June 20, 1967 B. H. STANG ETAL 3,327,217

TONE SIGNALING AUTOMATIC REMOTE CONTROL SYSTEM

Filed March 2, 1965 2 Sheets-Sheet 1

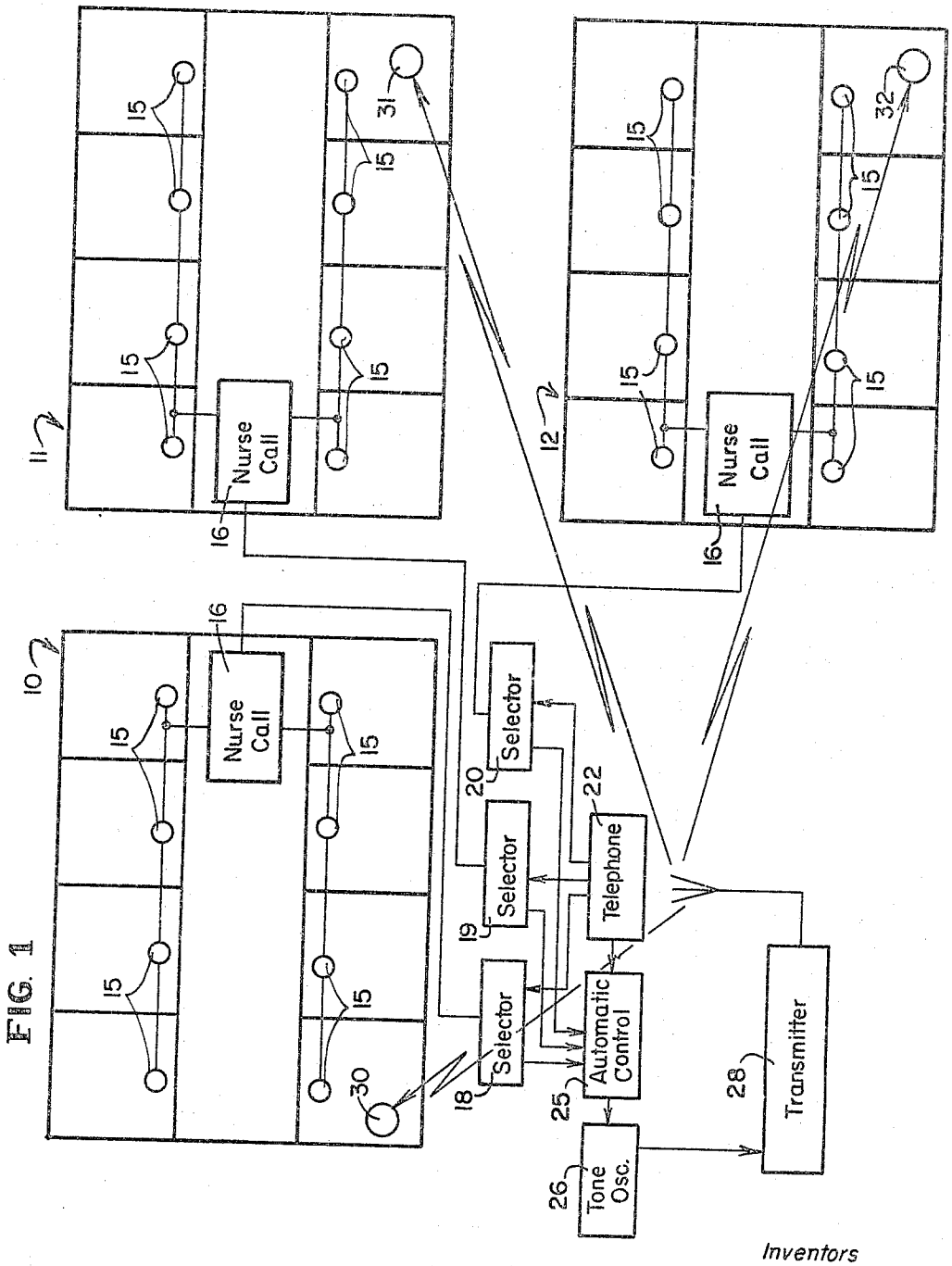

FIG. 1

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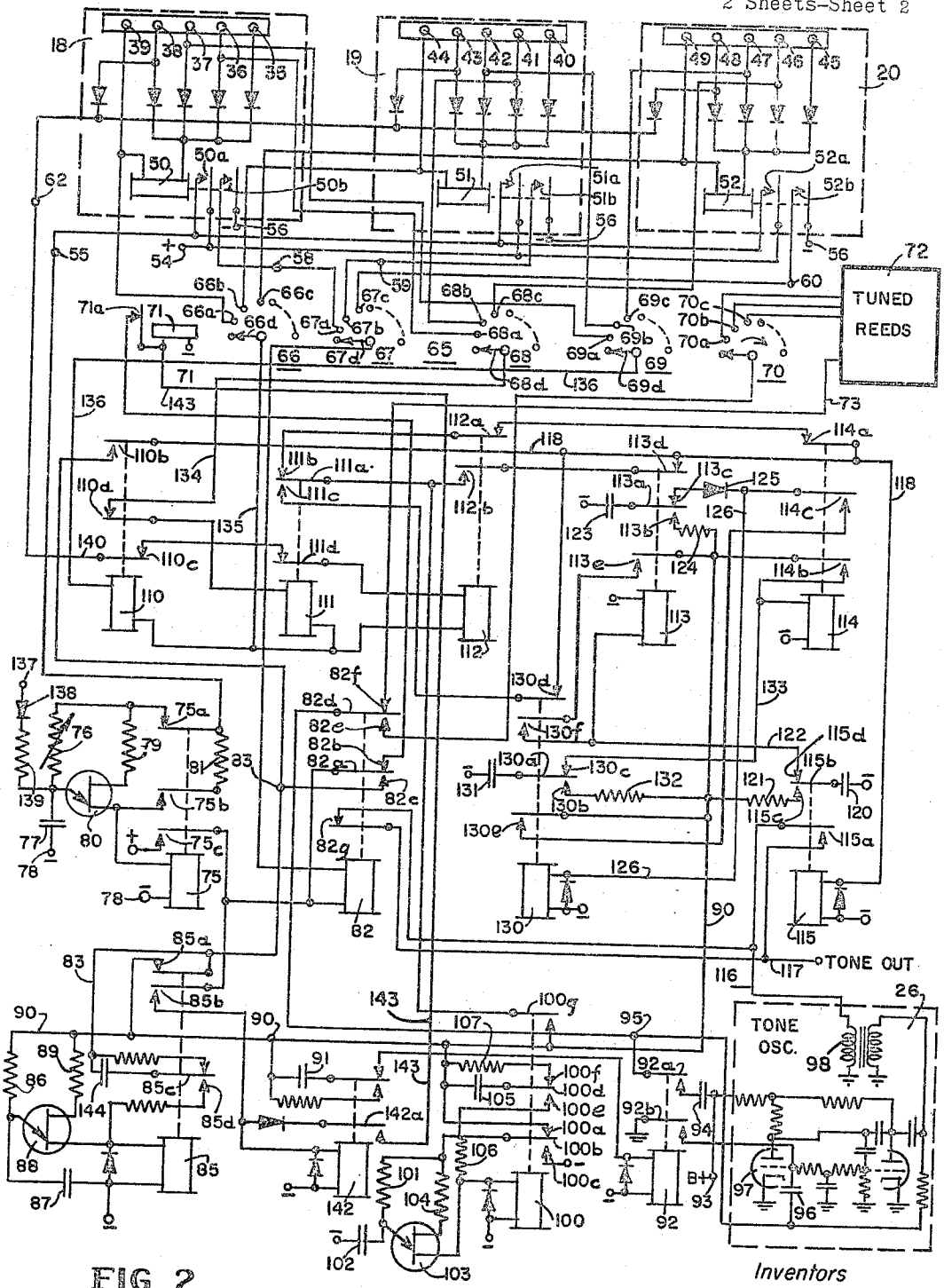

FIG. 2

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TONE SIGNALING AUTOMATIC REMOTE CONTROL SYSTEM

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12 Claims. (Cl. 325—55)

This invention relates generally to radio remote control systems and more particularly to an automatic system for applying coded signals to selected remote units, as for advising nurses of calls which require their attention.

Radio remote control systems have been provided in many applications. Such systems may provide alerting signals or voice signals which may be received by portable receivers which can be carried by a person. Available systems, however, have been too complicated and expensive for many applications. Further, such systems may require some operation on the part of the person receiving the message which would be impractical in many applications. For example, it may be desired to provide a message to a nurse who is on duty on a floor, which will reach the nurse when she is away from the desk or cannot see a visual indicator. However, the nurse may be performing some service which would make it impractical for her to provide a manual operation at the receiver. In such cases, it is desirable that the message be given to the nurse without any operation being required on her part. Further, it is desired that the message be automatically transmitted from existing nurse call facilities with a minimum of equipment. It is also desired that various nurses can be called on an individual basis, so that a particular nurse be given only the messages intended for her, and there is no requirement that she listen for a particular tone or code to determine that the message is for her. It is also desired that a single system and transmitter apply signals from a plurality of control stations in a hospital having a large number of sections to the nurses associated therewith to reduce the costs of the radio equipment.

It is, therefore, an object of the present invention to provide an automatic radio remote control system for giving messages to persons when they are away from a control station.

A further object is to provide a radio system which individually transmits messages from a plurality of control stations to individual receivers associated with such control stations, and which produce audible signals to indicate various different types of calls.

Another object of the invention is to provide an automatic radio nurse call system which transmits calls from particular nurse call stations to receivers carried by particular nurses and senses the nature of the calls to apply distinctive alarms at the individual nurse receivers.

A feature of the invention is the provision of a remote control system including selectors responsive to potentials at control stations for causing operation of an automatic control unit for applying tones individual to the control stations which are pulsed in accordance with the controls operated at the control stations. The system acts to send out calls from the control stations one after the other and to repeat unanswered calls after signals from all control stations have been transmitted.

