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(54) **Method of supervising an electrical contact**

Verfahren zur Überwachung eines elektrischen Kontakts

Méthode de surveillance d'un contact électrique

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- **PATENT ABSTRACTS OF JAPAN vol. 013, no. 232 (E-765), 29 May 1989 (1989-05-29) & JP 01 039119 A (NEC CORP), 9 February 1989 (1989-02-09)**

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Description

Background of the invention

[0001] The invention relates to a method of supervising the state of an electrical contact present in a load circuit and a supervision circuit.

[0002] In safety critical systems, the state (open or closed) of all kinds of electrical contacts (e.g. relay contacts) need to be supervised for detection of faults. In the prior art special relays are used, for example relays with guided contacts, that enable any detection of contact failures by supervising corresponding contacts.

[0003] According to US 5, 031, 110, an electric power distribution system includes three conductors of a three-phase power line segment which is protected by a protective relay. The protective relay monitors the current on the conductor through a current sensor and the voltage through potential transformers. If the conditions detected meet predetermined criteria, the protective relay energizes a coil of a trip relay having a contact, which, when closed, provides current for a station battery to the coil of the circuit breaker which opens a contact to interrupt the flow of current through the conductor. The status of the contact, which is an indication of the status of the circuit breaker, is monitored by the contact activity monitor.

Object of the invention

[0004] It is the object of the invention to provide a method and a circuit for supervising the state of an electrical contact provided in a load circuit.

Short description of the invention

[0005] This object is achieved by a method according to claim 1. Whenever the contact to be supervised is closed, a current is flowing through the contact and thus through the load circuit and the supervision circuit. If a current is flowing in the supervision circuit a first output signal corresponding to a first logic level is generated by the detection means. If the contact is open and thus if no current is flowing in the load circuit and the supervision circuit, a second output signal corresponding to a second logic level is generated by the detection means. The output signal of the supervision circuit can therefore be used for monitoring the state of the supervised electrical contact. If the state of the electrical contact changes, the output signal changes. In other words, each signal level of the output signal corresponds to a state of the electrical contact. The supervision circuit allows the use of cheap, commercial relays in safety critical applications.

[0006] It is particularly advantageous if the logic or signal level of the output signal is "high" if the contact is closed and "low" if the contact is open. The logic levels generated at the output of the supervision circuit can be used in evaluation units supervising several electrical contacts.

[0007] In a preferred variant of the method a first voltage is applied to the input of the detection means for generating a first signal level of the output signal when no current is flowing through the supervised contact, wherein the first voltage is reduced to a second lower voltage if a current is flowing through the supervised contact for generating a different signal level of the output signal. The reduction in voltage can be achieved by providing a diode in the supervision circuit. If the supervised contact is open, no current is flowing through the diode. In contrast, if the supervised contact is closed, a current is flowing through the diode and the supervised contact, thus pulling the first voltage down to the second voltage. The change in voltage is detected by the detection means and the output signal is changed accordingly. This method allows detection of the state of the supervised contact without any energy consumption from the load circuit.

[0008] If the load current through the contact is rectified the supervision circuit can be used with both, a load circuit operating with direct current and alternating current. It is also possible to design the supervision circuit such, that no feedback occurs from the load circuit to the supervision circuit and vice versa. Furthermore, if the load circuit is operated with direct current, no care must be taken when connecting the supervision circuit to the load circuit because the rectifier ensures that the current through the supervised contact will always be in the correct direction.

[0009] The object is also achieved by a supervision circuit for monitoring the state of an electrical contact of a load circuit according to claim 5. Such a supervision circuit can be designed with low energy consumption, and with almost no feedback between the supervision circuit and the load circuit. The supervision circuit allows supervision of a potential-free contact without energy consumption from the load circuit.

[0010] In a preferred embodiment the supervision circuit also comprises a diode which is connected in series with the supervised contact for reducing the voltage if a current flows through the diode and the supervised contact. The change in voltage causes the output signal of the detection means to change. The use of a separate voltage supply in the supervision circuit ensures that no energy is consumed from the load circuit.

[0011] The voltage supply can be realized particularly easily by two optoelectronic couplers connected in series. The two optoelectronic couplers are supplied with a control current via a separate voltage supply. Thus, a voltage of about 0,7 V is created between the base and emitter of each optoelectronic coupler. Hence, with the two optoelectronic couplers connected in series a voltage of about 1.4 V is created. The optoelectronic couplers are used as a controlled photoelectric cell. They generate a control voltage, which is independent from the voltage of the load circuit. Alternatively, specific integrated circuits can be used as voltage supply.

