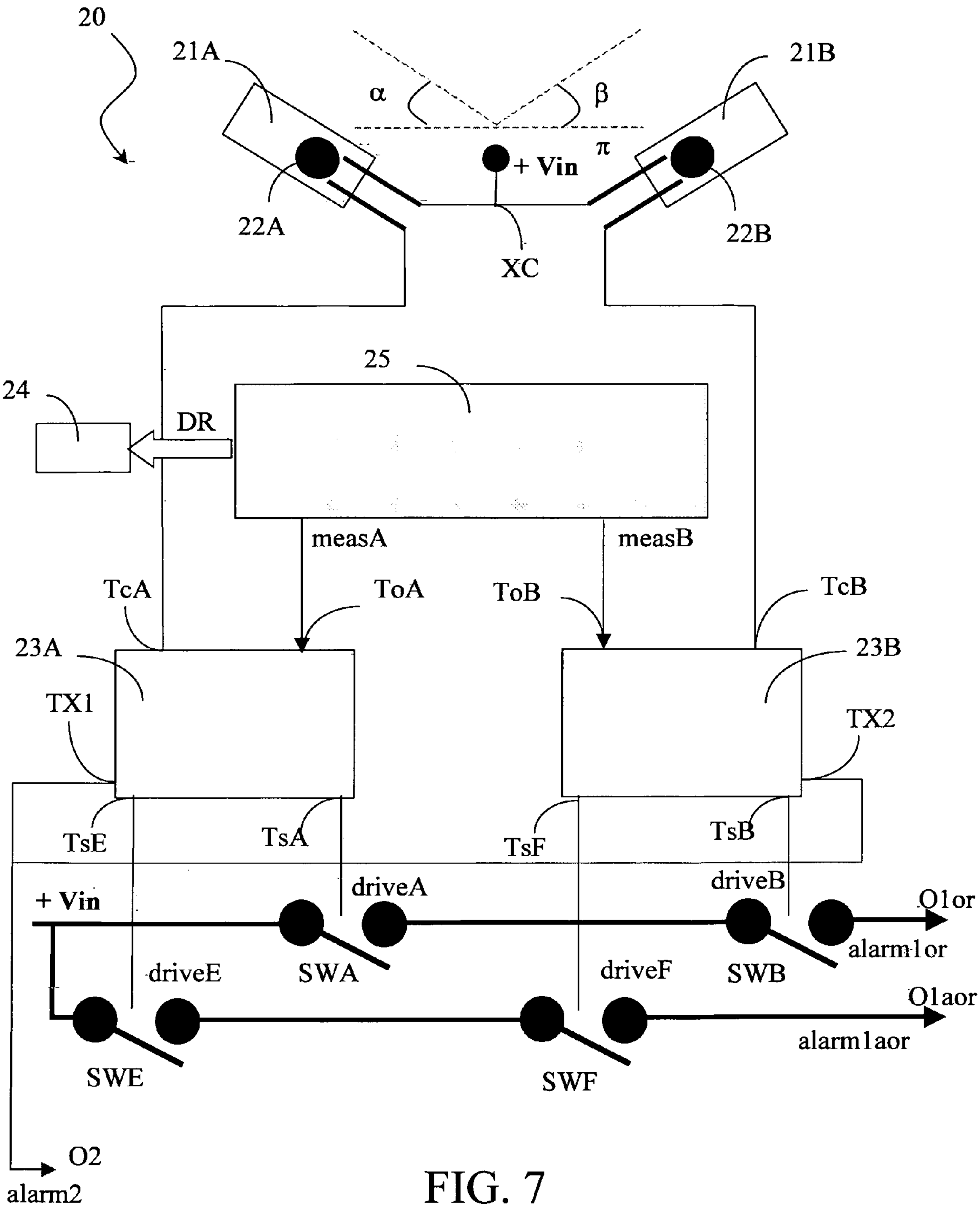
20
21A
21B
α
β
π
+ Vin
22A
22B
XC
25
24
DR
measA
measB
TcA
ToA
ToB
TcB
23A
23B
TX1
TX2
TsE
TsA
TsF
TsB
+ Vin
driveA
driveB
O1or
alarm1or
driveE
SWA
driveF
SWB
O1aor
alarm1aor
SWE
SWF
O2
alarm2

FIG. 7

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 06 42 5647

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X A	US 2004/085184 A1 (SIGMUND VOLKER [DE]) 6 May 2004 (2004-05-06) * the whole document * -----	26 1,16	INV. B66F11/04 B66F17/00
			TECHNICAL FIELDS SEARCHED (IPC)
			B66F B66C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	26 February 2007	Sheppard, Bruce

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons
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The members are as contained in the European Patent Office EDP file on
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26-02-2007

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82