Another feature of the invention is the provision of an automatic radio nurse call system including selectors individually responsive to potentials at individual nurse call stations and a control unit including a stepping switch having a plurality of levels each having contacts associated with the individual stations and a sequence circuit connected to the stepping switch and to the selectors

and acting to transmit a different tone for each different stepping switch position and for pulsing the tones in different ways depending upon which level of the stepping switch is energized. The sequence circuit includes a plurality of relays and timing devices for delaying the transmission of certain calls and for selectively transmitting different numbers of pulses to identify particular calls.

The invention is illustrated in the drawings wherein:

FIG. 1 is a block diagram of the automatic radio nurse call system of the invention; and

FIG. 2 is a circuit diagram of the selectors, control unit and tone oscillator of the system of the invention.

In accordance with the invention an automatic radio nurse control system is provided including selector units for connection to wired nurse call units provided in various sections of a hospital. The selector units each respond to any call at the associated nurse call unit, and applies a potential to a control unit which controls the transmission of tones from a radio transmitter. The signals from the radio transmitter are received by paging receivers carried by the nurses which produce audible calls for the individual nurses. The control unit includes a stepping switch having a plurality of levels, each having contacts associated with all the selector units. A relay sequence circuit is controlled by the connections from the selector units through the stepping switch contacts to control the transmission of tones. One level of the stepping switch selectively connects frequency selective reed devices resonant at different frequencies to a tone oscillator so that tones of a particular frequency are produced for each selector unit. Paging receiver units carried by the nurses respond only to the tone associated with the selector unit coupled to the nurse call for the section in the hospital in which that nurse works. The radio calls produced in response to calls applied to the nurse call units are delayed to permit the nurse to respond to the calls directly. The calls for various hospital sections are applied in sequence and are repeated if not answered. The sequence circuit pulses the tones to provide different calls as, for example, one short pulse for a normal call, two pulses for a priority call and a continuous tone for an emergency call.

The system can also transmit signals to indicate the presence of a telephone call, with the receiver producing a distinctive audio sound. In such case the signal is transmitted without delay. The telephone signal may take the form of three short calls. Other calls can be provided as desired in a particular system.

