June 30, 1970 H. T. FINCH ET AL 3,517,662

PATIENT IDENTIFICATION MARKER APPARATUS

Filed May 17, 1968 3 Sheets-Sheet 1

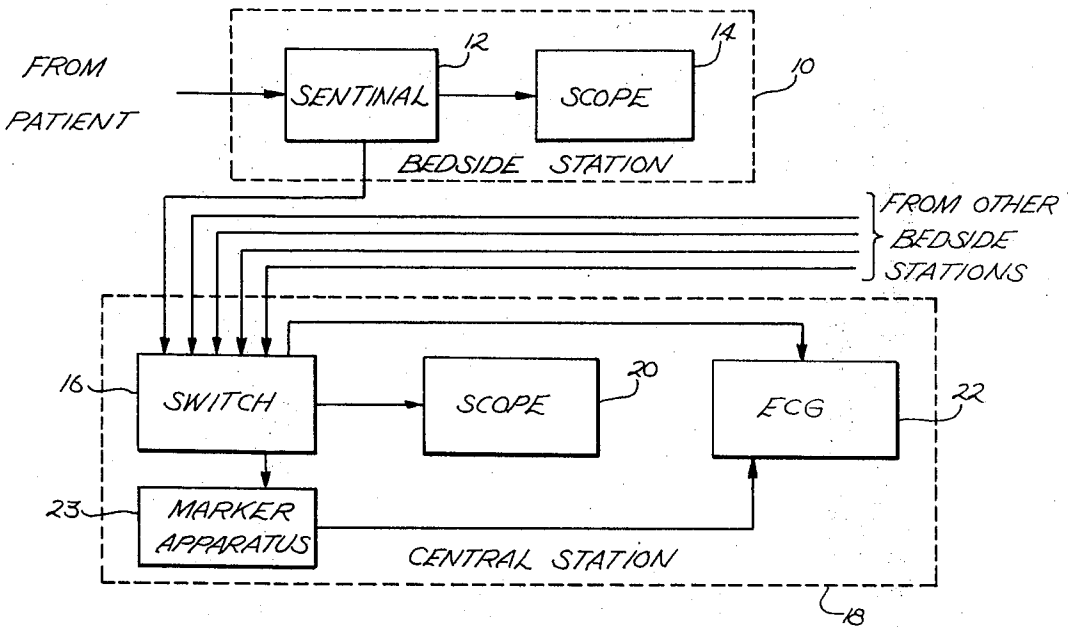


Fig. 1

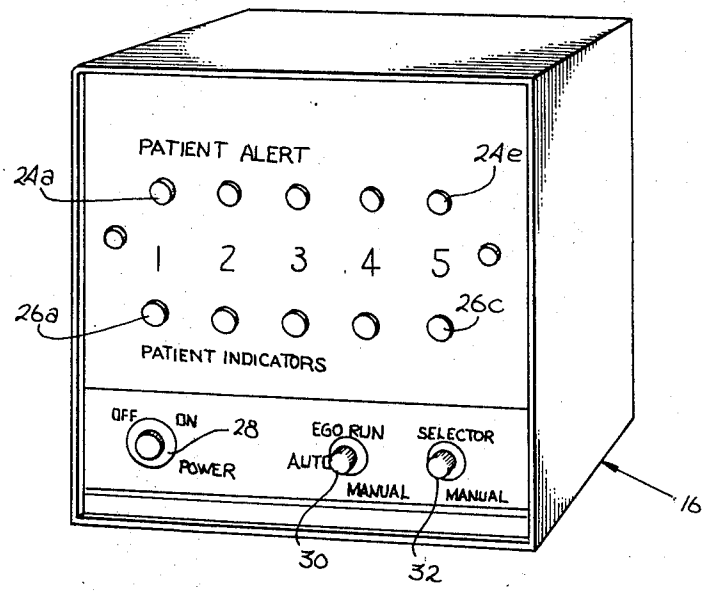


Fig. 2

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PATIENT IDENTIFICATION MARKER APPARATUS

Filed May 17, 1968 3 Sheets-Sheet 2

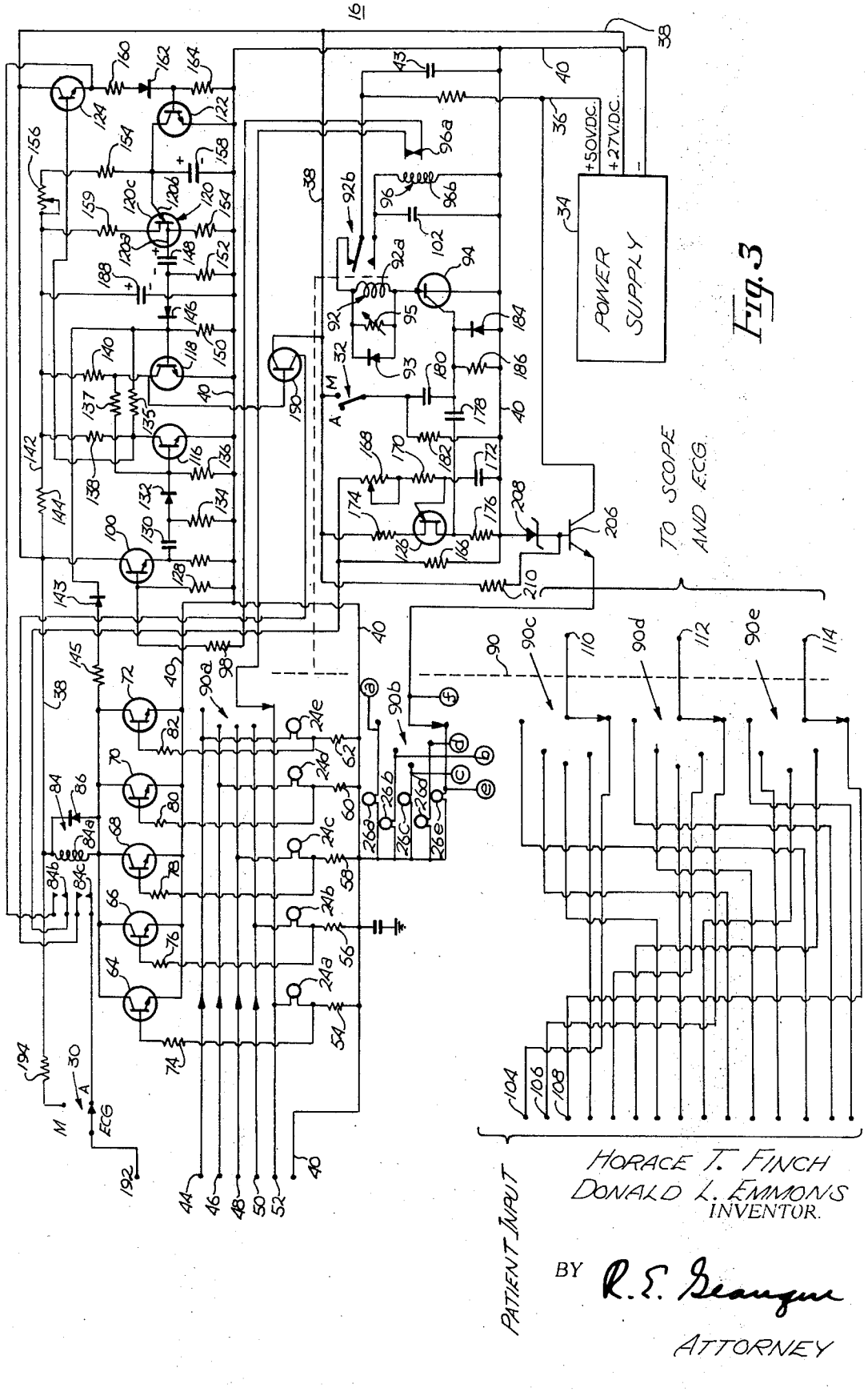


Fig. 3

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PATIENT IDENTIFICATION MARKER APPARATUS

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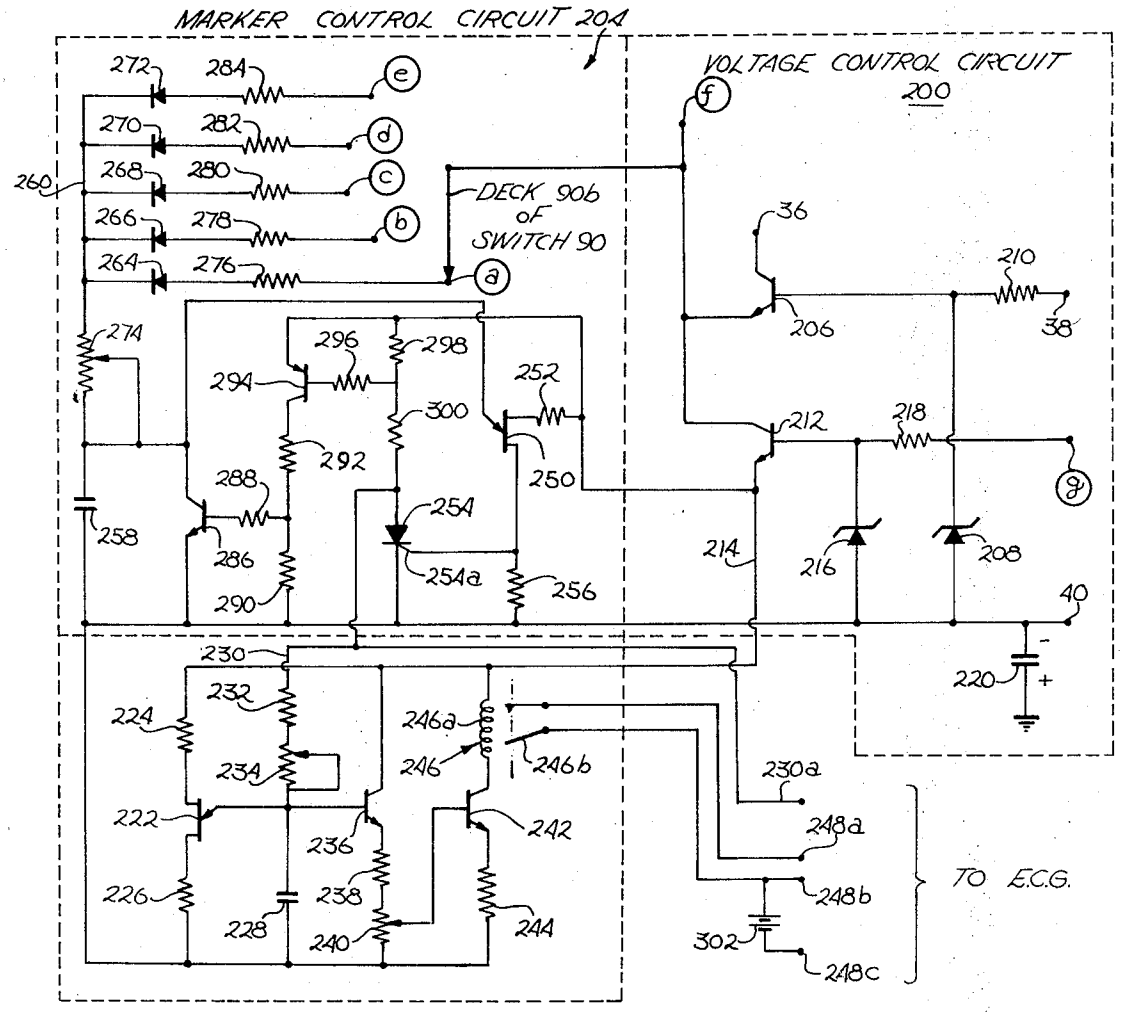


Fig. 4

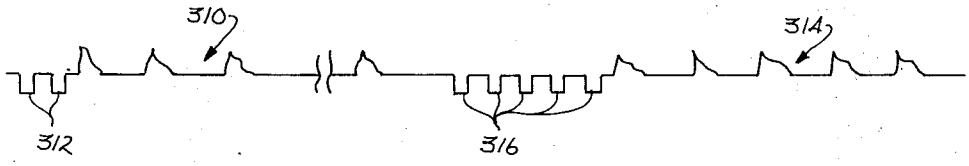


Fig. 5

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3,517,662

PATIENT IDENTIFICATION MARKER APPARATUS

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Continuation-in-part of application Ser. No. 624,007, Mar. 17, 1967. This application May 17, 1968, Ser. No. 730,003

Int. Cl. A61b 5/04

U.S. Cl. 128—2.06 6 Claims

ABSTRACT OF THE DISCLOSURE

In a patient monitoring system, a central station sequentially monitors ECG signals from a plurality of bedside stations. When the central station dwells on an input from a patient having an abnormal pulse rate, operation of a marker generator and a marker control circuit is initiated. The marker generator produces square wave pulses until disabled by the marker control circuit; the number of pulses generated is indicative of the particular patient being monitored. A single ECG associated with the central station prints out the square wave pulses followed by the ECG pattern of the patient having the abnormal condition, the recorded marker pulses thus serving to identify the ECG trace.

