United States Patent

Franklin et al.

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[54] STATUS DISPLAY PANEL INDICATING PERFORMANCE AS A FUNCTION OF TIME WITH RECORD FEATURE

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[51] **Int. Cl.**.....**G08b 21/00**

[58] **Field of Search**.....340/381, 166, 325, 309.4, 365, 340/323, 334, 337, 332, 225, 286 R; 235/92 MC, 92 PD, 92 ME, 92 T; 346/33; 128/21 R, 21 A, 21 P; 315/362, 169; 40/52

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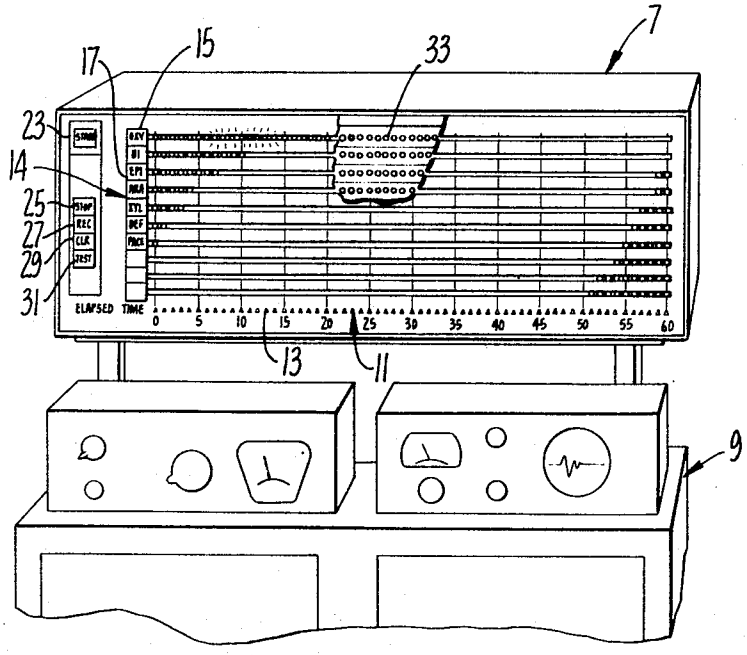
[57] **ABSTRACT**

The device of the present invention, termed a resuscigraph, coordinates and organizes systematically the effort of an individual or, more typically, a team of individuals in the performance of a given job involving multiple operations to be done either simultaneously or in a certain sequence as in the case of an attempt to resuscitate a person suffering a cardiac arrest, a common event in nearly every hospital. It is particularly useful in circumstances where the job to be done is of an emergency nature or where limitations of time, lack of personnel for purely coordinating purposes, or other factors, limit verbal intercommunication between team members.