Although reference has been made to a system for calling nurses, it is obvious that the automatic radio system can be used in other applications. For example, the system could be used to give messages to watchmen working in various sections of a large building to alert them of the presence of fire or of a burglar, or to advise them that a telephone or other call has been received.

FIG. 1 illustrates in block diagram form the automatic radio nurse call system of the invention. As previously stated, the system can be coupled to a plurality of wired nurse call systems, each of which operates in one section of a hospital. In FIG. 1, three sections are represented by the blocks identified as **10**, **11** and **12**. Each section of the hospital has a plurality of rooms, each of which has a nurse call switch **15**. The nurse call switches in each section are connected to a nurse control unit **16**. The radio nurse call system includes a selector unit connected to each nurse call unit, with selector units **18**, **19** and **20** being connected to the nurse call units **16** in the sections **10**, **11** and **12** respectively.

Nurse call units presently available indicate to a nurse that a patient in one of the rooms of the section is calling, and also gives an indication as to the urgency of the call. It is common practice to have three types of calls; nor-

mal calls, priority calls and emergency calls. The nurse control unit will produce potentials to energize one terminal to actuate an indicator such as a light for normal calls, will energize a second terminal to actuate a second indicator for priority calls, and will energize a third terminal to actuate the third indicator for emergency calls.

The three potentials from each nurse control unit are applied to the associated selector unit, so that the selector unit has information as to the type of call placed in any section of the hospital in which the nurse call unit is operative. The hospital may also have a telephone system indicated at **22** with an operator in attendance. When a telephone call is received for a nurse in one of the sections of the hospital, the telephone operator can operate a switch to apply a potential to the selector unit for that section and to the control unit **25**, so that information can be transmitted to the nurse that a telephone call has been received.

The selector units **18**, **19** and **20** in the three sections are connected to the automatic control unit **25**. This unit receives the information from the selectors in the individual sections and operates to control a tone oscillator **26** which applies tones to transmitter **28**. The transmitter **28** produces a carrier wave which is modulated by the tone from the oscillator **26**. The carrier waves from transmitter **28** are received by paging receivers **30**, **31** and **32** carried by the nurses in the sections **10**, **11** and **12** respectively.

Each paging receiver will respond to only one of the tones applied by oscillator **26**, so that when the nurse is in a room and cannot observe the nurses call unit, her paging receiver alerts her to any calls which are intended for her and are indicated on the nurse call unit for her section. Accordingly, the calls for the nurse in section **10** will be tones of a frequency to which the paging receiver **30** responds. Similarly, the calls for the nurse in section **11** will be tones of the tone frequency to which the paging receiver **31** responds, and the calls for the nurse in section **12** will be tones of the frequency to which the paging receiver **32** responds.

Although various codes can be used to advise the nurse of the type of call being placed, in the system to be described a single one second pulse indicates that a normal call has been placed. Two successive one second pulses indicate to the nurse that a priority call has been placed, and a long eight second pulse indicates that an emergency call has been placed. The system will produce three one second pulses to indicate a telephone call.

The system is arranged so that a call can be applied from the transmitter to the paging receivers every eight seconds. If a call appears at the call unit in the sections **10** and **11** at the same time, the call would be transmitted to the receiver **30** in section **10**, and eight seconds later the call for section **11** will be transmitted to the receiver **31**. If the call remains unanswered, it will be repeated after all calls have been transmitted. That is, if a call is transmitted to the receiver **30** in section **10**, and then a call is transmitted to the receiver **31** in section **11** and the nurse has still not answered the call in section **10**, the call to section **10** will be repeated. This operation continues as long as there is a call on the system.

FIG. 2 shows a complete circuit diagram of the selector units **18**, **19** and **20**, the automatic control unit **25** and the tone oscillator **26**. Terminal **35** of selector **18** is connected to a potential in the nurse call unit **16** which is energized when a normal call is placed. Terminal **36** is connected to a terminal energized when a priority call is placed, and terminal **37** is connected to a terminal which is energized when an emergency call is placed. Each of these terminals produces a positive potential, and the negative return is applied to the terminal **39**. Terminal **38** of the selector **18** receives a positive potential when the telephone operator operates a switch to indicate that a telephone call has been received. The terminals **40**, **41**, **42**, **43** and **44** of selector **19** are connected to the terminals of the nurse call unit in the section **11** in the same manner that the terminals of selector **18** are connected as has been described. Similarly, the terminals **45** to **49** of the selector **20** are connected to the nurse call in section **12**.

The terminals **35**, **36**, **37** and **38** of selector **18** are connected through individual isolating diodes to relay **50**. When any one of the terminals **35**, **36**, **37** and **38** of the selector **18** is energized, relay **50** is actuated. Similarly, the terminals of the selector unit **19** are connected to relay **51** and actuate this relay when a potential is applied. The terminals of selector unit **20** are connected to relay **52** and operate it in the same way. Each of the relays includes two sets of contacts, with the *a* contacts of the three relays being connected in parallel so that actuation of any one of the relays applies the positive potential from terminal **54** to the output terminal **55**. The *b* contacts of the relays **50**, **51** and **52** are individual to the selectors and apply a negative potential from terminal **56** to separate output terminals. Contacts **50***b* of relay **50** apply the negative potential to terminal **58**, contacts **51***b* apply the negative potential to output terminal **59**, and contacts **52***b* apply the negative potential to output terminal **60**. The terminal **55** therefore indicates that a call is placed on one of the selectors, and the terminals **58**, **59** and **60** indicate on which of the selectors **18**, **19** or **20** the call is being placed.

It should be noted that each of the terminals **38**, **43** and **48** to which the telephone indication is applied, is also coupled through a second diode to a telephone output terminal **62**. The presence of a telephone call therefore will actuate the relay at a selector, and also produce a potential at output terminal **62**.