The present application is a continuation-in-part of co-pending application Ser. No. 624,007, entitled Medical Monitoring System, filed Mar. 17, 1967.

BACKGROUND OF THE INVENTION

The present invention relates to a patient identification marker apparatus for use in an automatic medical monitoring system. More particularly, the invention relates to an apparatus for providing patient identification indicia directly on the print out of a single electrocardiograph used to transcribe sequentially the ECG patterns of a plurality of patients being monitored by the system.

It is common in present day medical monitoring systems to evaluate automatically various physiological characteristics of a plurality of intensive care patients. Typically, when certain functions, such as pulse, respiration rate, blood pressure, temperature, etc., exceed safe limits, the abnormal condition is sensed, an audible warning signal sounded and a light turned on to identify the patient in distress.

More complete medical monitor systems such as that described in our co-pending application, Ser. No. 624,007, entitled Medical Monitoring System, include one or more devices such as an electrocardiograph (ECG) to record the condition of the patient. In such systems, a central switch detects an alert signal indicative of abnormal patient condition and initiates operation of the ECG. Should two or more alert signals be detected, the switch causes sequential transcription of the electrocardiographic signals of each patient in distress.

A limitation of such prior art medical monitoring systems is that the ECG print out may contain consecutive cardiac patterns of several patients, with no indentification marks attributing each pattern to a specific patient. This particularly is a problem in systems wherein unattended ECG operation is initiated automatically by the monitor. At best the problem complicates the job of medical record keeping; at worst it could result in incorrect diagnosis were a particular ECG pattern attributed to the wrong patient.

The present invention provides a marker apparatus, adapted for use with a medical monitor system, which

facilitates automatic insertion of a patient identification directly onto the ECG print out. In a preferred embodiment, the apparatus causes transcription of a series of square waves on an ECG chart, the number of pulses identifying the patient whose cardiac pattern follows on the chart.

SUMMARY OF THE INVENTION

This invention relates to a medical monitoring system and, in particular, to a cardiac monitoring system wherein a plurality of bedside systems continuously transmit the patients' electrocardiographic (ECG) signals to a central monitoring station, where the signals can be sequentially monitored. As each patient's signal is monitored, a white light is illuminated in the central station to identify the patient. If any patient's heart beat rate is above or below prescribed limits, a red light is automatically illuminated at the central station, and an audible alarm signal can be energized. Also, an ECG is activated at the central station to provide a permanent recording of the distressed patient's ECG trace. The inventive patient identification marker apparatus automatically inserts a series of square waves on the ECG chart, the marks clearly identifying which patient's ECG trace has been recorded.

If there are no alarm signals received from any of the bedside stations, the central station is in "stand-by" condition, even if it is in the automatic mode of operation, and does not cycle through the signals received from the various patients. However, if the system is in the automatic mode, receipt of an alarm signal from any one or more of the patients will cause the central station system to start cycling through all of the patients' ECG signals sequentially. Each time a distressed patient's signal is received, the red light corresponding to the patient is illuminated and his ECG signal is recorded for fifteen seconds, or some other time period, as desired. A patient identification mark also is recorded on the ECG chart. After that time period has expired, the station sequentially steps through the remaining bedside stations to determine if there are other distressed patients. If so, it will stop and monitor that bedside station for the predetermined length of time, and then move to the next station. If there are no distressed patients, the central station will then remain in stand-by until another emergency occurs.

In manual operation, an operator can manually step the central station monitoring process through the various bedside stations, and record electrocardiographic traces for any length of time desired for any of the patients. As previously noted, ECG signals are received at the central station at all times from all patients, even though they are not all recorded.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, wherein like numerals designate like components, and in which:

FIG. 1 is a block diagram of a system embodying the invention;

FIG. 2 is a perspective view of a central station switch for monitoring up to five patients;

FIG. 3 is a circuit diagram of the switch shown in FIG. 2;

FIG. 4 is an electrical schematic diagram of an embodiment of the inventive patient identification marker apparatus configured for use with the switch shown in FIG. 2; and

FIG. 5 illustrates a typical ECG strip chart recording including patient identifying indicia generated by the apparatus of FIG. 4.

The system described herein is adapted to monitor the heart beats of five patients in an intensive care ward. However, the system is open-ended and may be adapted to monitor any number of patients up to a reasonable limit. Therefore, the invention is not to be considered as limited to monitoring any particular number of patients.

FIG. 1 illustrates a block diagram of a monitoring system embodying the invention. Each bedside station **10** (only one of which is shown) comprises a sentinel unit **12**, which provides signals to a bedside oscilloscope **14** and to a monitor switch **16** in a central station **18**. The signals provided from the bedside station **10** are representative of a particular patient's ECG condition and, if the patient's heart beat is above or below predetermined limits, an alarm signal is also transmitted to the central station. The switch **16** in the central station provides signals to a monitor oscilloscope **20** and to an electrocardiograph **22** if desired. Of course, only one bedside station can be monitored at one time. Patient identification marker apparatus **23** provides a marker signal to ECG **22**, which signal is recorded on the ECG chart to identify the patient whose cardiac pattern follows on the chart.

The sentinel **12** in each bedside station emits a continuous signal representing the particular patient's ECG and an alarm signal if the patient's heart beat rate falls below or goes above predetermined limits. Although the invention is not limited to the use of any particular unit, the Model 402 Sentinel manufactured and sold by The Birtcher Corporation, Los Angeles, Calif., is well suited to the application. That unit contains a meter, which visibly indicates the patient's heart beat rate, and also contains "high" and "low" limit switches. Along with the ECG signals, this unit provides an 18 volt signal to the central station indicating an alarm condition when the lower or upper limits of heart beat rate are exceeded, indicating a bradycardia or tachycardia condition in the patient.