6 Claims, 6 Drawing Figures



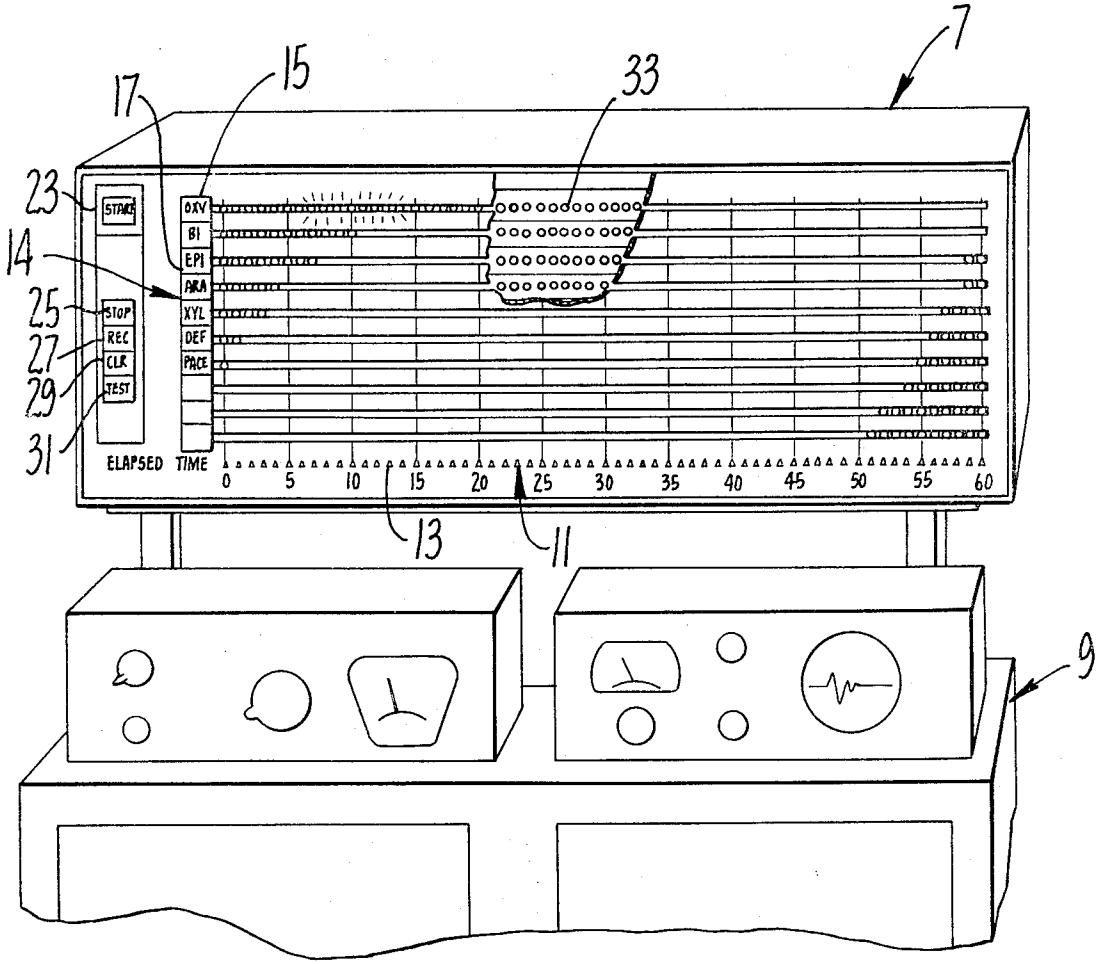


FIG. 1.

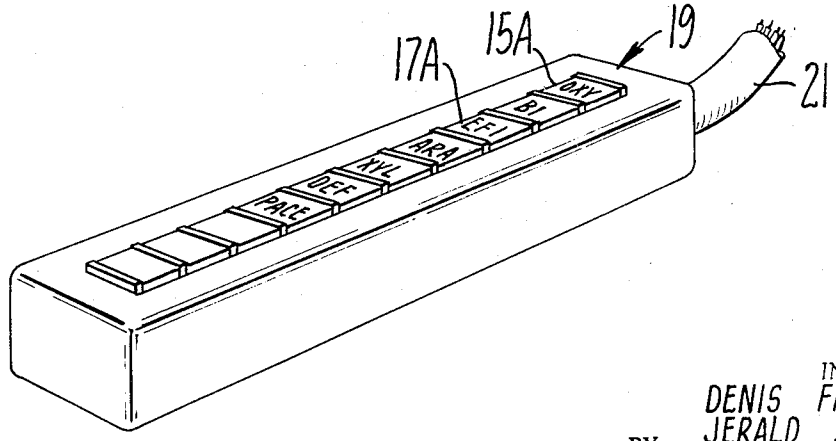


FIG. 2.

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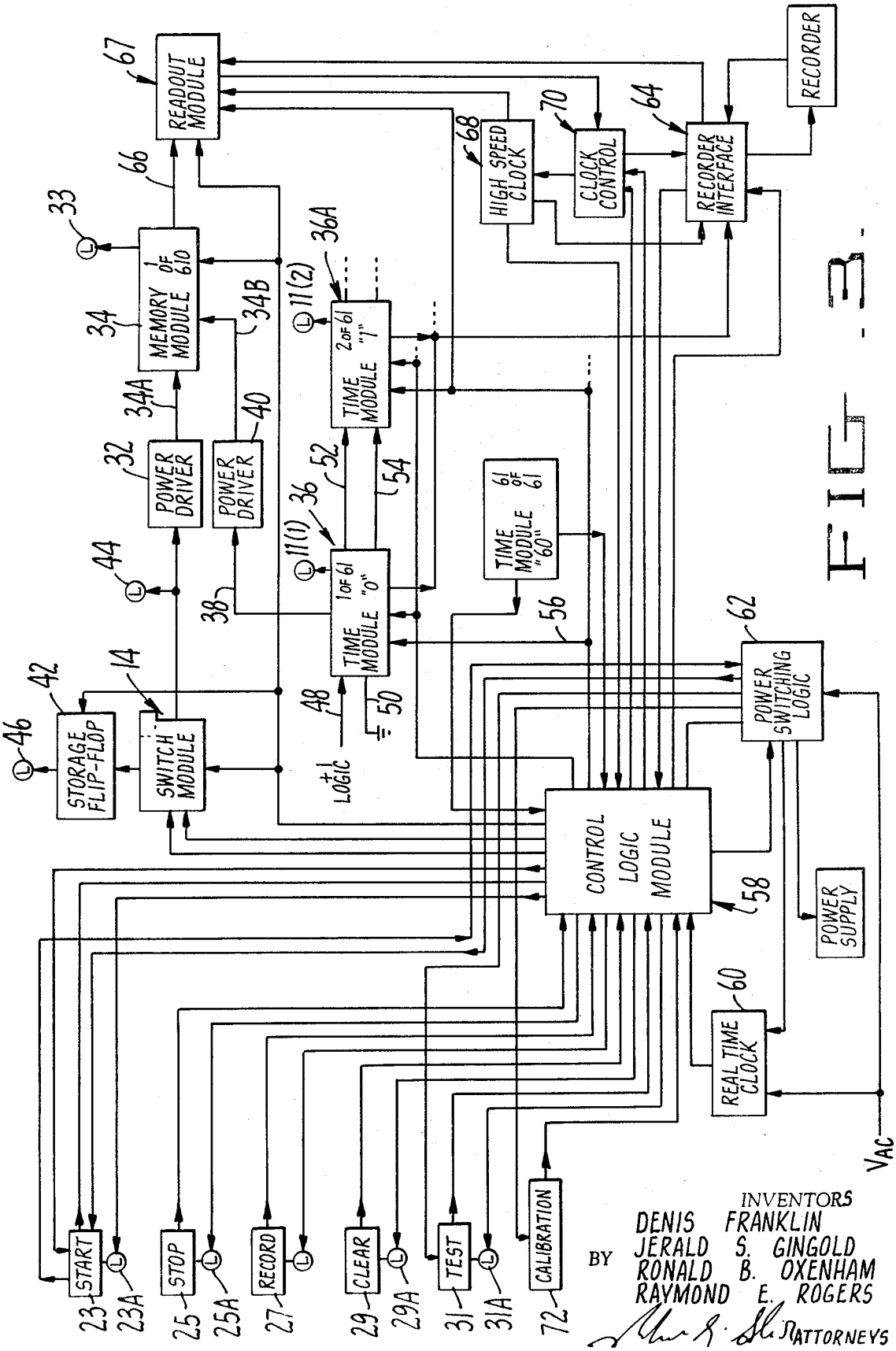

