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(54) Improvements relating to security alarm systems.

(57) An alarm system uses piezo-electric crystals (2) which when vibrated produce an electrical signal that is used to generate an alarm. Each crystal is in a sensor unit (1) with a latch circuit (13) and an indicator (15), and the threshold at which the alarm triggers latch-on and activates the indicator is adjustable. The latched-on alarm signal in normal use is passed by cable to a remote control module (21), where the actual alarm can be raised. For setting up, the sensor is provided with a periodic power supply from the control module and the alarms (24, 29) are disabled, so that during power-on periods an operator can adjust the sensor threshold without disturbance at the control module. If latching occurs at the wrong level, the subsequent momentary power-off restores the sensor to its primed state, enabling re-adjustment. As well as being responsive to sensor vibration above a set level, an alarm is raised if the cable circuit is broken or short circuited.

**EP 0 044 725 A2**

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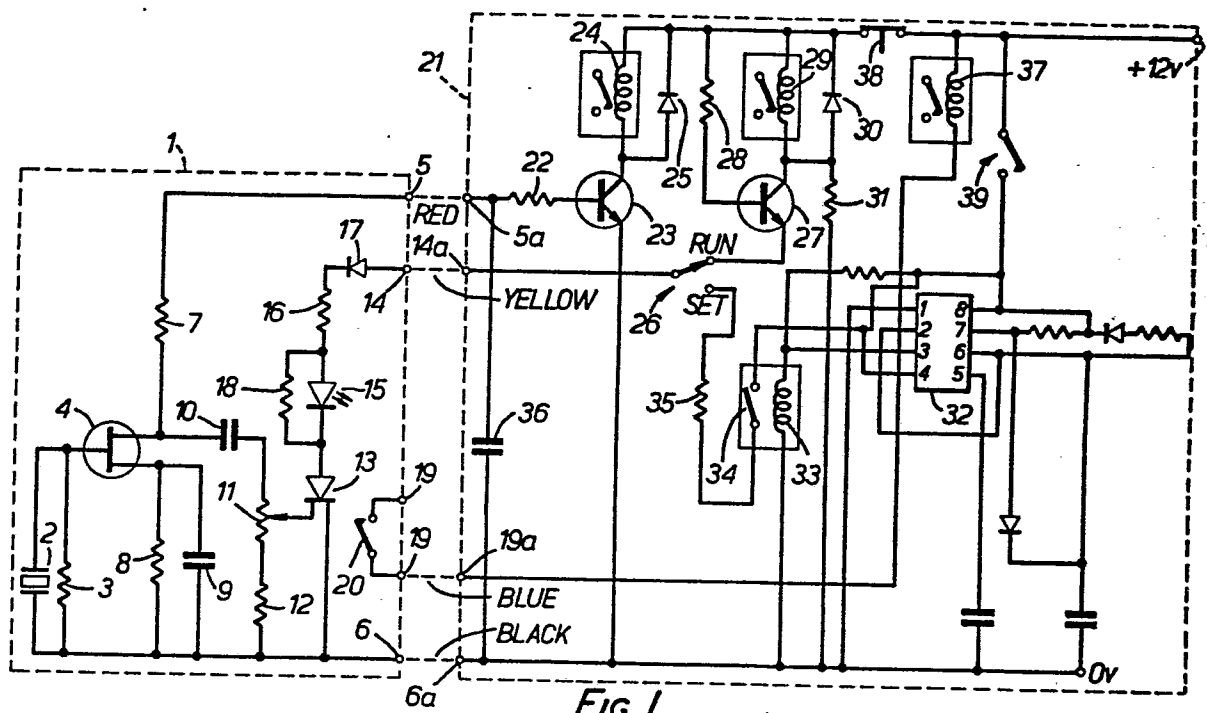


FIG. 1.

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"Improvements relating to Security Alarm Systems"

This invention relates to security alarm systems. It is particularly concerned with perimeter protection, which is a system that gives a warning or initiates some preventative or retaliatory action when any disturbance of the  
5 perimeter of the zone to be protected occurs. For example, external windows or doors of a building may be fitted with sensors which, when primed, respond to any shaking, vibration or other interference and send a signal to a central module.