The output terminals **55**, **58**, **59**, **60** and **62** which have been described, together with connections from input terminals of the selectors, are coupled to the automatic control unit **25**. This unit includes a stepping switch **65** having five levels designated **66**, **67**, **68**, **69** and **70**, and solenoid actuator **71**. Application of a potential to actuator **71** causes the movable contacts of the levels to step from one contact to another, with the interrupter contacts **71***a* providing the required pulsing action. Each level of the stepping switch must have enough contact for individual connection to the selector units of the system. In the system described only three selector units are shown so that only three contacts of each level are used. However, in a large hospital it may be desired to have a much greater number of selector units, and the stepping switch will require a correspondingly larger number of contacts.

The negative potentials from input terminals **39**, **44** and **49** of the three selector units are applied to the three contacts **66***a*, **66***b* and **66***c* of the first level **66**. The output terminals of the selectors which indicate which selector has been actuated are connected to the contacts of the second level **67** of the stepping switch, with terminal **58** being connected to contact **67***a*, terminal **59** being connected to contact **67***b*, and terminal **60** being connected to contact **67***c*. The potentials from input terminals **36**, **41** and **46** indicating a priority call are connected to the contacts **68***a*, **68***b* and **68***c* of the third level **68** in the stepping switch. The potentials from the input terminals **37**, **42** and **47** indicating emergency calls are connected to the contacts **69***a*, **69***b* and **69***c* of the fourth level **69** of the stepping switch.

The fifth level **70** of the stepping switch makes connections to individual tuned reed devices. These tuned reed devices control the frequency of the tone oscillator **26** so that various tones are applied to actuate the different paging receivers. The tuned reed devices are provided in a chassis **72**, with the coils associated with individual reeds being connected to the contacts **70***a*, **70***b* and **70***c* of the level **70** of the stepping switch. A fourth reed device on the chassis **73** is connected through conductor **73** to provide a constant tone when no specific tone has been selected.

The operation of the remainder of the automatic con-

trol unit 25 will be described in connection with various calls placed in the system. In the event that a call is placed in any of the call units connected to selectors 18, 19 and 20, as previously stated the terminal 55 will receive a positive potential. This potential is applied through normally closed contacts 75*a* of relay 75 to a timing circuit including variable resistor 76 and capacitor 77 connected to the negative terminal 78. This will cause capacitor 77 to charge at a rate dependent upon the setting of variable resistor 76. Capacitor 77 is connected to the emitter electrode of unijunction transistor 80 and when the capacitor 77 charges to a sufficient potential, the unijunction transistor fires so that the positive potential is applied from terminal 55 through contact 75*a*, resistor 79 and between the bases of the unijunction transistor 80 to the coil of relay 75. It is noted that the other terminal of relay 75 is connected to the negative potential 78 so that relay 75 is energized. When relay 75 operates, contact 75*b* thereof closes to hold relay 75 energized through resistor 81 as long as the potential remains at terminal 55.

When relay 75 operates, contacts 75*c* thereof provide the positive potential through normally closed contacts 82*a* and 82*b* of relay 82, and through the normally closed contacts 71*a* of the stepping switch 65 to energize the stepping switch actuator 71 so that the switch steps to the next contacts. If the potential remains, contacts 71*a* of the stepping switch will de-energize the actuator 71 which will cause the contacts 71*a* to again close to actuate the solenoid a second time. This operation will continue until the potential is removed from contact 82*b* of relay 82.

Assuming that the call which causes energization of terminal 55 originated from selector 18, in such case terminal 58 would also be energized to energize contact 67*a* of the stepping switch 65. This would apply a negative potential from the moving contact 67*d* of level 67 to relay 82. As a positive potential is applied through contacts 75*c* to relay 82, this relay operates and contact 82*a* thereof moves away from contact 82*b*, so that the potential is removed from the stepping switch actuator 71, and the switch will remain on the *a* contacts thereof. Contact 82*a* of relay 82 will now engage contact 82*c* to apply the positive potential to conductor 83.

The positive potential on line 83 is applied through normally closed contact 85*a* of relay 85 to conductor 90. This potential is applied through capacitor 91 to relay 92 to actuate the same during the time required for capacitor 91 to charge. Relay 92 closes contacts 92*a* to apply the B+ potential from terminal 93 through capacitor 94 to conductor 95. Conductor 95 is connected to contact 82*d* of relay 82, and when relay 82 is operated the B+ potential is applied through contact 82*e* to the movable contact of stepping switch level 70. This potential is applied through this level to the connected coil of one tuned reed to shock excite the reed so that it will vibrate. The reed coil is connected through conductor 95 to the tone oscillator 26 so that the oscillations of the vibrating reed control the frequency of the tone oscillator.

Relay 92 includes contacts 92*b* which ground the grid of triode 97 of the tone oscillator 26 so that it will immediately stop oscillating. This is necessary so that the oscillator will be conditioned to start to oscillate at a new frequency. For example, if the constant tone has been applied, contacts 92*b* will ground the oscillator so that it stops oscillating at the constant tone. Contacts 92*a* will shock excite the reed for the new tone so that the tone oscillator will start oscillating at the new frequency.

It will be noted that when relay 82 is released, contact 82*d* engages contact 82*f* so that the constant tone reed connected through conductor 73, is connected to the tone oscillator. This will, therefore, connect the constant tone reed when the relay 82 is released and a particular tone is no longer transmitted, so that the vibrations of the constant tone reed will be applied to the tone oscillator 26.

The tone oscillator 26 can be of known circuit configuration. The frequency of the oscillations produced is controlled by the reed connected thereto and through capacitor 96 to the grid of the triode tube 97. As previously stated, the tone frequency is controlled by the reed devices to correspond to the selector connected by the stepping switch, and in the example stated the frequency will correspond to the selector 18.