FIG - 3

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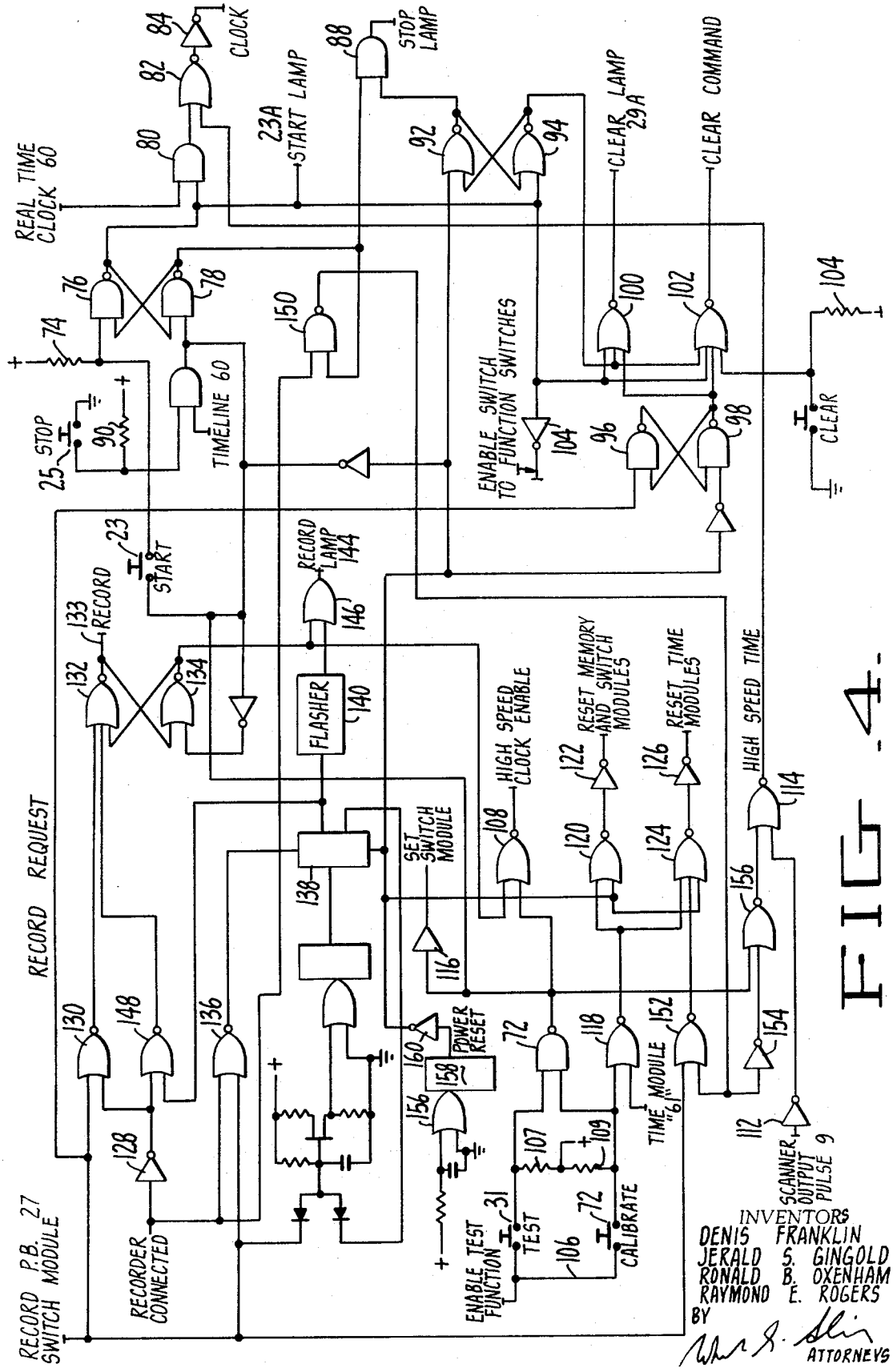