[0012] In a further preferred embodiment of the invention the detection means comprises an optoelectronic

coupler. An optoelectronic coupler is very sensitive to the change of the voltage at its input. A relatively small change in input voltage causes a change in the output of the optoelectronic coupler and thus in the output of the supervision circuit. In particular, if the supervised contact is closed, a control current flows over a diode and thus the voltage over the third optoelectronic coupler decreases, that now blocks the corresponding output. The use of an optoelectronic coupler as the detection means further has the advantage that the contact can be supervised dynamically, i.e. a change in the contact state is detected immediately. In general, the use of optoelectronic couplers has the advantage that different components can be at different potentials. Thus, the input side of the optoelectronic couplers forming the power supply can be at a different potential as the supervision and load circuit and the output side of the third optoelectronic coupler can yet again be at a different potential.

[0013] If the load circuit comprises a rectifier circuit, in particular a Graetz rectifier, for connecting the load power supply to the supervised contact, the supervision circuit according to the invention can be used with an alternating current or a direct current flowing in the load circuit because due to the rectifier the current through the supervised contact always flows in the same direction. The use of a Graetz rectifier also prevents a feedback from the load circuit to the supervision circuit.

[0014] Further advantages can be extracted from the description and the enclosed drawing. The features mentioned above and below can be used in accordance with the invention either individually or collectively in any combination. The embodiments mentioned are not to be understood as exhaustive enumeration but rather have exemplary character for the description of the invention.

Drawings

[0015] The invention is shown in the drawing.

Fig. 1 shows a drawing of the supervising and load circuit and the contact to be supervised;

Fig. 2 shows an oscilloscope output to illustrate the operation of the supervision circuit.

[0016] In the left hand side of Fig. 1 is shown a supervision circuit 1 comprising a voltage supply implemented by two optoelectronic couplers 2, 3 connected in series and the detection means 4 connected in parallel with the power supply. The optoelectronic couplers 2, 3 are supplied with a control current by the voltage supply 5 via resistor 6. The optoelectronic couplers 2, 3 generate a voltage at their base-emitter junction of 0,7 V, respectively. The optoelectronic couplers 2, 3 connected in series thus are an energy source for the detection means 4 provided with an optoelectronic coupler 7. The capacity 8 buffers the dc voltage supplied by optoelectronic couplers 2 and 3. The voltage supply formed by the optoelectronic couplers 2, 3 is highly resistive. The diode of optoelectronic coupler 7 is connected in parallel to the transistors of the optoelectronic couplers 2, 3. The photodiode of the optoelectronic coupler 7 causes the voltage to be stabilized. The output of the optoelectronic coupler 7 is connected to a voltage source 5a via resistor 9. If the full voltage generated by optoelectronic coupler 2, 3 is supplied to the input of the detection means 4, the output of the optoelectronic coupler 7 is pulled down to 0 V. Hence, the output signal at the output port E takes the logic level "low". In the supervision circuit 1 is also provided a diode 10 connected in series with a contact 11 to be supervised. If the contact 11 is in an open state, no current flows through diode 10. As soon as the contact 11 is closed, a current flows through diode 10, thereby reducing the voltage supplied to the input ports of the detection means 4. A reduction in the voltage at the input of the detection means causes the optoelectronic coupler 7 to switch off and the output signal E to take the logic "high" level. On the right hand side of Fig. 1 a load circuit 12 is shown, comprising a power generator 13 generating an ac current. It further comprises a load resistance 14 connected to the supervised contact 11, via a rectifier circuit 15, in particular a Graetz rectifier. The rectifier 15 ensures that the current flowing through contact 11 always flows in the same direction. Thus, the supervision circuit 1 can be used with a load circuit operating either with alternating or direct current. The rectifier 15 and the diode 10 avoid any feedback from the load circuit to the supervision circuit 1. The supervised contact 11 is part of a relay 16 which can be part of a safety critical application.