The potential on conductor 90 is also applied through normally closed contacts 100*a* and 100*b* of relay 100 to the timing circuit including resistor 101 and capacitor 102, which is connected to the minus potential. After a predetermined time interval, the potential on capacitor 102, which is applied to the emitter of unijunction transistor 103, reaches a value which causes the same to fire. The positive potential is then applied through resistor 104 and between the bases of the unijunction transistor 103 to energize the relay 100. When relay 100 operates, contact 100*b* engages contact 100*c* so that capacitor 102 discharges through resistor 101. This removes the positive potential from the unijunction transistor so that it ceases to fire. The positive potential on conductor 90 is applied through capacitor 105 and closed contacts 100*d* and 100*e* so that during charge of capacitor 105 current is supplied through resistor 106 to hold the relay 100 actuated for a predetermined time. Contacts 100*d* and and 100*f* of relay 100 are normally closed so that capacitor 105 discharges through resistor 107. The values of the components are selected so that relay 100 is held actuated for one second. The relay 100 continues to pulse when conductor 90 is energized, being actuated for a duration of one second, and open for a duration of one second, with the open time between pulses being controlled by the time constant produced by the values of resistor 101 and capacitor 102, and the actuated time being controlled by the charge time of capacitor 105.

Relay 100 acts to apply pulses of tones from the tone oscillator 26 to the output terminal connected to the transmitter 28, as will be described. This action takes place through the closing of contacts 100*g* of the relay. In the event that the call is a normal call, the closing of contacts 100*g* of relay 100 applies the positive potential from conductor 90 through the normally closed contacts 111*a* and 111*b* of relay 111, normally closed contacts 112*a* of relay 112, and normally closed contacts 114*a* of relay 114 to conductor 118 which energizes relay 115. Relay 115 is the transmit relay with contacts 115*a* closing when the relay actuates to connect the output 116 of the tone oscillator derived through transformer 98, to the tone output terminal 117. It will be noted that the tone output 116 is also connected to output terminal 117 through normally closed contacts 82*g* of relay 82 when this relay is not operated. This connection is used to apply the constant tone from the tone oscillator to the tone output terminal 117. When a call is placed, relay 82 is operated to open contacts 82*g* and remove the constant tone output. In such case the tone output is applied only through the contacts 115*a* of transmit relay 115.

When relay 115 is energized, movable contact 115*b* engages contact 115*c* so that capacitor 120 charges through resistor 121. Relay 115 will be held actuated only while relay 100 is conducting and contacts 100*g* thereof are closed. When relay 115 releases, the potential on capacitor 120 will be applied through contact 115*d* to conductor 122 to actuate relay 113. Relay 113 pulls in during the discharge time of capacitor 120, and causes contacts 113*a* and 113*b* thereof to close to charge capacitor 123 through resistor 124. Relay 113 is operated only during the discharge time of capacitor 120, and when it releases, contact 113*a* engages contact 113*c* so that the charge of capacitor 123 is applied through diode 125 and conductor 126 to actuate relay 130. When relay 130 is actuated, contacts 130*a* and 130*b* close to charge capacitor 131 through resistor 132. Relay 130 is actuated only through the discharge time of capacitor 123, and when it releases, contact 130*a* engages contact 130*c* so that the charge on capacitor 131 is applied through conductor 133 to relay 114.

Relay **114** operates to close contacts **114***b* thereof, which establish a holding circuit from conductor **90** for relay **114**. Operation of relay **114** opens contacts **114***a* thereof so that the circuit through conductor **118** for energizing relay **115** is open.

The action of relays **113**, **130** and **114** described above is relatively fast and occurs before the relay **100** will pulse a second time. Accordingly, the second pulse from the relay **100** will not be applied to the transmit relay **115**, and only the first pulse will actuate this relay. Therefore, only one pulse of tone will be applied to the transmitter under the conditions described above. As previously stated, this is the condition for a normal call and the nurse hears only one pulse of tone of one second duration.

Considering now the operation in the event that a priority call has been placed at the selector **18**, in such case the positive potential on terminal **36** will energize contact **68***a* on the stepping switch **65**. This potential is applied through the movable arm **68***d* to conductor **134**, and through normally closed contact **110***a* of relay **110** to energize relay **111**. It is to be noted that the other connection in relay **111** is through conductor **135** connected to the movable contact **66***d* of the stepping switch. This applies the negative potential from selector **18** to the relays **110**, **111** and **112** so that when the positive potential from the corresponding selector is applied, the relay is energized from the power supply associated with the selector unit which is operated.

Operation of relay **111** moves contact **111***a* away from contact **111***b* to open the circuit previously described for a normal call. Contact **111***a* engages contact **111***c* so that the positive pulse produced by relay **100** is applied through normally closed contacts **130***d* of relay **130** to conductor **118** which energizes relay **115**. Operation of relay **115** will cause the sequence of operation of relays **113**, **130** and **114** previously described to cause relay **114** to lock in. However, this does not break the connection to conductor **118** through which the pulses are applied to relay **115**, so that the second pulse from relay **100** is applied through this connection to actuate relay **115** a second time, and two pulses are transmitted. The second actuation of relay **115** will again charge capacitor **120** to actuate relay **113**, and this will charge capacitor **123** to actuate relay **130**. However, when relay **130** actuates, contacts **130***e* thereof will close and complete a holding circuit through contact **114***c* of relay **114** which was operated in response to the first pulse. Accordingly, after the second pulse, relay **130** is held operated and contact **130***d* thereof will open to de-energize conductor **118** and release relay **115**, and the system will transmit only two pulses.

Assuming that the call from selector **18** is an emergency call, the potential on terminal **37** will be applied to contact **69***a* of level **69**. This potential will be applied through moving contact **69***d* to conductor **136** which energizes relay **110**. Operation of relay **110** closes contacts **110***b* thereof which applies the positive potential from conductor **83** to conductor **118** which energizes relay **115**. It will be apparent that this will apply the tones from the oscillator **26** to the output terminal **117** independently of operation of the relay **100**. Accordingly, a continuous tone is applied when an emergency call is received for as long as the relay **110** is operated. The relay **110**, of course, will be de-energized if the nurse answers the call so that the potential is removed from the selector **118**. Relay **110** will also be de-energized when the stepping switch moves to a different contact.