FIG - 4

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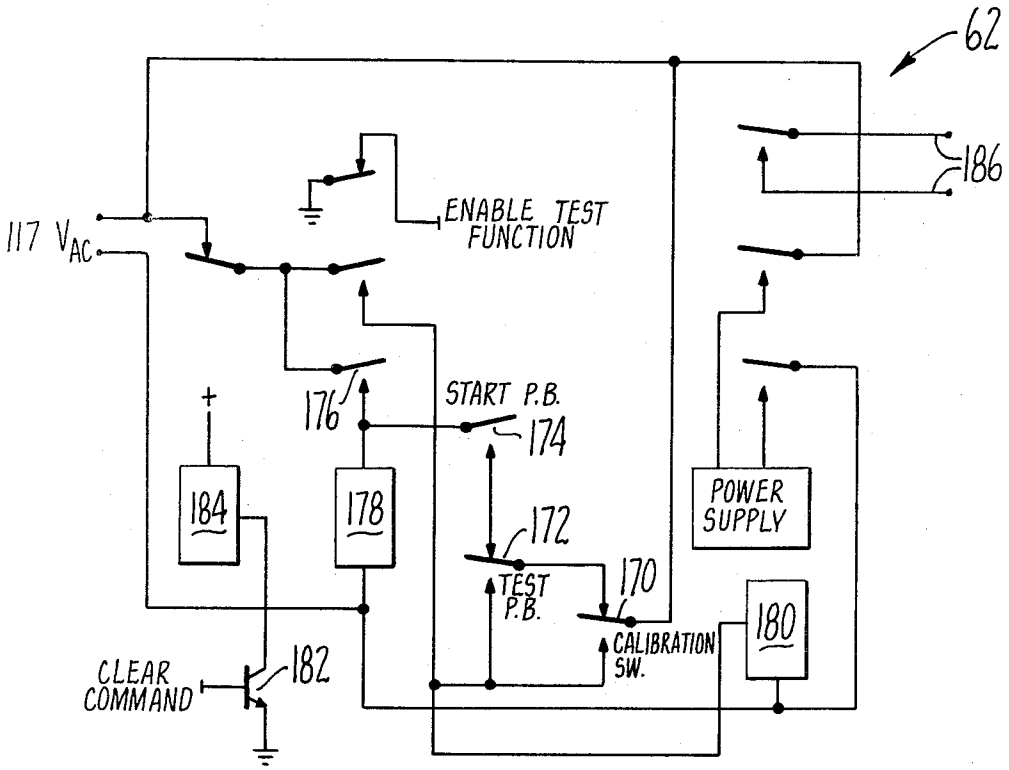

FIG. 5.

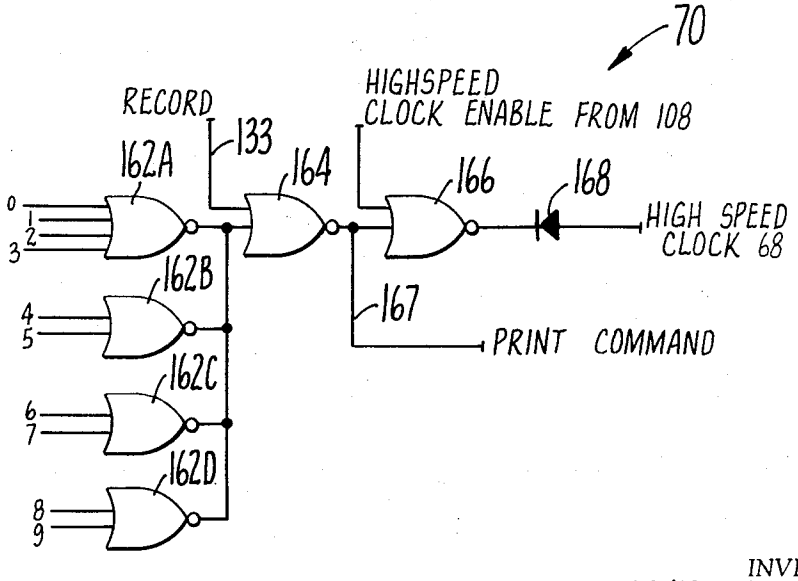

FIG. 6.

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STATUS DISPLAY PANEL INDICATING PERFORMANCE AS A FUNCTION OF TIME WITH RECORD FEATURE

BACKGROUND OF THE INVENTION

Cardiac arrest may occur anywhere in a hospital and at any time. If it should occur in an intensive care unit at a time when adequate medical and nursing personnel are present, i.e., in the presence of a well equipped and well trained cardiac resuscitation team, the changes for a successful resuscitation are maximal. If anything less than these ideal circumstances obtain, the odds drop off rapidly.

In none but the largest medical centers is there a complete, well equipped, well drilled, constantly available team with unchanging membership. In most cardiac arrest situations the emergency is discovered by a nurse. The call for help goes out and the team is formed ad hoc from physicians, nurses and technicians who happen to be present in the hospital. They arrive in random sequence and each must evaluate the status of the resuscitative effort before deciding if there is something he should do. The scene, even to a physician (who may not have attended such an effort in a month or two), is one of immense confusion, especially during the first few critical minutes.

At the present time there is no consistently effective way of organizing the resuscitation effort. When such a situation evolves, the most difficult and frequently impossible service to acquire is that of timekeeper, recorder and coordinator. Human memory of what has been done and of times elapsed is notoriously distorted in even the coolest of heads in this emergency situation.

SUMMARY OF THE INVENTION

Under the emergency situation outlined above, the resuscigraph performs as follows:

Prior to use, several large illuminated input switch buttons are labeled with lettered, slip-in inserts containing the names of appropriate drugs and procedures, e.g., OXY = oxygen, BI = bicarbonate, EPI = epinephrine, ARA = aramine, XYL = xylocaine, DEFIB = defibrillate, PACE = pacemaking and other items as pre-selected by the cardiologist. These can be provided at one end of a display panel and on a smaller control unit a "button board" at the patient's bed. Each switch button, when depressed, energizes an input channel to record the discrete act indicated by the button label, or a continuous process beginning with the initial depression of the button and ending with its second depression. This pre-selection capability permits variations according to the preference of the physician in charge of the given intensive care unit as to the drugs and procedures used.