The oscilloscopes **14** and **20** may, if desired, each be a Model 401 Monitorscope and the electrocardiograph **22** may be a Model 409/335 Electracardiograph, both of which are manufactured and sold by The Birtcher Corporation of Los Angeles, Calif. However, the invention is not limited to the use of any particular oscilloscopes or electrocardiographs.

FIG. 2 is a perspective view of the exterior of the central station monitor switch **16**. As shown, the switch **16** embodies on its front panel a plurality of red lights **24***a*–**24***e*, which, if illuminated, indicate one or more distressed patients. Its front panel also contains a plurality of white lights **26***a*–**26***e*, each of which, when illuminated, indicates, a particular patient being monitored. Only one of the white lights **26** can be illuminated at one time, whereas a plurality of red lights **24** can be simultaneously illuminated, if a plurality of patients are in distress. The switch **16** also has on its front panel a power on-off switch **28**, an ECG run switch **30** and a selector switch **32**. The functions of the latter two switches will become apparent from the description of the circuit diagram of FIG. 3. It is sufficient for the moment to say that both the ECG run switch and the selector switch **32** are spring biased toward the "automatic" position, and can only be manually depressed to the "manual" position to cause the switch **16** to set one position for each depression of the switch **32**, regardless of how long the switch is held in the "manual" position.

Although FIG. 2 illustrates a monitor switch adapted to receive signals from five patients, as does the schematic diagram of FIG. 3, it is pointed out that the system of the invention is open-ended, and any number of input signals can be accommodated with minor modifications to the system, without departing from the invention.

FIG. 3 is a circuit diagram of the monitor switch **16**. As shown, it embodies a power supply **34** that provides +50 volts direct current and +27 volts direct current on

lines **36** and **38**, respectively, while a line **40** serves as the return.

Connections are made from the various bedside stations **10** shown in FIG. 1 to input terminals **44**, **46**, **48**, **50** and **52** in the monitor switch **16**. These terminals receive +18 volt alert signals if one or more patients are in distress; if no patients are in distress (that is, too slow or too fast heart beat rates), no signals are present on terminals **44**–**52**. The terminals **44**–**52** are respectively connected to energize the red lights **24***a*–**24***e* located on the front panel of the switch **16**, if signals are received from the sentinels **12** in any of the bedside stations **10**. One side of each of the lights **24***a*–**24***e* is connected to one of the terminals **44**–**52**, and the other sides of the lights are respectively connected through resistors **54**–**62** to the return line **40**.

A plurality of NPN transistors **64**, **66**, **68**, **70** and **72**, equal in number to the number of patients being monitored, are provided, with the bases of the transistors being respectively connected through resistors **74**, **76**, **78**, **80** and **82** to the junctures of the lights **24***a*–**24***e* and resistors **54**–**62**. Thus, when any one of the lights **24***a*–**24***e* is energized, the voltage on the base of the corresponding NPN transistor will rise and bias that transistor into saturation. The transistors **64**–**72** serve primarily as switches to energize an operating coil **84***a* of the two-section relay **84**. The relay has two sets of contacts **84***b* and **84***c*, which are normally open when the relay is de-energized. One end of the relay coil **84***a* is connected to all of the collectors of the transistors **74**–**82**, and the other end of the relay coil is connected to the power supply line **38** (+27 v.). A diode **86** is connected across the relay coil **84***a*. The emitters of all of the transistors **64**–**72** are connected to the return line **40**.

One of the more important elements of the monitor switch **16** is a five-deck, five-position switch **90**, having decks **90***a*–**90***e* (for monitoring five patient bedside stations). The switch **90** is stepped through its five positions by a stepping relay coil **92**, which is energized through a two-position section **92***a*, as will be hereinafter described, which is normally in position to energize the relay coil **92** from the power line **36** (+50 v.). The relay coil **92** is paralleled by a diode **93** and a varistor **95**. In order for the relay coil **92** to be energized, a silicon controlled rectifier **94**, connected between the bottom end of the coil and the return line **40**, must be conducting. This action will be described later.

The input terminals **44**–**52** are respectively connected to the five contacts of the switch deck **90***a*. The rotor of the deck **90***a* is connected through normally-closed contacts **96***a* of a relay **96** and through a resistor **98** to the base of an NPN transistor **100**. A capacitor **102** is connected across the coil **96***b* of the relay **96**.

The contacts of the second deck **90***b* of the switch **90** are respectively connected to the return line **40** through the white lights **26***a*–**26***e*, and the rotor of the section **90***b* is connected to the power supply line **36** through a series regulating transistor **206**. The base of transistor **206** is maintained at a constant voltage by a Zener diode **208**, current to which is supplied via a resistor **210**. As the rotor of the section **90***b* steps from one position to another it causes the white lights **26***a*–**26***e* to be sequentially illuminated, thus indicating which patient is being monitored.

Sections **90***c*, **90***d* and **90***e* of the switch **90** serve to provide ECG signals from a particular bedside station to the central station. These signals are provided, for example, on terminals **104**, **106** and **108** respectively to one contact on each of the sections **90***c*, **90***d* and **90***e* from a first patient and the rotors of those sections provide these signals to output terminals **110**, **112** and **114**. These signals may be provided to the oscilloscope **20** and the ECG **22** shown in FIG. 1. The switch **90**, in this case, serves only as a selector and performs no other function. Of course, ECG signals from other bedside stations are supplied to

other contacts of the switch sections **90***c*, **90***d* and **90***e*, so that as the switch **90** is stepped through its various positions, the ECG traces of the patients are successively monitored and displayed on the oscilloscope **20** and/or permanently recorded on the ECG **22**.

In automatic operation, timing of the successive monitoring of patients is controlled by the timing circuits embodying transitstors **120** and **126**. It, in turn, is controlled by the silicon controlled rectifier **94** and by transistors **100**, **116**, **118**, **120**, **122**, **124** and **126**. The transistors **100**, **116**, **118**, **122** and **124** are NPN type, while the transistors **120** and **126** are uni-junction transistors. Of course, the particular types of transistors used are matters of design choice, and the invention is not limited to the use of any particular type or types.