Considering now the operation when a telephone call is received, as previously stated terminal **62** will receive a positive potential from the input terminals **38**, **43** and **48** of the selectors. A potential is also applied directly from the telephone control **22** to the automatic control unit **25** when the telephone operator actuates the switch to call the nurse in any section of the hospital. This potential is applied from terminal **137** through diode **138** and resistor **139** to the emitter of unijunction transistor **80**, so that it immediately fires to operate relay **75**. Although it is desirable to delay the operation of the system in response to calls from the nurse call unit since the nurse may receive the call directly therefrom and in such case the radio call is not necessary, for a telephone call, the system will call the nurse as soon as the telephone operator operates the switch to initiate the call. The potential at terminal **62** of the selectors is applied through conductor **140**, normally closed contacts **110***c* of relay **110**, and normally closed contacts **111***d* of relay **111** to energize relay **112**. It should be noted that emergency and priority calls take precedence over telephone calls, and if either of these calls has been placed, the connection through the contacts of relays **110** and **111** is broken, and the telephone call cannot be placed.

Operation of relay **112** closes contacts **112***b* thereof to apply the positive potential pulses produced by actuation of relay **100** through normally closed contacts **113***d* of relay **113** to conductor **118** to operate relay **115**. Relay **115** releases after the first pulse, and the relays **113**, **130** and **114** will operate in sequence as has been described to lock relay **114**. After the second pulse, relays **113** and **130** will operate in sequence and to lock relay **130** as has been previously described in the operation of a priority call. However, since neither relay **114** nor **130** controls the application of the pulses to the conductor **118**, a third pulse will still be applied to operate relay **115**. When the relay **115** releases, the charge on capacitor **120** is applied through conductor **122** to actuate relay **113**. This relay is now locked through the circuit including closed contacts **113***e* and contacts **130***f* of relay **130**. This causes normally close contacts **113***d* to open so that additional pulses from the relay **100** are not transmitted to the relay **115**. Accordingly, for a telephone call, three pulses of tone are applied to terminal **117** and are transmitted from the transmitter **28** to the paging receivers.

The positive potential applied to line **83** by actuation of relay **82** is applied through normally closed contact **85***a* of relay **85** to the charging circuit including resistor **86** and capacitor **87** which is connected to the negative potential. When capacitor **87** charges to a particular value, it will cause the unijunction transistor **88** to fire so that the positive potential is applied through resistor **89** and the base electrodes of the transistor **88** to energize relay **85**. The time constant provided by resistors **86** and capacitor **87** is selected so that transistor **88** will not fire until after a period of eight seconds. During the period before relay **85** operates an emergency call of eight seconds duration can be transmitted, or normal, priority or telephone calls which include one, two or three pulses of one second duration.

When relay **85** operates, contacts **85***a* thereof open so that the positive potential is removed from conductor **90**. This prevents further pulsing action of relay **100**. Contacts **85***b* of relay **85** apply positive potential from contacts **75***c* of relay **75** to relay **142** to actuate the same. This relay closes contacts **142***a* to apply the positive potential through conductor **143** to the stepping switch actuator **71**. This causes the stepping switch to move to the next contact. Accordingly, any calls placed through selector **18** will now be disconnected by the stepping switch. Operation of relay **85** causes **85***c* and **85***d* thereof to close so that relay **85** remains operated for the time required for capacitor **144** to charge. This provides the required minimum delay between operating sequences.

When the stepping switch has moved to the *b* contacts thereof, any calls registered on selector **19** will be transmitted. If no other calls are registered in the system, the stepping switch will stop at the *b* contacts, since normal terminal **55** will be de-energized and relay **75** will be released. If a call is registered on selector **20**, the potential on terminal **55** will cause relay **75** to remain operated and the potential applied through contacts **75***c* will hold the stepping switch energized so that it will step on to the *e* contacts thereof which are connected to selector **20**. It will be apparent that additional selectors can be used and

the stepping switch will continue stepping until the level 67 thereof is energized to actuate relay 82 which opens the connection to the stepping switch actuator through contacts 82*a* and 82*b*. It will be apparent that the normal, emergency, priority and telephone calls will be transmitted in exactly the same way when the call is initiated from selector 19 or 20 as has been described for calls initiated through selector 18.

The automatic radio nurse call system of the invention has been found to be extremely useful, particularly in a hospital in which only one nurse is on duty in a section. This may be the case at night or at other times when the one nurse can take care of the requirements of the patients. Under such conditions the nurse when in a room taking care of one patient will be advised of other calls which are placed. She is also advised of the nature of the call so that if an emergency or priority call is placed she can give this her immediate attention.

A single radio nurse call system can be used to send messages to nurses operating in different sections of a hospital. Each nurse will receive only the calls from her nurse call unit and she will not be bothered by other sections of the hospital. Since a call can be transmitted every eight seconds, even though a plurality of calls are placed at the same time the calls will all be transmitted in a relatively short time. Also, the calls are repeated until answered, so cannot be overlooked by the nurse.

We claim:

1. An automatic radio remote control system including in combination, radio transmitter means, a plurality of radio receivers each adapted to respond to a tone of a particular frequency, a plurality of selector units each having a plurality of input terminals for receiving potentials indicating the presence of different calls, each of said selector units having an output terminal and means producing a potential thereat in response to a potential at any one of said input terminals, control means connected to said output terminals and actuated in response to a potential on any one of said selector units, said control means including stepping means having a plurality of positions each connected to said input terminals of one of said selector units, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of portions individually connected to said positions of said stepping means, said frequency selective means being coupled to said oscillator means through said control means to provide a different frequency for each position of said stepping means, said control means including means for controlling the application of tone signals from said oscillator means to said radio transmitter means in accordance with the potentials applied to said stepping means by said selector units, whereby tone signals are transmitted in response to operation of a particular selector unit which are of a frequency to which a particular receiver responds.

2. An automatic radio remote control system including in combination, a transmitter for transmitting a modulated carrier wave, a plurality of receivers for receiving the wave and each being adapted to respond to a modulating tone of a particular frequency, a plurality of selector units individually associated with said receivers and each having input means for receiving a plurality of calls, each of said selector units having output means and means producing a signal thereat in response to a call at said input means, control means connected to said output means and actuated in response to a signal at any one of said selector units, said control unit including stepping means having a plurality of positions each responsive to said input means of one of said selector units, tone frequency selective means having a plurality of portions individually coupled to said positions of said stepping means, said frequency selective means being operative to provide a tone of a different frequency for each position of said stepping means, said control means operating to apply tone signals to said transmitter in accordance with the signals applied to said stepping means by said selector units, whereby tone signals are transmitted in response to operation of a particular selector unit which are of the frequency to which the associated receiver responds.