The sensor that has most generally been used for  
10 this type of system is an inertia sensor, which usually takes the form of a metallic body resting in almost unstable equilibrium on electrical contacts. Any small disturbance lifts it clear of one contact, thus breaking a circuit. It is virtually impossible to adjust the sensitivity, and they  
15 are prone to giving false alarms.

It has been proposed to replace these sensors with ones using a piezo-electric crystal and an electrical circuit which enables the sensitivity to be finely adjusted. However, during setting up, it is important to know at the  
20 sensor when the correct adjustment has been made, and yet not to set off alarms at the central module. It is common for the sensors to be connected in a chain back to the central control, and another consideration is that the

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adjustment of one sensor should not affect any of the others.

For convenience, certainty and the avoidance of duplication the indicator that shows when the sensor is correctly set should also be one that marks that sensor out when it is later disturbed in earnest to set off an alarm. To be of any use, such an indicator has to stay on long after the disturbance has ceased, and this is not readily compatible with the setting up process where the indicator should go off and the sensor revert to its pre-vibration state either once it is set up correctly, or if an incorrect adjustment has been made and the operator wants to vary the sensitivity further.

It is the aim of this invention to provide a system where the setting up of individual sensors does not encounter these problems.

According to the present invention there is provided a security alarm system comprising a control module and at least one sensor at a location remote from the control module and cable-connected thereto, wherein the sensor has a piezo-electric crystal which, above a pre-settable limit of vibration, generates an alarm signal that is transmitted to the control module and indicated at the sensor, such indication being latched on after vibrations have ceased or decayed, and wherein the control module has alarm means responsive to the alarm signal, and timing means switchable into circuit to transmit a periodic signal to the sensor which primes the

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sensor to its pre-vibrated state, removing any local indication of vibration.

Thus, when setting up, the sensor can be vibrated until the indicator comes on. If this is at too high a level, 5 for example, the operator waits for the timer to restore the sensor to its initial state, while making an adjustment to increase the sensitivity, and then imparts more experimental vibrations. He can repeat this until satisfied that the sensitivity is correct. When the timer is in circuit for 10 this setting up, the alarm means can be automatically rendered inoperative.

Conveniently the timing means provides a power supply for the sensor, whose indicator is governed by a SCR which is triggered on by a local vibration and switched off 15 by momentary removal of the power supply. In normal use there will be a continuous power supply.

The cable connection may comprise a four-core cable with the wires coupled in pairs to form two loops out and back from the control module, one for supply voltage and 20 the other for neutral. Many sensors can be connected in parallel across them. The alarm means preferably include alarms responsive to severance of any wire of the cable at any point, in addition to an alarm which works when the sensor is vibrated. Each sensor may include a switch arranged 25 to open one of these loops when its cover is removed, this conveniently being a reed switch operable by a small magnet fitted inside the cover. Thus, in theory all the sensors and all the parts of the cable will raise an alarm should there be any tampering.

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For a better understanding of the invention, one embodiment will now be described, by way of example, with reference to the accompanying drawing in which:

Figure 1 is a circuit diagram of a sensor and  
5 a control module, and

Figure 2 is a general system layout diagram.

The sensor is housed in a casing indicated diagrammatically by the broken line 1. It has a piezo-electric crystal 2 in parallel with a resistor 3 to apply  
10 an input to the gate of a field effect transistor (FET) 4. The drain and source of the FET 4 are connected to supply voltage terminals 5 and 6, there being a resistor 7 between the drain and positive terminal 5 and a resistor 8 and capacitor 9 in parallel between the source and earth terminal  
15 6. The drain is also coupled by capacitor 10 to potentiometer 11 whose other end is earthed via resistor 12. The tap of the potentiometer goes to the gate of an SCR 13 which is in series, between earth and a further terminal 14, with a light emitting diode (LED) 15, resistor 16 and diode 17, the LED being  
20 bridged by resistor 18. In use, the voltage at terminal 14 will be that, or approximately that, of the terminal 5. A pair of terminals 19 bridging a normally closed reed switch 20 complete the sensor. This switch is associated with a magnet inside a cover for the casing 1, to open should anyone  
25 try to tamper with the sensor by removing that cover.