The base of the transistor **100** is connected through a resistor **128** to the power supply return line **40**. The collector of that transistor is connected directly to the power supply line **38** (+27 v.). The emitter of the transistor **100** is connected to the base of the transistor **116** through a capacitor **130** and a diode **132**. The juncture of the capacitor **130** and the diode **132** is connected to the return line **40** through a resistor **134**, and the base of the transistor **116** is connected to the return line through a resistor **136**.

The transistors **116** and **118** comprise a bistable flip-flop, with the collector of the transistor **116** being connected to the base of the transistor **118** through a resistor **134** and the collector of the transistor **118** being connected to the base of the transistor **116** through a resistor **136** The collectors of the transistors **116** and **118** are respectively connected through resistors **138** and **140** to a line **142**, which is connected through a resistor **144** to the power supply line **38**. The emitters of the transistors **116** and **118** are connected directly to the power supply return line **40**.

The base of the transistor **118** is connected to all of the collectors of the transistors **64–72** through a diode **143** connected in series with a resistor **145**. The base of the transistor **118** is also connected to one terminal **120***a* of the uni-junction transistor **120** through a diode **146** and a capacitor **148**. A resistor **150** connects the base juncture of the diode **146** and the base of the transistor **118** to the return line **40**, and a resistor **152** connects the juncture of the diode **146** and the capacitor **148** to the same line. The terminal **120***a* is also connected to the return line **40** through a resistor **154**.

The emitter **120***b* of the uni-junction transistor **120** is connected directly to the collector of the transistor **122**, to the supply line **142** through a resistor **154** serially connected with a rheostat **156**, and to the return line **40** through a capacitor **158**. The resistor **154**, rheostat **156** and capacitor **158** determine the rate at which the stepping relay **92** operates, as will be later described.

The emitter **120***b* of the uni-junction transistor **120** is also connected to the collector of the transistor **122**, and its electrode **120***c* is connected to the line **142** through a resistor **159**. The emitter of the transistor **122** is connected directly to the return line **40**, and its collector is connected to the juncture of the resistor **154** and the capacitor **158**, and, as stated, to the emitter of the uni-junction transistor **120**.

The emitter of the transistor **124** is connected to the base of the transistor **122** through serially connected resistor **160** and diode **162** and thence to return line **40** through resistor **164**. The collector of the transistor **124** is connected directly to the power supply line **38** and to the collector of the transistor **100**. The base of the transistor **124** is connected directly to the collector of the transistor **116**. The emitter of the transistor **124** is also connected to one contact of the section **84***b* of the relay **84**. The other contact of the section **84***b* is connected through a resistor **166** to the return line **40**, and through a rheostat **168** and a resistor **170** to the emitter of uni-junction transistor **126** and thence to the return line **40** through a capacitor **172**. One electrode of the transistor **126** is connected to the supply line **38** through the resistor **174**, and the other electrode is connected to the return line **40** through a resistor **176**. The top (as seen in FIG. 3) of the resistor **176** is connected through capacitors **178** and **180** to the pole of the "automatic-manual" switch **32**. A resistor **182** is connected between the pole of the switch **32** and the return line **40**. It is pointed out that the "automatic" contact on the switch **32** is unconnected, whereas the "manual" contact is connected to the supply line **38**.

The gate electrode **94***g* of the silicon controlled rectifier **94** is connected to the juncture of the capacitors **178** and **180**. It is also conncted to the return line **40** through a diode **184** and a resistor **186** connected in parallel. A capacitor **188** is connected between the lines **142** and **40** to act as a filter.

An NPN transistor **190** has its base connected to the collector of the transistor **118**, and its collector is connected to the supply line **38**. Its emitter is connected through the contacts of relay section **84***c* and through switch **30** to a terminal **192**. When the switch **30** is in "automatic" position, the transistor **190** will provide a voltage, at appropriate times, on the terminal **192** to energize an oscilloscope, an ECG or an audible alarm. When the switch **30** is in "manual" position, the supply line **38** is connected directly to the terminal **192** through a resistor **194**.

In operation, when no alert signals are being received from the bedside stations, transistors **64**, **66**, **68**, **70**, **72**, **100**, **116**, **120**, **126** and silicon controlled rectifier (SCR) **94** are non-conducting. Thus, the coil **84***a* of the relay **84** is not energized and the contacts **84***b* and **84***c* are open. In this state, the transistor **124** is conducting as are the transistors **118** and **122**. In this condition, the coil of stepping relay **92** is unenergized because the SCR is non-conducting. Hence, the switch **90** will remain in a fixed position.

If a +18 volt alarm signal is received on any of the terminals **44–52**, it causes one of the red lights **24***a–24e* to light, which biases one or more of the transistors **64–72** into saturation. This energizes the coil **84***a* of the relay **84** and causes the contacts **84***b* and **84***c* to close. When the contacts **84***b* close, it supplies a bias voltage to the transistor **126**, which biases the uni-junction transistor into conduction. The transistor **126**, rheostat **168**, resistor **170** and capacitor **172** comprise a pulse generator, which supplies pulses through the capacitor **178** to the control electrode **94***g* of the SCR **94**. The repetition rate of the pulses is determined by the setting of the rheostat **168** and is normally set at approximately 0.4 second.

As each pulse is received by the SCR **94** from the transistor **126**, the relay **92** is energized. When the relay **92** is energized it mechanically loads a spring (not shown), which moves the switch **90** one step. The relay coil **92***a* is energized through contacts **92***b* from the supply line **36**. Thus, when the relay **92** is energized, the contacts **92***b* connect the supply line **36** to the coil **96***a* of the relay **96**.

When the normally-closed contacts **96***a* of the relay **96** open, they disconnect the base of the transistor **100** from the rotor of the switch section **90***a* and the transistor **100** remains in its non-conducting state. At this time, the contacts **92***b* have de-energized the coil **92***a* of the relay **92**. The anode supply voltage for the SCR **94** is thus broken and SCR **94** is turned off. This de-energized the coil **92***a* of the relay **92** and the contacts **92***b* return to the position shown in FIG. 3. The SCR **94** and the relay **92** are again energized when the next pulse is received from the transistor **126**.