3. An automatic radio remote control system including in combination, a radio transmitter, a plurality of remote radio receivers each adapted to respond to a tone of a particular frequency, a plurality of selector units for applying calls to individual receivers and each having a plurality of input terminals for receiving potentials representing the presence of a call, each of said selector units having an output terminal and relay means producing a potential thereat in response to a potential at any one of said input terminals, control means connected to said output terminals and actuated in response to a potential on any one of said selector units, said control means including a stepping switch having a plurality of levels each having contacts for a plurality of positions, means connecting said contacts for each position to said input terminals of one of said selector units, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of resonant devices individually connected to the contacts of one of said levels of said stepping switch, said resonant devices being coupled to said oscillator means through said one level to provide a different frequency for each position of said stepping switch, said control means including relay means for controlling the application of tone signals from said oscillator means to said radio transmitter in accordance with the potentials applied to said switch contacts by said selector units, whereby a tone signal is transmitted in response to operation of each selector unit which is of a frequency to which the associated receiver responds.

4. An automatic radio remote control system for transmiting calls from a plurality of control stations to a plurality of movable remote positions individually associated with the control stations, said system including in combination, a plurality of selector units individually coupled to the control stations and each having input means for receiving signals indicating the presence of different calls, each of said selector units having output means and means producing a signal thereat in response to a call at said input means, control means connected to said output means and actuated in response to a signal at any one of said selector units, said control means including stepping means having a plurality of positions each responsive to said input means of one of said selector units, tone frequency selective means having a plurality of portions individually coupled to said positions of said stepping means, said frequency selective means being operative to provide a different frequency for each position of said stepping means, radio transmitter means, said control means being operative to apply tone signals to said radio transmitter means in accordance with the signals at said selector units, said transmitter means transmitting waves modulated by tone signals of frequencies individual to the signals from the selector units, and a plurality of radio receivers for receiving the transmitted signals at the remote positions, each of said receivers responding only to a particular tone frequency to thereby reproduce calls from one selector unit.

5. An automatic radio remote control system for transmitting calls from a plurality of control stations to a plurality of movable remote positions individually associated with the control stations, said system including in combination, a plurality of selector units individually coupled to the control stations and each having input means for receiving signals indicating the presence of different calls, each of said selector units having output means and means producing a signal thereat in response to a call at said input means, control means connected to said output means and actuated in response to a signal at any one of said selector units, said control means including stepping means having a plurality of positions each responsive to

said input means of one of said selector units, tone frequency selective means having a plurality of portions individually coupled to said positions of said stepping means, said frequency selective means being operative to provide a different frequency for each position of said stepping means, radio transmitter means, said control means being operative to apply tone signals to said radio transmitter means representing signals at said selector units with signals representing individual selector units being applied in turn, said control means including means for pulsing said tone signals to identify the different calls at the individual selector units, said transmitter means transmitting waves modulated by tone signals of frequencies individual to the selector units, and a plurality of radio receivers for receiving the transmitted signals at the remote positions, each of said receivers responding only to a particular tone frequency to thereby reproduce calls only from one selector unit.

6. An automatic remote control system including in combination, a plurality of selector units each having a plurality of input terminals for receiving potentianls indicating the presence of different calls, each of said selector units having an output terminal and means producing a potential thereat in response to a potential at any one of said input terminals, control means connected to said output terminals and actuated in response to a potential on any one of said selector units, said control means including stepping means having a plurality of portions rendered active in turn, each of said portions being connected to said input terminals of one of said selector units, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of portions individually connected to said portions of said stepping means, said frequency selective control means being coupled to said oscillator means through said control means to provide a different frequency for each portion of said stepping means, said control means including means for controlling the transmission of tone signals from said oscillator means in accordance with the potentials applied to said stepping means by said selector units.

7. An automatic remote control system including in combination, a plurality of selector units each having input means for receiving signals indicating the presence of different calls, each of said selector units having an output terminal and means producing a signal thereat in response to a signal at said input means, a control unit connected to said output means and actuated in response to a signal at any one of said selector units, said control unit including stepping means having a plurality of positions coupled to said input means of said selector units respectively, tone oscillator means connected to said control unit and controlled thereby, frequency control means having a plurality of portions individually coupled to said positions of said stepping means, said frequency control means being coupled to said oscillator means through said control means to provide a different frequency for each position of said stepping means representing the selector unit coupled thereto, said control unit applying tone signals from said oscillator means representing individual selector units in turn, said control means including means for pulsing the tone signals to identify different calls in accordance with the signals at said input means of the individual selector units.

8. An automatic radio nurse call system for transmitting signals from nurse call stations to nurses at positions remote from said stations, said system including in combination, a plurality of selector units each adapted to be coupled to a nurse call station and having a plurality of input terminals for receiving potentials representing different calls placed at such station, each of said selector units having an output terminal and relay means producing a potential thereat in response to a potential at any one of said input terminals, control means connected to said output terminals and actuated in response to a potential on any one of said selector units, said control means including a stepping switch having a plurality of levels each with a contact for each position of said switch, means connecting contacts for each position to said input terminals of individual selector units, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of resonant devices individually connected to the contacts of one of said levels of said stepping switch, said resonant devices being coupled to said oscillator means through said one level to provide a different frequency for each position of said stepping switch, a radio transmitter, said control means including relay means for applying tone signals from said oscillator means to said radio transmitter in accordance with the potentials at said input terminals of said selector units, said transmitter transmitting waves modulated by tone signals of frequencies individually associated with said selector units, and a plurality of radio receivers adapted to be carried by a nurse for receiving the transmitted signals, each of said receivers responding only to a tone of the frequency associated with one selector unit so that each nurse receives only calls placed at one nurse call station.