The person discovering the cardiac arrest would, as soon as the device was brought to the bedside of the patient and simultaneously with the giving of the alarm, start the resuscigraph. This act initiates a timer which would then energize a row of lights across the bottom of a display panel, the lamps lighting in sequence, left to right at a rate of one per minute. Each light remains on once lit. This gives the effect of a "time bar" beginning at the left and extending further toward the right across the base of the display panel as time progresses. Using the abscissa of the graphic display as representing time is consistent with conventional medical and other charting and would therefore facilitate easy reading of the display by those in attendance on the patient.

As each of the 10 acts or functions pre-selected to be recorded is performed, the person initiating or doing it, or an assistant or observer, presses the appropriate switch button either on the display panel or on the accessory input "button board" at the patient's bed, which switch button corresponds to the act or function.

With the initial depression of a selected switch button, a point of light appears at the intersection of the horizontal line corresponding to the function button depressed and a vertical line extending upwardly from the last time indicating light to have become illuminated. If that particular function has been pre-selected for discrete recording, no other light on that horizontal line will be lit until the button is depressed again. If the function has been pre-selected for continuous recording, the succeeding lights on the horizontal line will come on at intervals of 1 minute until (a) the function button is pressed again, (b) the machine is stopped or (c) 60 minutes of recording time has elapsed. If stopped with the function button, recording can be restarted by depressing it again.

Persons arriving later at the scene, such as the anesthesiologist, the residents, cardiologist, technicians, nursing supervisors or the patient's physician, may ascertain by observing the display panel how much time has elapsed since the treatment of the cardiac arrest was commenced and what steps have already been taken to correct it. They may then proceed with their own roles in the effort and record their progress as has been set forth.

At the conclusion of the effort, a STOP button is pressed, stopping the timer but leaving the illuminated data displayed on the panel.

Either simultaneously with the entering of data into the device, as described above, or at the conclusion of the effort, the data on the display panel can be transferred digitally to an accessory device, such as a digital recorder, an X-Y plotter, a computer or intermediate storage device. The transfer is effected into a separate recording device upon depressing a RECORD button. In this manner, a permanent record may be made for attachment to the patient's chart and for subsequent teaching and review by the resuscitation team. Up to the present time, except in very unusual circumstances, no such detailed record has been made during cardiac resuscitative efforts.

Subsequent to the making of the desired number of recordings to the display, the CLEAR button is pressed. This turns off the power, the display erases and the memory modules are cleared. The device is then ready for reuse.

Between uses a TEST button may be pressed to illuminate all of the lamps on the board at once to ascertain if any lamps or circuits are defective.

The unique quality and function of this device is in the fact that it permits discrete acts or continuous processes to be recorded easily, quickly and almost effortlessly by the individual doing a given job, and provides an instantaneous visual display of the information in a lucid format and of appropriate size for the circumstances.

It enables any member of the team to enter the information that a given act or function has been instituted or completed by him. He may enter the information without speaking or moving from his work position by pressing the appropriate large, labeled, illuminated switch button. The information will then instantly be displayed in graphic form on an illuminated display panel of sufficient size and placement so that any other team member may ascertain at a glance what parts of the job have already been done and in what sequence and therefore may decide what his own next action should be.

In its basic form, the device will display the time of performance of up to say ten different acts or functions. Each act or function may be recorded only once in any given minute over a maximum period of 60 minutes by which time the effort will have either been successful or will have been in vain.

In general, the broad object of the present invention is to provide a device which is capable of recording the time of performance of any one of several acts or procedures utilized in connection with attempts to correct a condition which has arisen under emergency circumstances.

Another object of the present invention is to provide a device which, having recorded the time of performance of various acts or procedures, retains these for eventual recordation as a permanent record.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a device embodying the present invention, showing it installed on a cardiac resuscitation equipment cart.

FIG. 2 is an enlarged view of a button board which can be placed for control purposes at any convenient point.

FIG. 3 is a block diagram of the control and logic functions embodied in the device shown in FIG. 1.

FIG. 4 is a logic diagram of the control circuit.

FIG. 5 is a block diagram of the power switching circuit.

FIG. 6 is a logic diagram showing the record function.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A device embodying the present invention is shown in FIG. 1, the device being housed in a suitable cabinet generally designated 7 which may be located at any convenient point such as mounted on a cardiac resuscitation cart 9. In the device illustrated, the mechanism is designed to run for 60 minutes and to indicate intervals of 1 minute although it is obvious that a shorter or longer running period might be selected and/or that the intervals might be longer or shorter than 1 minute. Similarly, in the device illustrated, 10 different functions are shown but here again a greater or smaller number might be used.

Along the bottom of the device is located a plurality of lights, generally designated 11, there being 60 lights each of which indicates a 1 minute interval. For instance, the light designated 13 represents 13 minutes of elapsed time and so on. At the left of the numbered lights is a row of push buttons 14, there being one button for each row of lights. Each of the buttons represents some particular technique, for example, button 15 for oxygen and button 17 for epinephrine. A separate button board 19 can be provided connected by a flexible cable 21 to the cabinet 7. The button board 19 has thereon buttons corresponding with the buttons on the main panel 14 and are in parallel therewith. Thus, button 15A is in parallel with button 15, button 17A is in parallel with button 17 and so on. Thus, one can produce the same function by pushing either button 15 or 15A and the choice would only be which is the more convenient to the operator. Naturally more than one button board 19 might be employed with corresponding switches in parallel, or the button board could be eliminated.