[0017] In Fig. 2 the top signal 20 corresponds to the signal A at the input of relay 16 of Fig. 1, meaning that in normal operation the relay is caused to switch, e.g. to close contact 11, if the logic level of signal A is "high". Signal 21 corresponds to the voltage between points B and C in Fig. 1. Due to the rectifier 15 a rectified signal 21 is obtained if the contact 11 is in an open position. However, if contact 11 is closed, points B and C are at the same potential and therefore the signal decreases to 0. Signal 22 corresponds to the voltage present between points D and C in Fig. 1, and thus to the voltage applied to the detection means 4. Signal 23 corresponds to the output of the supervision circuit 1 at point E. A first marker 24 is located in a position where the signal 20 is in a low state. This indicates that in normal operation the contact 11 should be open. Accordingly, in this state a rectified voltage lies between points B and C (see signal 21). The full voltage generated by optoelectronic couplers 2, 3 is applied to the input of optoelectronic coupler 7. Therefore, the signal at output E is at the logic level "low". Another situation is shown at marker 25. A high voltage or the logic "high" level is applied to the relay 16. This causes the contact 11 to close and hence the voltage between B and C to decrease to 0. This also indicates, that a current is flowing to diode 10, thus reducing the voltage applied to input of the optoelectronic coupler 7 (signal 22).

This reduction in voltage at the input of optoelectronic coupler 7 results in the output of the optoelectronic coupler 7 to turn off and hence the signal at output E to increase to its logic level "high". Thus, by supervising the state of the electrical contact via the supervision circuit, the operation of the relay is monitored. One can detect, if the state of the electrical contact changes in accordance with a change of the signal A.

[0018] In a method of supervising the state of an electrical contact 11 present in a load circuit 12, an output signal 23 is generated by a detection means 4 present in a supervision circuit 1 also connected to said contact 11. The output signal 23 changes depending on whether the contact 11 is open or closed. Thus, the state of the electrical contact 11 can be monitored.

Claims

1. Method of supervising the state of an electrical contact (11) present in a load circuit (12), wherein an output signal (23) is generated by a detection means (4) present in a supervision circuit (1) also connected to said contact (11) and wherein the logic level of the output signal (23) changes depending on whether the contact (11) is open or closed, **characterized in that** a voltage is applied to the detection means (4) by a separate voltage supply (optoelectronic couplers 2, 3) of the supervision circuit (1).

2. Method according to claim 1, **characterized in that** the logic level of the output signal (23) is "high" if the contact (11) is closed and "low" if the contact (11) is open.

3. Method according to claim 1, **characterized in that** a first voltage applied to the input of the detection means (4) for generating a first signal level of the output signal (23) when no current is flowing through the supervised contact (11) is reduced to a second lower voltage if a current is flowing through the supervised contact (11) for generating a different signal level of the output signal (23).

4. Method according to claim 1, **characterized in that** the load current through the contact (11) is rectified.

5. Supervision circuit (1) for monitoring the state of an electrical contact (11) of a load circuit (12), said supervision circuit (1) comprising a detection means (4) generating an output signal (23), wherein the contact (11) to be supervised is connected to the supervision circuit (1), and the output signal (23) is altered if the state of the contact (11) changes, **characterized in that** the supervision circuit (1) comprises its own voltage supply (optoelectronic couplers 2,3), applying a voltage to the detection means (4).

6. Supervision circuit according to claim 5, **characterized in that** the supervision circuit (11) also comprises a diode (10) which is connected in series with the supervised contact (11) for reducing the voltage if a current flows through the diode (10) and the supervised contact (11).

7. Supervision circuit according to claim 6, **characterized in that** the voltage supply is realized by two optoelectronic couplers (2, 3) connected in series.

8. Supervision circuit according to claim 5, **characterized in that** the detection means (4) comprises an optoelectronic coupler (7).

9. Supervision circuit according to claim 5, **characterized in that** the load circuit (12) comprises a rectifier circuit (15), in particular a Graetz rectifier, for connecting the load power supply (13) to the supervised contact (11).

Patentansprüche

1. Verfahren zur Überwachung des Zustandes eines elektrischen Kontaktes (11), der in einem Lastkreis (12) vorhanden ist, in welchem ein Ausgangssignal (23) durch eine Erkennungseinrichtung (4) erzeugt wird, die in einem Überwachungskreis (1) vorhanden ist, der ebenfalls mit dem Kontakt (11) verbunden ist, und in welchem sich der Logikpegel des Ausgangssignals (23) in Abhängigkeit davon ändert, ob der Kontakt (11) offen oder geschlossen ist, **dadurch gekennzeichnet, daß** eine Spannung an der Erkennungseinrichtung (4) durch eine separate Spannungsversorgung (optoelektronische Koppler 2, 3) des Überwachungskreises (1) angelegt wird.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der Logikpegel des Ausgangssignals (23) "high" ist, wenn der Kontakt (11) geschlossen ist, und "low" ist, wenn der Kontakt (11) offen ist.

3. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** eine erste Spannung, die am Eingang der Erkennungseinrichtung (4) zum Erzeugen eines ersten Signalpegels des Ausgangssignals (23) angelegt ist, wenn kein Strom durch den überwachten Kontakt (11) fließt, auf eine zweite niedrigere Spannung verringert wird, wenn Strom durch den überwachten Kontakt (11) zum Erzeugen eines anderen Signalpegels des Ausgangssignals (23) fließt.

4. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, daß** der Laststrom durch den Kontakt (11) gleichgerichtet wird.

5. Überwachungskreis (1) zum Überwachen des Zu-

standes eines elektrischen Kontaktes (11) eines Lastkreises (12), wobei der Überwachungskreis (1), der eine Erkennungseinrichtung (4) umfaßt, ein Ausgangssignal (23) erzeugt, in welchem der zu überwachende Kontakt (11) mit dem Überwachungskreis (1) verbunden wird, und sich das Ausgangssignal (23) ändert, wenn sich der Zustand des Kontaktes (11) ändert, **dadurch gekennzeichnet, daß** der Überwachungskreis (1) seine eigene Spannungsversorgung (optoelektronische Koppler 2,3) umfaßt, die eine Spannung an die Erkennungseinrichtung (4) anlegen.

6. Überwachungskreis nach Anspruch 5, **dadurch gekennzeichnet, daß** der Überwachungskreis (11) ebenfalls eine Diode (10) umfaßt, welche in Reihe mit dem überwachten Kontakt (11) zum Verringern der Spannung geschaltet ist, wenn ein Strom durch die Diode (10) und den überwachten Kontakt (11) fließt.

7. Überwachungskreis nach Anspruch 6, **dadurch gekennzeichnet, daß** die Spannungsversorgung durch zwei optoelektronische Koppler (2, 3) realisiert wird, die in Reihe geschaltet sind.

8. Überwachungskreis nach Anspruch 5, **dadurch gekennzeichnet, daß** die Erkennungseinrichtung (4) einen optoelektronischen Koppler (7) umfaßt.

9. Überwachungskreis nach Anspruch 5, **dadurch gekennzeichnet, daß** der Lastkreis (12) eine Gleichrichterschaltung (15) umfaßt, insbesondere einen Graetz-Gleichrichter, zum Verbinden der Lastspannungsversorgung (13) mit dem überwachten Kontakt (11).

Revendications

1. Procédé de surveillance de l'état d'un contact électrique (11) se trouvant dans un circuit de charge (12), où un signal de sortie (23) est généré par un moyen de détection (4) présent dans un circuit de surveillance (1) également relié audit contact (11) et où le niveau logique du signal de sortie (23) change en fonction de ce que le contact (11) est ouvert ou fermé, **caractérisé en ce qu'**une tension est appliquée sur le moyen de détection (4) par une alimentation en tension séparée (photocoupleurs 2, 3) du circuit de surveillance (1).

2. Procédé selon la revendication 1, **caractérisé en ce que** le niveau logique du signal de sortie (23) est "haut" si le contact (11) est fermé et "bas" si le contact (11) est ouvert.

3. Procédé selon la revendication 1, **caractérisé en ce qu'**une première tension, appliquée à l'entrée du moyen de détection (4) afin de générer un premier niveau de signal du signal de sortie (23) lorsque aucun courant ne circule au travers du contact surveillé (11), est réduite à une seconde tension inférieure si un courant circule au travers du contact surveillé (11) afin de générer un niveau de signal différent du signal de sortie (23).

4. Procédé selon la revendication 1, **caractérisé en ce que** le courant de charge au travers du contact (11) est redressé.

5. Circuit de surveillance (1) destiné à surveiller l'état d'un contact électrique (11) d'un circuit de charge (12), ledit circuit de surveillance (1) comprenant un moyen de détection (4) générant un signal de sortie (23), où le contact (11) à surveiller est relié au circuit de surveillance (1), et le signal de sortie (23) est modifié si l'état du contact (11) change, **caractérisé en ce que** le circuit de surveillance (1) comprend sa propre alimentation en tension (les photocoupleurs 2, 3) appliquant une tension au moyen de détection (4).