Assuming the SCR 13 to be non-conductive, when the crystal 2 is subject to vibration, its electrical

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output will be amplified by the FET 4, and if the amplified signal is sufficient the resultant signal to the SCR 13 will turn the latter on, giving current flow through the LED 15. The sensitivity of the circuit is  
5 adjusted by the potentiometer 11 so that it can be set to respond at a particular level of vibration. Removal of the voltage at terminal 14 will restore the SCR to the non-conductive state, but until that happens it will remain triggered on and the LED will stay lit, even though  
10 vibrations may have ceased.

The control module is housed in an enclosure indicated diagrammatically by the broken line 21. It has input terminals 5a, 6a, 14a and 19a to which the terminals 5, 6, 14 and 19 will be connected by four core cable. The  
15 wiring can be doubled up on terminals 5, 6 and 14, but there will be one wire into one terminal 19 and another wire from the other terminal 19. There will generally be several sensors such as that described all connected electrically in parallel but series linked chain-fashion by lengths  
20 of such cable. The last terminals 5 and 14 and 6 and 19 of the final one in the chain are short circuited, as seen in Figure 2. This also illustrates three such chains all wired back to the control module, but with all the sensors in parallel.

25 The terminal 5a is connected through a resistor 22 to the base of a grounded emitter NPN transistor 23 in whose collector circuit is a coil 24 of a relay in

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parallel with a protective diode 25. There is a large anti-interference capacitor 36 between the terminal 5a and earth.

5 The terminal 14a goes to the common pole of a switch 26 in one state of which it connects to the emitter of a second NPN transistor 27. The base of this transistor is connected to the positive supply through resistor 28, and in its collector circuit there is the coil 29 of another relay in parallel with a protective diode 30, this being  
10 earthed through a resistor 31.

In its other state the switch 26 connects terminal 14a to a timing circuit. This consists of a timer 32 energised from the supply voltage and with associated circuitry as shown but which it is not essential  
15 to describe. Its function is to energise the coil 33 of a relay periodically to close a switch 34; for example the closure times being seven seconds interspersed with open times of a half to one second. When the switch 34 is closed it will be seen that the positive supply voltage is  
20 applied to terminal 14a, with a slight drop through protective resistor 35.

The terminal 19a is connected through the coil 37 of yet another relay to the positive supply, and the relay coils 24, 29 and 37 all operate alarm switches as described  
25 below. A reset button switch 38 can temporarily cut off the positive supply to coils 24 and 29, but the coil 37 is unaffected by it. A further switch 39 can turn off the timer circuit when that is no longer required.

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The normally closed reed switches 20 are connected in series and should any one of them be opened it will be seen that the coil 37 will be de-energised and this will activate one alarm. The same alarm will  
5 be actuated if the cable, or at least one of the lines from terminals 6a and 19a, is cut at any point between the control module and any of the sensors.

Assuming first that the switch 26 is connected to the timing circuit, the system can be set up without  
10 actuating any alarm. The relay coil 29 will effectively be de-energised, since the transistor 27 is disconnected at its emitter and is thus non-conductive and since the resistor 31 will not pass sufficient current to operate the relay. The associated alarm will be held off. The  
15 transistor 23 will be conductive, energising coil 24 and holding its associated alarm off. When the timer closes the switch 34 there is positive supply voltage at terminal 14a. An operator can then test any sensor at its site by creating some form of vibration, for example  
20 by rattling the window to which the sensor may be attached, or by directly tapping on the sensor casing 1. There will be means by which he can adjust the potentiometer 11, and he can set this so that the local LED 15 lights up at a particular desired level of vibration. After the timer  
25 'on' period the voltage at 14 is temporarily removed and so both the LED and SCR go off, and the LED remains off

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when the voltage returns. If the operator is not satisfied with his setting-up so far he can continue with the test vibrations and adjust the potentiometer until satisfied. Any response he does get from the LED is not reflected by an alarm at the control module since there remains the supply voltage on the base of the transistor 23 through terminals 14a and 5a. Even when the supply is briefly removed by relay switch 34, the transistor 23 will stay conductive since its base voltage will decay only slightly by virtue of the capacitor 36.