At the left hand side of the device various switches are provided. These include a start button 23, a stop button 25, a record button 27, a clear button 29 and a test button 31.

It will be understood that a light bulb is provided for each row and for each column so that in the embodiment illustrated, 60 bulbs are employed in each row, making a total of 600. A typical bulb is designated 33 and when this bulb is lit it indicates that oxygen was administered during the 27th minute of the rescue effort.

To aid in an understanding of the invention, the broad overall operation will first be described followed by a more detailed description of the manner in which the device functions. To initiate the operation, one first pushes the start button 23. This starts the elapsed time clock running so that the lights 11 switch on in succession from the left at 1 minute intervals. As some operation is commenced, one of the buttons 14 is depressed and this will cause the appropriate light for that function and that minute interval to come on and remain on. In FIG. 1, the lights from the first row from minute 7 to minute 13 are shown as lit, showing that oxygen was administered during that interval. Thus, anyone entering the room can tell at a glance what techniques have been employed and at what time and for how long. When the emergency is over, the stop button 25 is depressed which stops the running of the clock and the elapsed time indicator but which leaves all of the lit buttons and lit indicator lights on. If one now wishes to make a record of the effort, the record button 27 is depressed which actuates a suitable recorder such as a digital recorder, which may record the event on tape or other suitable recorder as is well known to those skilled in the art. A permanent record is thus preserved for further study and evaluation. After recording, if this is done, the clear button 29 can be depressed, clearing the board for a repetition of the cycle and turning the machine off. From time to time between uses the test button 31 can be depressed and this serves to light all of the bulbs on the board, revealing any bulb which might be burned out or other malfunction, such as a defective lamp driver.

The device of the present invention employs a solid state switching and is explained largely in terms of logic functions. However it will be understood that tubes, latching relays or the like could be used to perform the various functions.

The entering of data for memory and display is done by means of the ten function buttons 14 arranged vertically near the left border of the display panel. Each of these buttons and its associated horizontal row of 60 indicator lamps is circuited identically with the rest. When a function button 14 is pressed (e.g., button 15) a circuit is established through a current amplifier 32 to one input of each of 60 memory modules 34 associated with the indicator lamps (e.g., 33) in that function row. Because each memory modules input is through an AND gate, only one which is simultaneously receiving another signal current from the time module 36 will have its flip-flop set and will produce output to its lamp driver (not illustrated) and indicator lamp 33.

The time modules 36 selectively and sequentially energize 60 time lines 38, each conditioned by its own power driver 40, each corresponding to 1 minute of operation of the device and each connecting to one of the AND gate inputs 34A and 34B of ten memory modules 34. These 10 memory modules are the ones associated with the indicator lamps arranged in a vertical column extending upward from the time indicator lamp to which the time line corresponds.

Thus, for instance, during the 5th minute of operation of the device, the fifth time line will be energized by its time module and the 10 memory modules serving the 10 indicator lamps vertically arranged on the "5 minute" line on the face of the device will each have one of the two AND gate inputs activated. If, during that minute, any one of the function buttons is pushed, each of the memory modules associated with the indicator lamps in its horizontal row will have the other of the AND gate inputs activated.

However, in this case only one lamp's memory module AND gate would have had both inputs activated fulfilling the logical AND requirement. That lamp alone would have its flip-flop set and would become illuminated.

Each of the function switches 14 has an associated function switch module which performs housekeeping on the function switch in the following manner. The function switch module has a position monitor output which sets a storage flip-flop 42 on the first occasion the function button is pushed. The storage flip-flop energizes a lamp driver (not shown) which in turn lights the lamps 46 in the function button, causing it to become illuminated and to remain so throughout the remainder of the run.

A second function switch module output is a conditioned one which is selectable for either continuous or discrete function display. The selection is made via a separate mechanical option switch for each function button. These option switches are located under a plate on the left (front orientation) lower corner of the front panel of the device but are not illustrated. If discrete display is chosen, the function switch changes state once when the button is pushed and once again when it is released. If continuous display is desired, the function switch will change state once when the button is pushed and released, and a second time when it is pushed and released again.

Regardless of which mode is selected, the function switch module conditioned output drives a power driver 32 which in turn energizes one line to each of the AND gates of the memory modules of the 60 indicator lamps in its horizontal row as described above e.g., at 34A. In addition this conditioned output drives lamp drivers not shown that light two more lamps 46 which are also in each function button. Hence, whenever the button is pushed in the discrete mode, the function button will become twice as bright (i.e., both 44 and 46 illuminated) "acknowledging" to the user that it has been

pushed. In the same way the function button will become twice as bright when pushed and remain at that level of brightness until pushed again when the button is in the continuous mode.