9. An automatic radio nurse call system for transmitting signals from nurse call stations to nurses at positions remote from said stations, said system including in combination, a plurality of selector units each adapted to be coupled to a nurse call station and having a plurality of input terminals for receiving potentials representing different calls placed at such station, each of said selector units having an output terminal and relay means producing a potential thereat in response to a potential at any one of said input terminals, control means connected to said output terminals and actuated in response to a potential on any one of said selector units, said control means including a stepping switch having a plurality of levels each with a contact for each position of said switch, means connecting contacts for each position to said input terminals of individual selector units, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of resonant devices individually connected to the contacts of one of said levels of said stepping switch, said resonant devices being coupled to said oscillator means through said one level to provide a different frequency for each position of said stepping switch, a radio transmitter, said control means including relay means for applying tone signals from said oscillator means to said radio transmitter in accordance with the potentials applied to said selector units, with tone signals of frequencies representing calls from different selector units being transmitted in turn, said control means including timing means for pulsing said tone signals to identify different calls at the selector units, said transmitter transmitting waves modulated by said pulsed tone signals, and a plurality of radio receivers adapted to be carried by a nurse for receiving the transmitted signals, each of said receivers responding only to a tone of the frequency associated with one selector unit so that each nurse receives only calls placed at one nurse call station.

10. An automatic radio nurse call system for transmitting signals from nurse call stations which provide normal, priority and emergency calls to nurses at positions remote from said stations, said system including in combination, a plurality of selector units each adapted to be coupled to a nurse call station and having a plurality of input terminals for receiving potentials representing different calls placed at such station, each of said selector units having an output terminal and relay means producing a potential thereat in response to a potential at any one of said input terminals, control means including delay means connected to said output terminal for causing delayed actuation of said control means, said control means including a stepping switch having a plurality of levels each with a contact for each selector unit, means connect-

ing said input terminals of individual selector units to predetermined contacts of said levels of said stepping switch, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of resonant devices individually connected to the contacts of one of said levels of said stepping switch, said resonant devices being coupled to said oscillator means through said one level to provide frequencies individually associated with said positions of said stepping switch, a radio transmitter, said control means including pulsing means for pulsing the tone signals from said oscillator means and relay means connected to said stepping switch for controlling the application of said tone pulses to said radio transmitter in accordance with the potentials at said input terminals of said selector units, said relay means applying one pulse of tone to indicate a normal call and two pulses of tone to indicate a priority call, said control means acting to apply a continuous tone signal to indicate an emergency call, said control means including sequence means coupled to said stepping switch to cause said stepping switch to stop at the position having contacts connected to a selector unit at which a call is placed to transmit a tone signal representing such call and then to step to the next position connected to a selector unit at which a call is placed and to transmit a tone representing such call, and a plurality of radio receivers each adapted to be carried by a nurse for receiving the transmitted signal, each of said receivers responding only to a tone signal of the frequency associated with one selector unit so that each nurse receives only calls placed at one nurse call station.

11. An automatic radio nurse call system for transmitting signals from nurse call stations for providing normal, priority, emergency and telephone calls to nurses at positions remote from said stations, said system including in combination, a plurality of selector units each having a plurality of input terminals, means coupling a number of said input terminals to a nurse call station so that potentials representing different calls placed at such station are applied to said terminals, telephone calling means connected to each selector unit for applying a potential to one of said input terminals to indicate a telephone call, each of said selector units having an output terminal and relay means producing a potential thereat in response to a potential at any one of said input terminals, control means connected to said output terminal through delay means to cause delayed actuation of said control means, means connecting said telephone calling means directly to said control means to cause operation of said control means without delay, said control means including a stepping switch having a plurality of levels each with a contact for each selector unit, means connecting said input terminals of individual selector units to predetermined contacts of said levels of said stepping switch, said control means including sequence means coupled to said stepping switch to cause said stepping switch to stop at the position having contacts connected to a selector unit at which a call is placed to transmit a tone signal representing such call and then to step to the next position connected to a selector unit at which a call is placed, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of resonant devices individually connected to the contacts of one of said levels of said stepping switch, said resonant devices being coupled to said oscillator means through said one level to provide a different frequency for each position of said stepping switch, a radio transmitter, said control means applying tone signals from said oscillator means to said radio transmitter in accordance with the potentials applied to said selector units, said control means including pulsing means for pulsing said tone signals and relay means connected to said stepping switch and controlled thereby for applying one pulse in response to a potential representing a normal call, two pulses in response to a potential representing a priority call and three pulses in response to a potential representing a telephone call, said control means acting to apply a continuous tone to indicate an emergency call, and a plurality of radio receivers each adapted to be carried by a nurse for receiving the transmitted signal, each of said receivers responding only to a tone signal of the frequency associated with one selector unit so that each nurse receives only calls placed at one nurse call station.

12. An automatic radio nurse call system for transmitting signals from nurse call stations and from telephone calling apparatus to nurses at positions remote from said stations, said system including in combination, a plurality of selector units each having a plurality of input terminals, means coupling a number of said input terminals to a nurse call station so that potentials representing different calls placed at such station are applied to said terminals, means coupling the telephone calling means to each selector unit to apply a potential to one of said input terminals to indicate a telephone call, each of said selector units having an output terminal and relay means producing a potential thereat in response to a potential at any one of said input terminals, control means including delay means connected to said output terminals for causing delayed actuation of said control means selector units, means connecting said telephone calling means directly to said control means to cause operation of said control means without delay, said control means including a stepping switch having a plurality of levels each with a contact for each selector unit, means connecting said input terminals of individual selector units to predetermined contacts of said levels of said stepping switch, tone oscillator means connected to said control means and controlled thereby, frequency selective means having a plurality of resonant devices individually connected to the contacts of one of said levels of said stepping switch, said resonant devices being coupled to said oscillator means through said one level to provide a different frequency for each position of said stepping switch, a radio transmitter, said control means applying tone signal from said oscillator means to said radio transmitter in accordance with the potentials applied to said selector units, and a plurality of radio receivers each adapted to be carried by a nurse for receiving the transmitted signal, each of said receivers responding only to a tone signal of the frequency associated with one selector unit so that each nurse receives only calls placed at one nurse call station.

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