Thus there is no need for the operator to return to the control module when he is setting up the sensors, which he can do entirely by reference to the local LEDs. Once he is satisfied that all is in order, and it may well be that the various sensors will be set at different sensitivities according to location, the operator will return to the control module and change over the switch 26. He can also open switch 39 as the timer is no longer required.

In this position the system is set to give an alarm should any of the sensors be disturbed above their threshold. Before there is such a disturbance, transistor 23 will be held on by the high voltage from the emitter of transistor 27 and the consequently energised relay coil 24 will be holding its switch closed, blocking the associated alarm. The transistor 27 will still be off and the relay

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coil 29 de-energised. Should any one of the sensors be disturbed sufficiently to switch on its SCR 13, there will be a current path from the emitter of transistor 27 to earth. This lowers that emitter voltage and also  
5 the base voltage of transistor 23. The latter will turn off, de-energising relay coil 24 and causing operation of one alarm. The current flow through transistor 27 will increase, energising relay coil 29 sufficiently to operate its associated switch and hence another alarm.

10 It will be seen that if there is any short circuit in the sensors or in the cables connecting them, the voltage drop at terminals 5a and 14a will operate the alarms associated with relays 24 and 29. If there is severance of either of the cable wires connecting to  
15 terminals 5a and 14a, the bias voltage to the base of transistor 23 will be removed, de-energising relay 24 and setting off the associated alarm. This lends itself to those wires being in circuit with door or other contacts which, when separated, generate this alarm.

20 Although vibrations may cease, the associated SCR will remain on until the reset switch 38 is opened, removing the supply voltage from terminals 5a and 14a. When the reset switch is closed on release, the control module is ready to receive another alarm signal, and all  
25 the sensors are likewise prepared with their SCRs off.

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When setting-up, instead of relying on capacitor 36 keeping the transistor 23 conductive and its alarm off while the timer is temporarily off, arrangements may be made to block that alarm independently. Then, when the system is set up and switch 26 changed over, it can be released ready for activation. The other alarms can be similarly blocked.

The alarms do not have to be in the control module itself, although that will generally have at least pilot lights indicating what alarm has been tripped. Audible alarms may be far removed, for example in a local police station. Their activation will not then be betrayed to an intruder, unless he is astute enough to notice a very small LED on the sensor he has disturbed and to know what its illumination means. There may also be timing means to switch off at least an audible alarm after a short period, but leaving a visual indication on, for example a flashing light.

It will be appreciated that this system raises an alarm if any of the sensors are vibrated above a selected threshold, if anyone attempts to tamper with a sensor by removing its cover, if any single one of the wires in the connecting cables is cut, and if the 12V power supply fails.

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CLAIMS

1. A security alarm system comprising a control module (21) and at least one sensor (1) at a location remote from the control module and cable-connected thereto, wherein the sensor (1) has a piezo-electric crystal (2) which, above a pre-settable limit  
5 of vibration, generates an alarm signal that is transmitted to the control module (21) and indicated at the sensor, such indication (15) being latched on after vibrations have ceased or decayed, and wherein  
10 the control module (21) has alarm means (24; 29) responsive to the alarm signal, characterised in that for setting up the system timing means (32) in the control module are switchable into circuit to transmit a periodic signal to the sensor which primes the sensor to its  
15 pre-vibrated state, removing any local indication of vibration.
2. A system as claimed in claim 1, characterised in that when the timing means (32) are in circuit, the alarm means (24, 29) are rendered inoperative.
- 20 3. A system as claimed in claim 1 or 2, characterised in that the periodic signal is a power supply for the sensor, the sensor being primed when the power supply resumes after an interruption, and then being settable by reference to its local indication (15).
- 25 4. A system as claimed in claim 1, 2 or 3,

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characterised in that the sensor has a SCR (13) which is latched on by a vibration above said limit.

5        5. A system as claimed in any preceding claim, characterised in that the local indication at the sensor is provided by a LED (15).

6. A system as claimed in any preceding claim, characterised in that the power supply to the sensor is via two pairs of wires coupled to form two loops out and back from the control module, one for supply voltage and the  
10       other for neutral, and wherein the alarm means (24, 37) is responsive to interruption of either loop at any point.