A shift-register composed of the 61 time modules e.g., **36** and **36A** satisfies two basic timekeeping requirements. First it illuminates the elapsed time lamps **11** along the lower border of the display panel, one each minute from left to right. And second it energizes the 60 time lines **34B** described above one at a time sequentially from left to right, each remaining energized for 1 minute. The "61 bit shift-register" has two outputs from each of its time modules. The first output is to a lamp driver (not illustrated) which when enabled remains enabled so that the elapsed-time lamps **11** stay on once lit. This gives the effect of a "bar chart" indicator of elapsed time across the base of the display panel as set forth above in the general description of the device. The second output is amplified by a power driver **40** and supplied via a time line **34B** to one AND gate input of each of the 10 memory modules associated with the indicator lamps vertically oriented above that time modules elapsed-time lamp.

The internal operation of the shift register merely assures that the time modules will be polled for their output in sequence, each for one minute's time. This is accomplished by forcing the low end of the shift-register by lines from a "constant one" signal source **48** and **50** at a shift rate of one per minute. Successive shift information is carried between the time modules of the shift-register by interconnecting lines **52** and **54** and is clocked by a bus **56**. At the start of each run, all of the time modules are reset by the control logic **58**. The once-a-minute advance of the shift-register is initiated and controlled by a signal from the real-time clock **60** via the start switch and through the control logic **58**. The real-time clock **60** is started by the power switching logic **62** and after the device is cleared the real-time clock returns to the null position.

The real-time clock assembly **60** consists of a Synchronous Motor with inputs from the AC line and from the power switching logic **62** and has a cam that drives a micro switch to produce contact grounding output at 1 minute intervals. The motor is naturally homing but this feature is overridden during running.

When the record button **27** is pressed, information as to the off-or-on status of each of the function indicator lamps on the display panel is transferred to the recorder interface **64** so that it will be available to an accessory device such as an X-Y plotter or digital recorder for the purpose of making a permanent record. This is accomplished in a fashion very similar to data input. But the off-or-on set of the flip-flop in the indicator lamp's memory module is gated out of the memory module (without changing the set of the flip-flop) instead of in. The logic of this AND gate states that if during any given minute — say minute 5 — a given function row's indicator lamp memory module is found to be set "on," an output from the memory module will be produced for routing to the recorder interface. One of the inputs to this AND gate is intrinsic, i.e., the "on" set of the flip-flop. The other is extrinsic i.e., an energized time line from a time module in the shift register. The AND gate outputs from each of the 60 memory modules in a given horizontal function row are collected in a readout bus **66** and connected to readout module **67**. There is one readout bus for each of the 10 horizontal function rows. A high speed clock **68** scans the readout buses sequentially and continuously during record. The recorder interface obtains time information directly from the time modules, i.e., it knows which minute's time line is energized. It obtains data from the readout module as to the results of the scanning of the readout buses by the high speed clock. Therefore it has obtained the data as to which, if any, function indicator lamps were on during any given minute of operation. This is all that is required for a permanent record to be produced by an accessory device.

The record button may be pressed either at the start of a run or at its conclusion. In the former case the time-line advance will occur in the usual one line per minute fashion under the control of the real-time clock. Readout will occur simultaneously with data input. If the record button is pressed at the end of a run when the real-time clock has been stopped, a separate output from the high speed clock **68** will advance the shift register at high speed. The high-speed clock control module **70** will then coordinate matters so that there is a time line advance followed by scanning of the 10 readout buses, transmission of the date to the recorder interface and another time line advance. The whole readout process will take only several seconds under these conditions.

Pressing the start button **23** energizes the power switching logic **62** and the device latches into the power-on-state. The control module **58** will cause the elapsed time circuits to begin to operate as described above and the start button lamps will become illuminated.

Either when the end of the hour is reached or when the stop button **25** is depressed, the function switch modules and the real-time clock are disabled by the control logic **58** and the lamps **25A** inside the stop button become illuminated.

Pressing the clear button **29** will have no effect until the record button **27** has been pressed at least once. If that has been done, pressing the clear button causes a request to be sent to control logic **58** to clear the device. If the device has been stopped and the record button pressed at least once, control logic acknowledges the request by dropping power from the device.

When the device is in the power-off state, pressing the test button **31** will bring power up, illuminate the lamps in the test button **31A**, set all the function switch memory modules to "on," and advance through the shift-register using the high speed clock. This will have the effect of illuminating all the function indicator lamps and will test much of the associated circuitry. The calibrate switch **72** will have the same effect except that at the end of each sweep across the display panel, time and memory modules will be reset, then rescanned until the switch is returned to the "off" position.

The control logic module is shown in the logic diagram of FIG. **4**. When the start pushbutton **23** is pushed, power is brought up on the machine. The logic part of the start switch, is enabled and provides a ground signal for logic operation. If one of the test buttons **31** had been pushed and brings the power up, a gate **72** insures that the start button is inhibited. If the start button is the one that brings the power up, the power switching logic disables the test button **31**. If the start pushbutton is the one initiating operation then the logical ground produced by the start switch sets a flip-flop. This signal line is normally biased high by a resistor **74**. The flip-flop consists of two NAND gates **76** and **78** cross-coupled. This flip-flop remembers the fact that the machine is in the normal operating mode. This allows the real-time clock **60** to energize the clock line by means of an AND gate **80**, a NOR gate **82**, and a power driver **84**. The start light **23A** is also lit. The flip-flop is reset by an AND gate **86** working as a negative logic OR **88**. This functions as an "or" for the stop button or time line. Time line **60** is normally high and goes low at the end of an hours' run. The stop signal line is normally held positive by a resistor **90**. This flip-flop is also reset by "power on."