If, when the contacts **96***a* are closed, the base of the transistor **100** receives a positive alarm voltage from the rotor of switch section **90***a*, it will be biased into conduction and supply a pulse through capacitors **130** and diode **132** to the base of flip-flop transistor **116** to bias it into

conduction. When the transistor **116** conducts, it reduces the bias on both transistors **118** and **124** and causes them to be non-conducting. When the transistor **124** is not conducting, it can no longer supply voltage to the bias network comprising transistor **126** and SCR **94** so the stepping relay coil **92** will be de-energized and the relay will remain in its last position. At this time, both a red and a white light are illuminated along with sounding an audible alarm, if desired.

When the transistor **118** is cut off, the transistor **190** is biased into conduction to supply a signal through the contacts **84***c* of the relay **84** to the output terminal **192** to turn on external equipment such as an ECG, oscilloscope or alarm.

With the transistor **122** non-conducting because of lack of base bias, the capacitor **158** will charge at a rate determined by the values of the rheostat **156**, the resistor **154** and its own impedance value. After a predetermined length of time, as set by the time constant of the circuit, transistor **120** will conduct and transmit a pulse to the flip-flop transistor **118**. This length of time is preferably set at about 15 seconds. When the transistor **118** is biased into conduction by the pulse from transistor **120**, its collector voltage drops, thus causing transistor **116** to become non-conducting. As the collector voltage of transistor **116** rises, it biases the transistor **124** into conduction.

If an alert signal is still present on any of lines **44–52**, relay **84** will remain energized, contacts **84***b* will be closed, and conduction of transistor **124** will result in the charging of capacitor **172** via rheostat **168** and resistor **170**. When capacitor **172** has charged sufficiently to cause transistor **126** to conduct, SCR **94** also will conduct, supplying current to advance stepping switch **90** to the next position. As described above, switch **90** will continue to advance until it reaches a position at which an alert signal is present. If only one patient is in distress, only one red light will be lit, and switch **90** rapidly will step through all positions until it once again reaches the alert position. Switch **90** will dwell at this position for another nominal 15 second period, the cardiac pattern of the patient in distress again being recorded by the ECG during this dwell time.

If more than one patient is in distress, a corresponding number of red lights will be illuminated. Switch **90** rapidly will step to the next position at which an alert signal is present, dwell at this position for a nominal 15 seconds, advance to a different position at which an alert is present, dwell there for 15 seconds, and continue in this manner as long as an alert signal is present on any line. Of course, the ECG pattern of each patient in distress will be recorded during the respective dwell time of switch **90** at each alert position.

If all alert signals should terminate during a dwell period of switch **90***a*, all red lights will be extinguished. However, since transistor **116** is conducting during the dwell period, current will still be supplied to relay coil **84***a* via transistor **116**, resistor **134**, diode **143** and resistor **145**. Thus the control signal at terminal **192** will remain on until the end of the dwell period, thereby ensuring that the ECG signals of the patient previously in distress will be printed out for the entire nominal 15 second dwell time. At the end of the dwell period transistory **116** will stop conducting, thereby causing the contacts of relay **84** to open. Thus when transistor **124** again begins to conduct, no current will be supplied to charge capacitor **172**. In this case, switch **90** will not advance, and the monitor switch will remain idle until another alert signal is detected.

To place the system in the manual mode of operation, the switch **30** is moved to the manual position, which connects the power supply line **38** through the resistor **194** to the output terminal **192**. Thus, power is continuously supplied to the terminal **192** to energize an ECG or other external display device. In order to monitor one patient after another, the switch **32** is repetitively closed, which causes a pulse to be transmitted from the supply line **38** through the capacitor **180** and resistor **186** to the gate electrode **94***g* of the SCR **94**. This causes the relay **92** to step the switch **90** one step for each closure of the switch **32**. Maintaining the switch **32** closed does not cause the relay **92** to be repeatedly actuated. However, the switch **90** will remain in its previous position and the external device energized (so long as the switch **30** is held in the manual position) to monitor a particular patient until the switch **32** is again actuated or the system is returned to manual operation, or is over-ridden by an alarm signal.

If, while the system is in the manual mode of operation, an alarm signal is received on one of the input terminals **44–52**, the system returns to its automatic mode of operation and over-rides the manual mode. Thus, the cycle of operation previously described goes into effect.

Shown in FIG. 4 is a schematic diagram of a preferred embodiment of the inventive patient identification marker apparatus configured for use with the central monitor switch **16** illustrated in FIGS. 1, 2 and 3. Referring to FIG. 4, the marker apparatus is seen to comprise a voltage control circuit **200**, a marker generator **202**, and a marker control circuit **204**. Voltage contol circuit **200** functions to regulate the voltages available from power supply **34** (see FIG. 3) and to supply these regulated voltages to marker generator **202** and marker control circuit **204**. Marker generator **202** begins to produce a square wave output to an associated electrocardiograph **22** (see FIG. 2) as soon as selector switch **90** stops at a position at which a patient alert signal is present. The number of square waves produced by generator **202** is controlled by marker control circuit **204** so as to correspond with the identification number of the patient in distress. The square wave output from marker generator **202** is recorded by ECG **22** immediately preceding transcription of the patient's heart wave, thereby providing permanent identification indicia on the ECG recording.

Referring specifically to FIG. 4, voltage control circuit **200** comprises a transistor **206**, a Zener diode **208** and a resistor **210**, which components also are shown for clarity in the schematic diagram of FIG. 3. The collector and emitter of transistor **206** are connected in series between the +50 volt DC line **36** from power supply **34** to the armature of deck **90***b* of selector switch **90**. The base of transistor **206** is connected to DC return line **40** via Zener diode **208** and to the +27 volt DC line **38** via resistor **210**. Voltage control circuit **200** (see FIG. 4) also comprises a transistor **212**, the collector and emitter of which are connected in series between the emitter of transistor **206** and the regulated voltage line **214** to marker generator **202** and marker control circuit **204**. The base of transistor **212** is connected via a Zener diode **216** to DC return line **40** and via a resistor **218** to the junction (*g*) between resistor **98** and relay switch contacts **96***a* (see FIG. 3). A capacitor **220** connected between DC return line **40** and ground provides additional filtering for the system.