7. A system as claimed in claim 6, characterised in that the sensor has a removable cover and includes a  
15       switch (20) arranged to open one of said loops when that cover is removed, thereby to actuate an alarm (37).

8. A system as claimed in claim 6 or 7, including a plurality of sensors (1) connected in parallel across said loops.

20       9. A system as claimed in any preceding claim, characterised in that the alarm means (24, 29) are arranged to be actuated on the occurrence of a short circuit in the cable connection.

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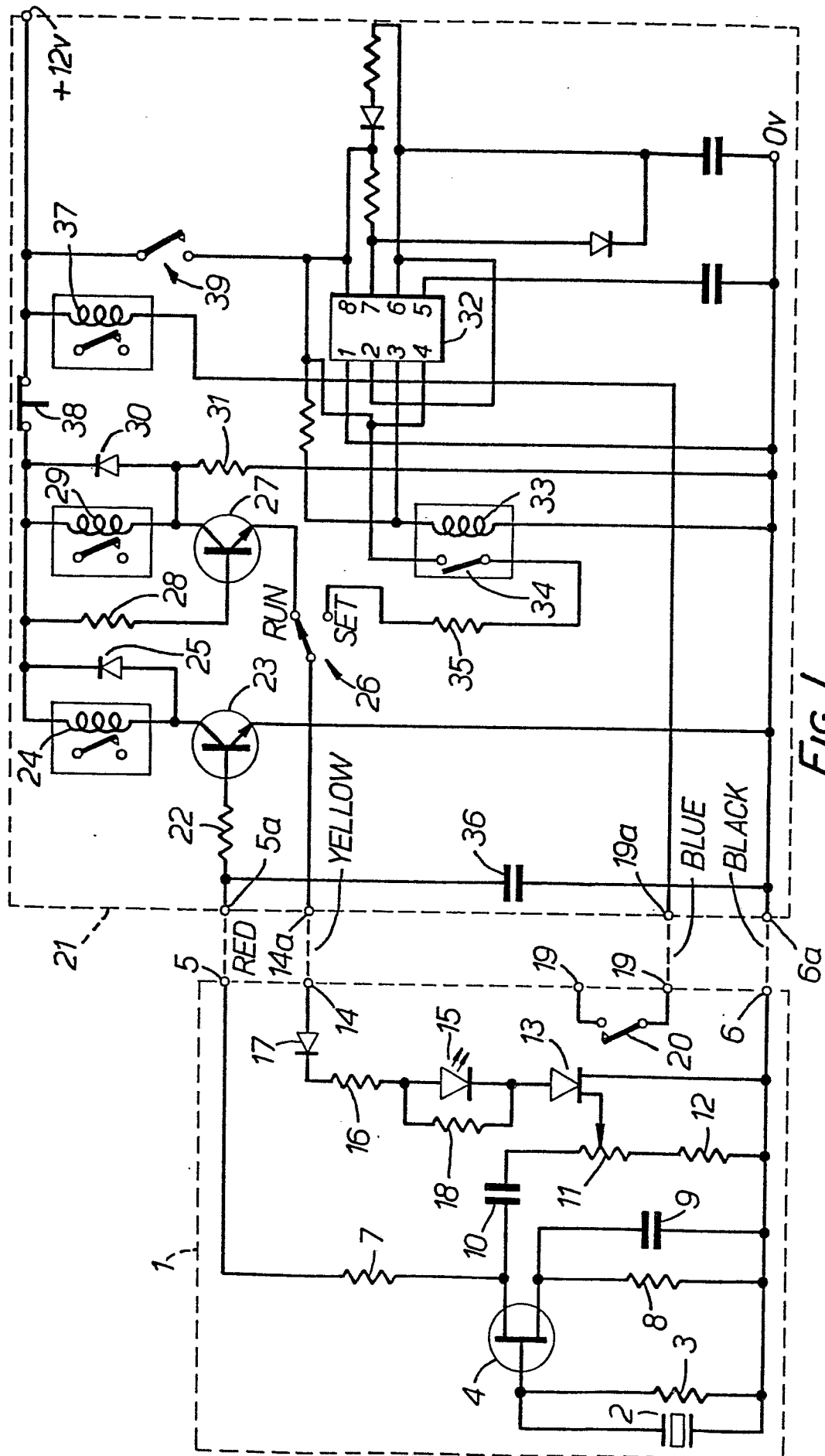


FIG. 1.