There is an auxiliary flip-flop used to remember that the machine has been in the normal operation mode after the operation has stopped. This flip-flop consists of two NOR gates **92** and **94** cross-coupled and initially reset. If the normal run flip-flop **76–78** is reset, (operation stopped) then this fact is "anded" with the fact that the run was normal to light the stop light. A separate flip-flop **96** and **98** records the fact that the record button has been pushed. The record request memory, together with the termination of a normal run are functionally "anded" at **100** to light the clear light that signifies that the clear gate is enabled at **102**. The clear button line normally is held high by means of a resistor **104**. When the clear gate **102** is satisfied, the power is dropped from the

machine. The function switches are enabled by 104 during a normal run. If the power is off the machine, a ground through line 106 is supplied to the test and calibrate buttons 31 and 72. If either one of the buttons is pushed, power is brought up on the machine and the high speed clock is enabled through 108. Both the test and calibrate button lines are held high by resistors 107 and 109. The high speed clock output from line 112 is then allowed to advance the time modules through gates 114 and 82. The high speed clock is not illustrated in detail but briefly it includes a unijunction oscillator operating at a 500Hz rate. The timing is determined by a R-C circuit. The output pulse is carried to a Schmidt Trigger which shapes the pulse for subsequent logic. The output of the Schmidt Trigger drives a binary counter which is coupled to a binary to decimal decoder. The decoder provides 10 outputs and the output "nine" is also taken out to a separate line 112. The function switches are also set in this mode through amplifier 116. There is an additional set of gates 118 used to recycle the test operation for the calibrate switch 72. This is done by resetting the switch and memory modules through 120 and 122 and the time modules through 124 and 126 when time module is set through 118. If a permanent record is requested 27 the recorder status is tested. If the recorder is connected through 128 a gate 130 is used to set the record flip-flop. This flip-flop consists of two NOR gates 132 and 134 cross-coupled. If the recorder is not connected a gate 136 is used to reset a timer 138. This timer consists of an RC network that is allowed to charge when the timer flip-flop is reset and the record button is released. This last is done so that the disconnected recorder indication of a flashing record button lamp 144 will extend over 20–30 seconds. The record light 144 comes on continuously when the record flip-flop 146 is set. The setting of the record flip-flop also enables the high speed clock through gate 108. There is a gate 148 that allows the record flip-flop to be set if the recorder is connected while the timer is running. A gate 150 is used to detect that the recorder is connected and the machine is not in the normal run mode. This then "allows" the high speed clock output number nine to the clock line through amplifier 154 and gate 114. This also resets the time modules through 152, 124 and 126 so the memory modules may be rescanned for readout. A power-on reset circuit starts the machine and includes 156, 158 and 160.

The high speed clock control is shown in FIG. 6 and was previously designated 70. The "stop" requests from the 10 readout modules are brought into an expanded OR gate 162A through D. This is then put into an AND gate 164 with information from 133 that a permanent recording is wanted. The output of this gate gives a command through the line 167 to the recorder interface to print. It also disables the high speed clock through 166 and 168.

The power switching logic previously generally designated 62, is shown in FIG. 5. The input power from the 117 VAC mains is brought into the unit ready to be applied to the machine power supplies. If the start button 23 is pushed with power off, the power is applied through contacts 170, 172 and 174 to Relay 178. Relay 178 then latches itself on through contacts 176 and power is also applied to the coil of Relay 180. This Relay applies power to the various system power supplies through its contacts as shown. Relay 178 is cleared by the clear command through a transistor relay driver 182 to Relay 184. Power is also applied to Relay 180 by means of either the test button 31 or calibrate button 72. But in this case Relay 178 is not latched. A separate set of contacts on Relay 180 is used to "enable" the real-time clock at 186. The logic test functions are enabled by means of Relay 178 being not latched.

We claim:

1. A memory and display device comprising in combination:
   a. a plurality of rows of indicators,
   b. said rows being arranged in a plurality of columns whereby a matrix is formed,
   c. a number of AND gates corresponding to the number of indicators each having an output, the output of each AND gate controlling one of said indicators,
   d. a real-time clock producing a series of timed output pulses, each of said output pulses having means to actuate one input of all of the AND gates in a single column, and means whereby successive pulses actuate successively each column in turn,
   e. a plurality of manual function switches, each function switch corresponding to one of said rows, each of said function switches actuating the other input of each of the AND gates in the row corresponding to said switch whereby,
   f. one or more of said function switches can be closed at any time causing an indicator to actuate corresponding to the time at which said switch is closed and said indicator will continue to stay actuated as the clock pulses pass to successive columns.

2. The structure of claim 1 wherein 60 columns of indicators are provided in each row, said indicators being active at 1 minute intervals.

3. The structure of claim 1 wherein a storage device is incorporated with said matrix whereby at the end of a cycle a record can be made showing the period during which each of said indicators was activated.

4. The structure of claim 3 wherein each of the function switches has a first mode of action and a second mode, said first mode closing a contact only while the switch is depressed and said second mode keeping a contact closed until the switch is pressed a second time.

5. The structure of claim 1 wherein the display device is mounted in a housing with a first set of function switches thereon and having a remote button board with a plurality of function switches in parallel with the switches on the display device.

6. The structure of claim 1 wherein the matrix consists of 10 rows of indicators and 10 function switches, each of said function switches controlling one of said row.

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