Marker generator **202** comprises a uni-junction transistor **222**, the source of which is connected via a resistor **224** to regulated voltage line **214**, and the drain of which is connected to DC return line **40** via a resistor **226**. The gate electrode of transistor **222** is connected to DC return line **40** via a capacitor **228**, and to a control line **230** from marker control circuit **204** via a fixed resistor **232** and a variable resistor **234**, which resistors are connected in series. As will be described below, transistor **222** and its associated components function as a pulse generator, the pulse repetition rate of which is determined primarily by the values of capacitor **228** and resistors **232** and **234**.

As may be seen in FIG. 4, the gate electrode of transistor **222** also is connected to the base of a transistor **236**, the collector of which is connected directly to regu-

lated DC voltage line **214**. The emitter of transistor **236** is tied to DC return line **40** via a series connected fixed resistor **238** and a variable resistor **240**. The adjustable contact on resistor **240** is connected to the base of a transistor **242**, the emitter of which is connected via a resistor **244** to DC return line **40**. The collector of transistor **242** is connected via the coil **246***a* of a relay **246** to regulated voltage line **214**. The contacts **246***b* of relay **246** are connected to output terminals **248***a* and **248***b*.

Marker control circuit **204** (see FIG. 4) comprises a uni-junction transistor **250**, the source of which is connected via a resistor **252** to the regulated DC voltage line **214**. The drain of uni-junction transistor **250** is connected directly to the control electrode **254***a* of a silicon controlled rectifier (SCR) **254** and via a resistor **256** to DC return line **40**. The gate of transistor **250** is connected to DC return line **40** via capacitor **258**, and to the common cathode terminal **260** of a plurality of diodes **264–272** via a variable resistor **274**. The anode terminal of each of diodes **264–272** is connected via a respective one of resistors **276–284** to terminals (*a*) through (*e*) respectively on deck **90***b* of selector switch **90**.

The control electrode of transistor **250** also is connected directly to a collector of transistor **286** and thence through the emitter thereof to DC return line **40**. The base of transistor **286** is connected to DC return line **40** via a pair of series connected resistors **288** and **290**. The junction of resistors **288** and **290** is connected via a resistor **292** to the collector of a transistor **294**. The emitter of transistor **294** is connected directly to regulated DC voltage line **214**, and the base of transistor **294** is connected to line **214** via a pair of series connected resistors **296** and **298**. The junction of resistors **296** and **298** is connected to the anode of SCR **254** via a resistor **300**. The cathode of SCR **254** is connected directly to DC return line **40**.

In operation, Zener diode **208**, which typically may have a breakdown voltage of 15 volts and which is connected across the +27 volt output of power supply **34**, maintains a constant voltage at the base of transistor **206**. Transistor **206** in turn functions as a series regulator to provide a regulated voltage at the deck **90***b* armature contact of selector switch **90**. Similarly, Zener diode **216** maintains a constant voltage level, typically 11.2 volts, at the base of transistor **212** whenever a positive voltage is present at terminal (*g*). Transistor **212** serves as a series regulator to provide a regulated voltage on line **214** to marker generator **202** and marker control circuit **204**. Note that as described above, a voltage is present at terminal (*g*) only when selector switch **90** dwells at a position at which an alert is present. Thus, a regulated DC voltage appears on line **214** exactly as selector switch **90** steps to an "alert position," the regulated voltage remaining on during the entire ECG recording period and terminating when selector switch **90** commences to advance to the next position.

Uni-junction transistor **222** functions as a saw-tooth pulse generator, the period of which primarily is determined by the values of capacitor **228** and the sum of fixed resistor **232** and variable resistor **234**. Preferably, the values of these time-constant-control components are selected so that the generally saw-tooth output of the pulse generator has a period of about 180 milliseconds. Operation of the pulse generator is initiated as soon as a voltage is present on line **214**, i.e., as soon as selector switch **90** steps to a position at which an alert signal is present.

Transistor **236** serves as an impedance matching circuit connecting the output of pulse generating transistor **222** to the base of transistor **242**. The setting of variable resistor **240** preferably is selected so that transistor **242** will reach saturation approximately 100 milliseconds after the initiation of each saw-tooth pulse from transistor **222**. Thus transistor **242** will be saturated for a duration of approximately 80 milliseconds during each period of the pulse generator. Saturation of transistor **242** causes relay **246** to energize, closing its normally open contacts **246***a*, thereby switching *on* a voltage applied across terminals **248***a* and **248***b*. If desired, a voltage source such as battery **302** (shown in phantom in FIG. 4) may be provided, so that the output between terminals **248***a* and **248***c* comprises a square wave signal which will be *on* for 80 milliseconds, and *off* for 100 milliseconds during each period of marker generator **202**. As will be described hereinbelow, the number of square waves produced identifies the patient in distress.

The operation of marker control circuit **204** (see FIG. 4) may be understood by recognizing that transistor **250** and its associated components also comprise a pulse generator, the period of which is determined by the values of capacitor **258**, resistor **274** and a selected one of resistors **276–284**. As soon as selector switch **90** reaches an "alert position," a regulated voltage is supplied to marker control circuit **204** on line **214**. Simultaneously, a regulated voltage is applied to one of resistors **276–284** via transistor **206** and the armature of switch deck **90***b*. The latter voltage begins to charge capacitor **258**, via resistor **274**, and when the gate threshold voltage of uni-junction transistor **250** is reached, transistor **250** begins to conduct. The resultant voltage drop across resistor **256** is sufficient to turn On SCR **254**, dropping the voltage at the anode terminal **230** of SCR **254** to zero. Since the voltage at line **230** is the charging source for capacitor **228** associated with saw-tooth generating transistor **222**, the square wave output of marker generator **202** is inhibited when SCR **254** begins to conduct.

Resistors **276–284** are selected to have appropriate values such that SCR **254** is turned On, and the output of marker generator **202** inhibited, after generation of a number of square waves equal to the position of switch **90**. Thus resistor **276** is selected so that if switch **90** has stopped at position **1**, capacitor **258** will charge sufficiently so as to turn On transistor **250** and SCR **254** after a period substantially equal to 180 milliseconds. In this period, relay **246** will have closed only once, generating only a single square wave prior to the termination of operation of marker generator **202** due to conduction of SCR **254**. Similarly, the value of resistor **278** is selected so that should switch **90** come to rest at position **2**, the time required to charge capacitor **258** sufficiently to turn On SCR **254** will be approximately 360 milliseconds. Thus, the output of marker generator **202** will be inhibited after two square waves have been generated. Similarly, the value of resistors **280**, **282** and **284** are selected to insure that the output of marker generator **202** will be inhibited respectively after the generation of three, four or five square waves.