6. Circuit de surveillance selon la revendication 5, **caractérisé en ce que** le circuit de surveillance (11) comprend également une diode (10) qui est reliée en série au contact surveillé (11) afin de réduire la tension si un courant circule au travers de la diode (10) et du contact surveillé (11).

7. Circuit de surveillance selon la revendication 6, **caractérisé en ce que** l'alimentation en tension est réalisée par deux photocoupleurs (2, 3) reliés en série.

8. Circuit de surveillance selon la revendication 5, **caractérisé en ce que** le moyen de détection (4) comprend un photocoupleur (7).

9. Circuit de surveillance selon la revendication 5, **caractérisé en ce que** le circuit de charge (12) comprend un circuit de redressement (15), en particulier un redresseur de Graetz, destiné à relier l'alimentation de la charge (13) au contact surveillé (11).

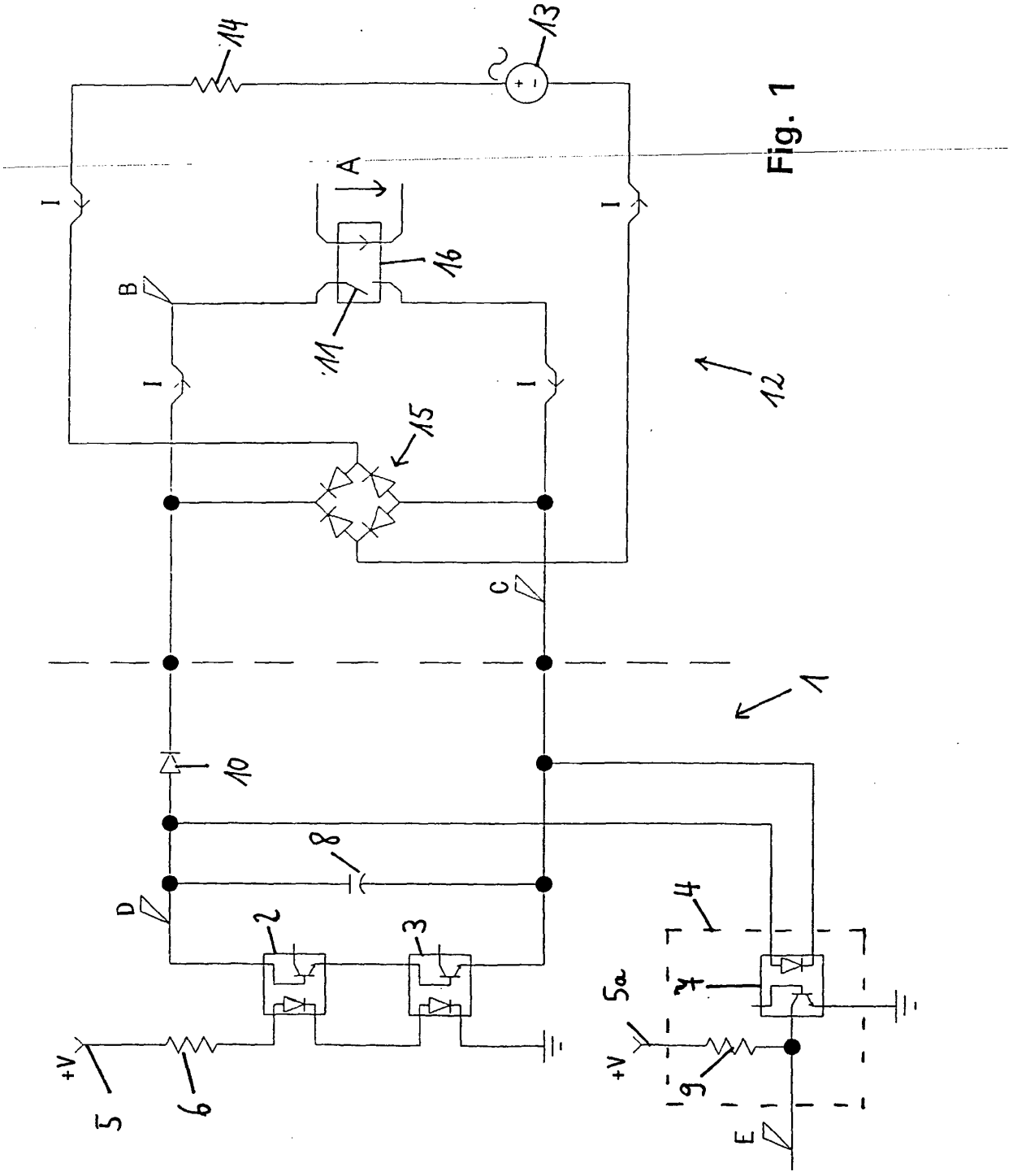

Fig. 1

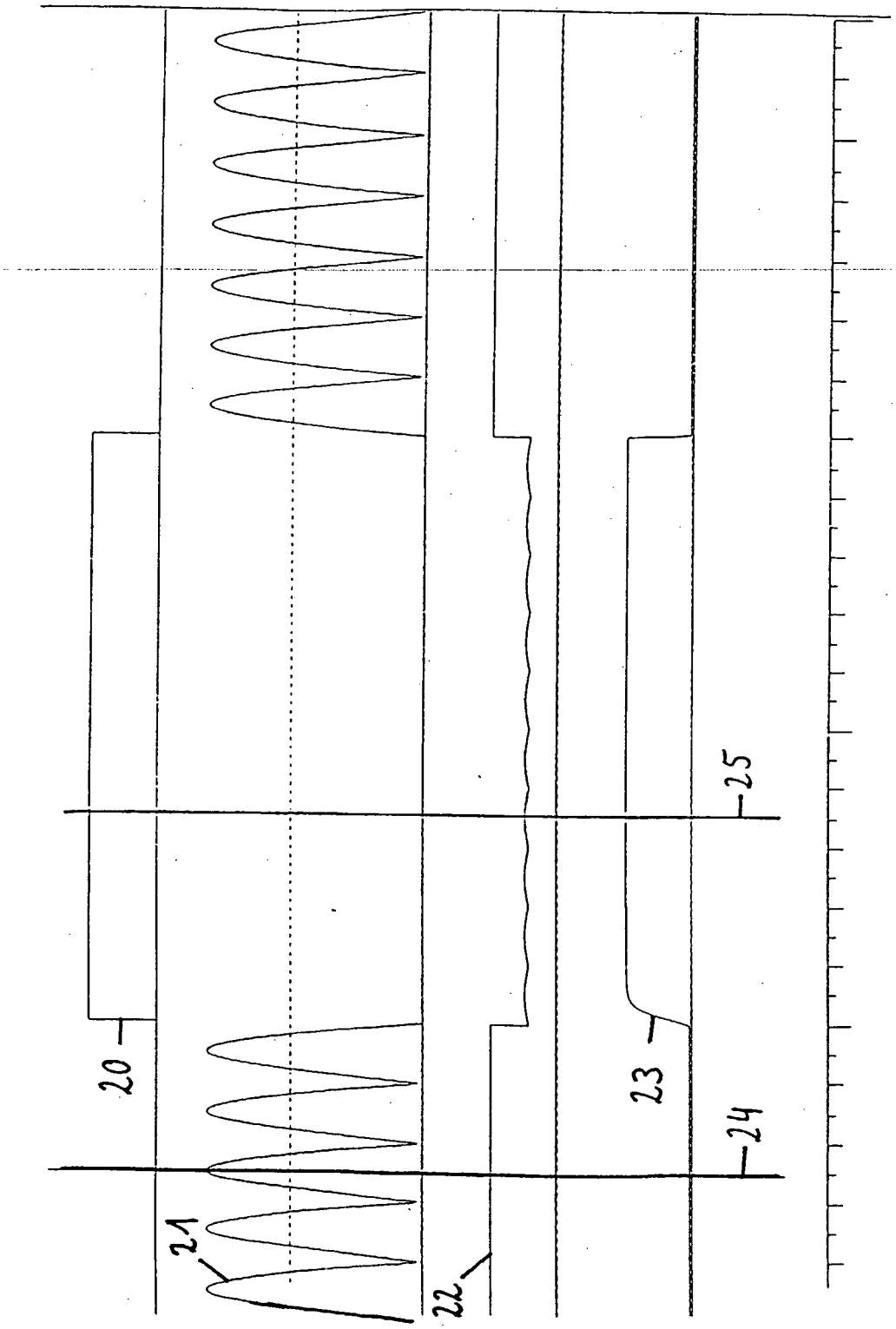

Fig. 2