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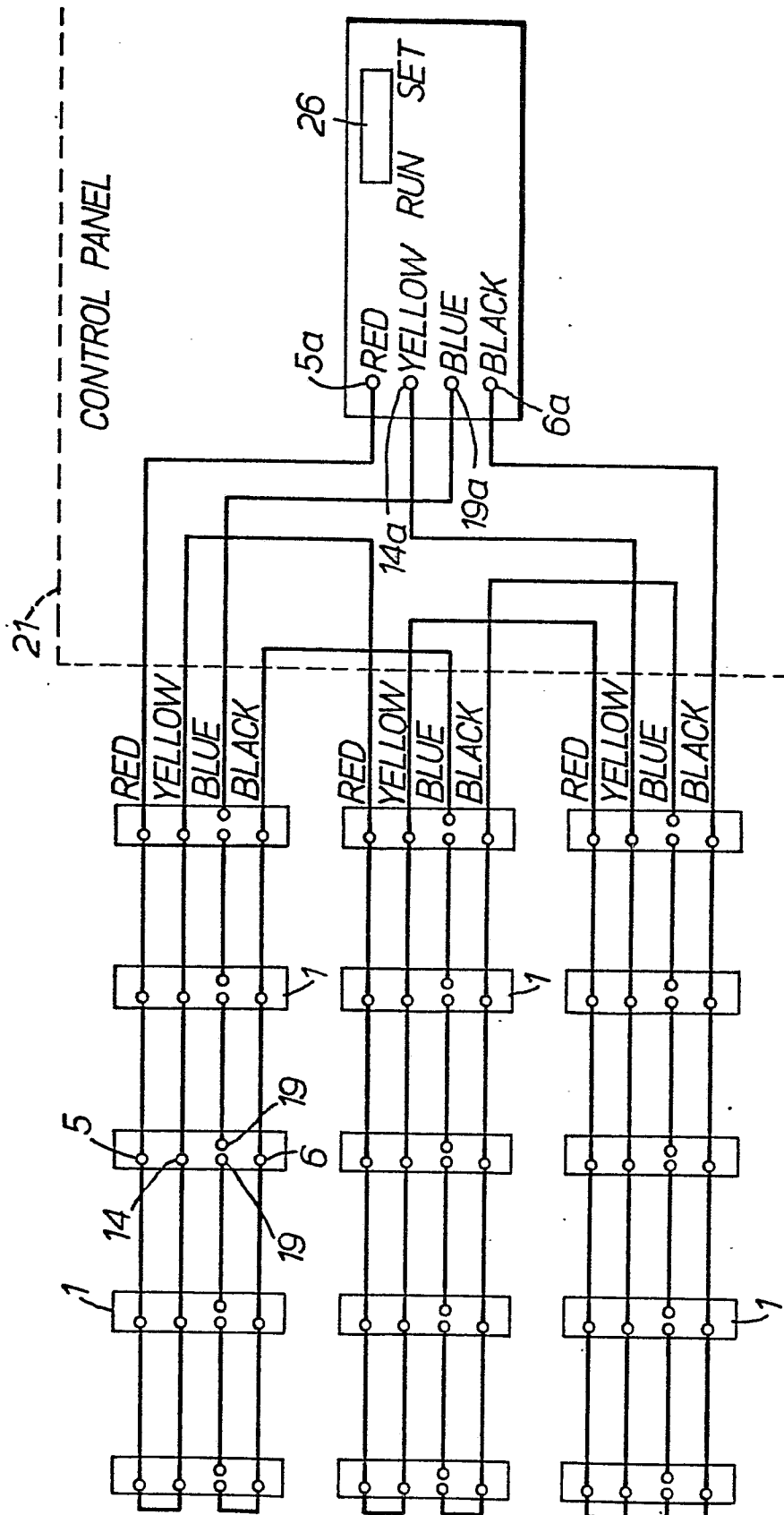


FIG.2.