Referring again to the operation of marker control circuit **204** (see FIG. 4) conduction of SCR **254** also results in sufficient voltage drop across resistor **298** to turn On transistor **294**. The resultant current flow causes sufficient voltage drop across resistor **290** to turn On transistor **286**. Conduction of transistor **286** discharges capacitor **258** and ensures that capacitor **258** will not subsequently be charged until the next operating cycle of the inventive marker apparatus. SCR **254** remains conducting, and hence the output of marker generator **202** remains inhibited, until the end of the nominal 15 second dwell time of switch **90**, during which dwell time the heart wave pattern of the patient in distress is recorded by associated EGG **22**. When switch **90** steps to the next position, the base voltage at transistor **212** momentarily is interrupted (due to momentary opening of relay contact **96***a*), thereby interrupting the voltage on line **214** and turning SCR **254** Off.

To review, when selector switch **90** stops at a position at which an alert signal is present, a positive voltage appears at terminal (*g*) thereby turning On the regulated voltage on line **214** to marker generator **202** and marker control circuit **204**. Simultaneously, one of the

white lights **26***a*–**26***e* (see FIG. 2) lights up, and a regulated voltage appears at one of resistors **276**–**284**. Marker generator **202** begins to provide a square wave output. At the same time, marker control circuit **204** begins a timing cycle which results in the termination of the square wave output from marker generator **202** after a period sufficient to allow the generation of a number of square waves uniquely indicative of the patient whose ECG subsequently is to be transcribed.

The manner in which the output of the inventive patient identification marker apparatus is utilized is a matter of choice and will depend in part upon the circuitry of the particular ECG machine used. As described earlier, the ECG is turned on as soon as switch **90** comes to rest at an "alert position," this condition producing a control voltage on line **192** (see FIG. 3). Simultaneously, a voltage is provided at terminal **230***a* (see FIG. 4) which may be utilized by the associated ECG to inhibit temporarily print-out of the ECG pattern itself. (Recall that the voltage on line **230** is present only for that duration of time during which patient identification square waves are produced by marker generator **202**.) The output signal from marker generator **202**, taken either across the switch contacts between terminals **248***a* and **248***b* or the square wave produced between terminals **248***a* and **248***c*, then may be used by the associated ECG to deflect its writing stylus by a slight amount either above or below the base line. This deflection results in the transcription of a series of pulses at the beginning of the ECG trace, corresponding in number to the identification number of the patient in distress. At the end of the square wave train from marker generator **202**, the ECG inhibit signal on line **230** terminates, and the ECG commences to record the cardiac pattern of the patient in distress. As described above, this recording continues for a period of approximately 15 seconds (minus the time required to print the identification marks).

A typical ECG trace as may be transcribed using the inventive patient identification marker apparatus is shown in FIG. 5; in this illustrative recording, patients **2** and **5** both are in alert. Referring to FIG. 5, the initial ECG trace **310** is preceded by two square waves **312** generated by the inventive marker apparatus at the beginning of the period during which patient number **2** is being monitored. The next ECG trace **314** is preceded by five pulses **316** generated by the inventive marker apparatus while patient number **5** is being monitored. Thus the resultant recording, produced by a single ECG operating in conjunction with the inventive automatic medical monitor system described hereinabove, includes a permanent indicia identifying each ECG trace with the specific patient being monitored. The apparatus thus overcomes a shortcoming of the prior art wherein successive ECG traces, although recorded from different patients, did not contain patient identifying indicia.

While the invention has been described hereinabove in terms of the preferred embodiment shown in schematic diagram form in FIG. 4, the invention clearly is not so limited. Thus, for example, marker generator **202** could comprise a free running multivibrator, operation of which is initiated when a central monitor switch senses a predetermined condition associated with particular patient being monitored. Marker control circuit **204** then may comprise a monostable multivibrator (one-shot) the operation of which is initiated simultaneously with that of the free running multivibrator, and which has a monostable time period indicative of which patient is being monitored. Such monstable multivibrator could be adapted to disable the free-running multivibrator at the end of the one shot period. Of course, other circuits having like functions will be obvious to those skilled in the digital circuitry art and may be substituted for marker generator **202** or for marker control circuit **204**.

Although the invention has been described and illustrated in detail, it is to be clearly understood that the same is by way of illustration and example only and is not to be taken by way of limitation, the spirit and scope of this invention being limited only by the terms of the appended claims.

What is claimed is:

1. A patient identification marker apparatus comprising:

a medical monitor system adapted to detect a distress condition of a patient being monitored;

a signal generating means being actuated upon the detection of a distress condition from said medical monitor system for generating a series of pulses;

means responsive to said signal generating means for producing a pulse which is on for a portion of a period of the signal of said signal generating means and off for the remainder of said period;

means for supplying energy to said signal generating means; and

timing means responsive to the distress condition of said medical monitor system for terminating said energy to said signal generating means after a duration of time indicative of the particular patient in distress.

2. The apparatus as defined in claim **1** wherein said timing means comprises a pulse generating means, and including means responsive to the monitor system for controlling the time constant thereof.

3. The apparatus as defined in claim **1** and further comprising voltage control means for supplying regulated DC voltage to said timing means and to said signal generating means during periods when a distress condition is dected by said monitor system.

4. The apparatus as defined in claim **1** and wherein said timing means includes:

a pulse generator, and including means responsive to the monitor system for controlling the time constant thereof; and

voltage control means for supplying regulated DC voltages to said pulse generator and to said signal generating means during periods when a distress condition is detected by said monitor system.

5. The apparatus as defined in claim **1** and wherein said medical monitor system includes a recording means for recording a physiological condition of said distressed patient and for recording indications of said pulses prior to recording said physiological conditions to identify the conditions with the patient.

6. The apparatus as defined in claim **1** and wherein said timing means includes:

a pulse generator, and including means responsive to the monitor system for controlling the time constant thereof;

voltage control means for supplying regulated DC voltage to said pulse generator and to said signal generating means during periods when a distress condition is detected by said monitor system; and

said medical monitor system including a recording means for recording a physiological condition of said distressed patient and for recording indications of said pulses prior to recording said physiological condition to identify the conditions with the patient.

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