Sept. 30, 1952 J. E. KREINER 2,612,551

PAGING SYSTEM

Original Filed Feb. 26, 1949 2 SHEETS—SHEET 1

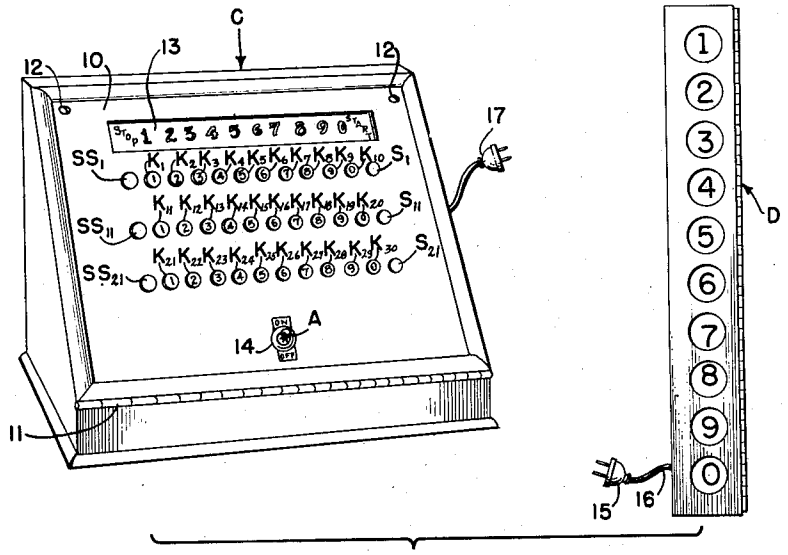


FIG. 1

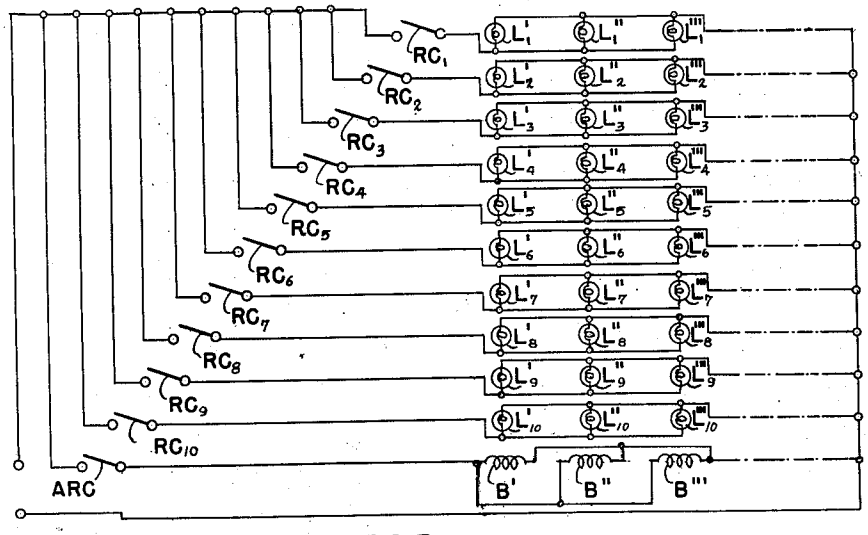


FIG. 3

INVENTOR.
JOHN E. KREINER

BY Hoag, Kilburn & Carlson

ATTORNEYS

Sept. 30, 1952 J. E. KREINER 2,612,551

PAGING SYSTEM

Original Filed Feb. 26, 1949 2 SHEETS—SHEET 2

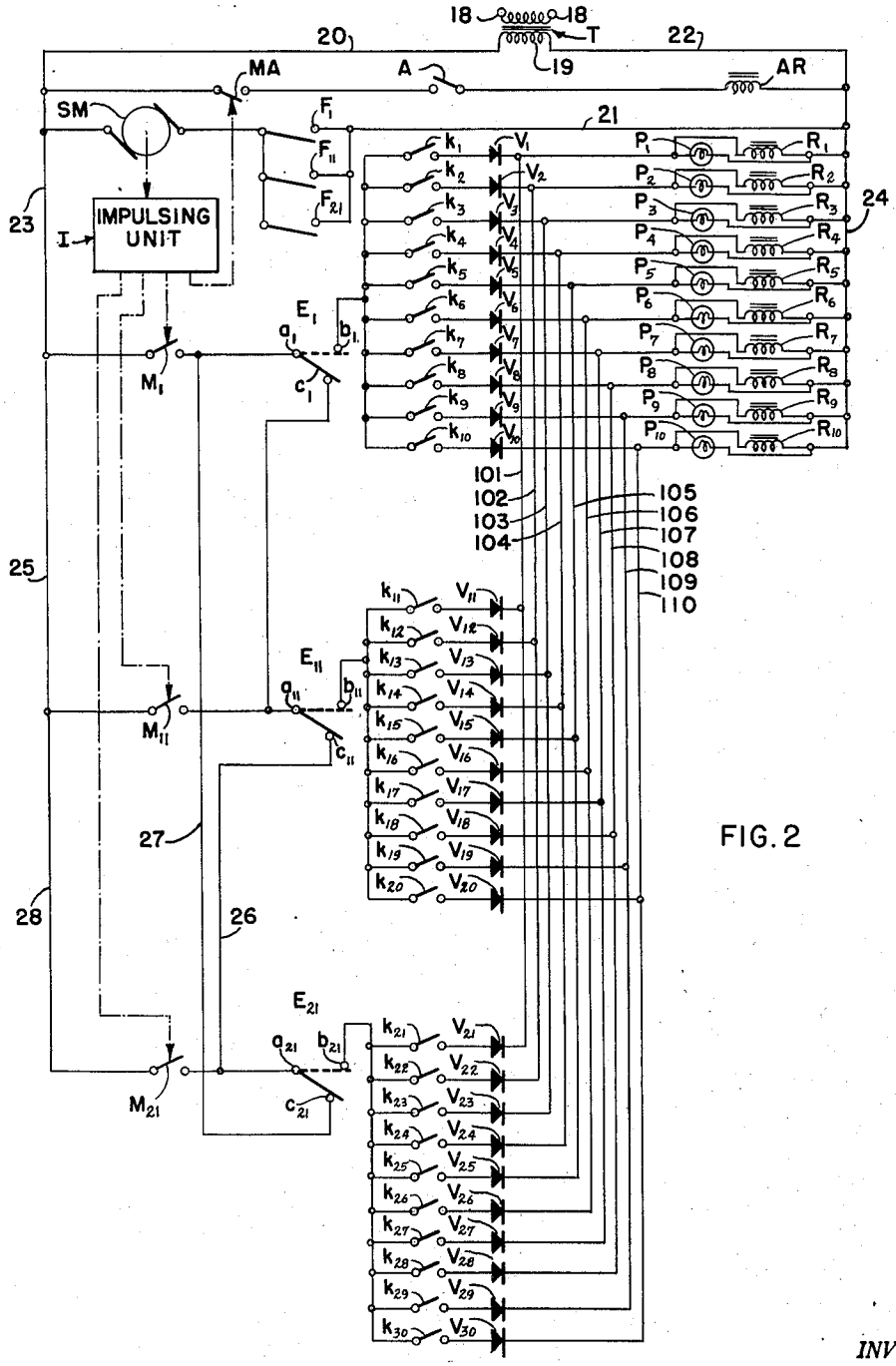


FIG. 2

INVENTOR.
JOHN E. KREINER

BY Hoag, Kilburn and Carlson

ATTORNEYS

Patented Sept. 30, 1952 2,612,551

UNITED STATES PATENT OFFICE

2,612,551

PAGING SYSTEM

John E. Kreiner, Palatine, Ill., assignor to Edwards Company, Inc., Norwalk, Conn., a corporation of New York

Continuation of application Serial No. 78,657, February 26, 1949. This application April 7, 1951, Serial No. 219,834

9 Claims. (Cl. 177—353)

1

This invention relates to signalling systems for initiating signals locally and selectively for controls at one or more remote points; this application is a continuation of my application Serial No. 78,657, filed February 26, 1949, now abandoned.

The present invention relates to signalling systems employing both visual and audible signals. More particularly, it relates to that kind of a system in which a coded visual and audible signal is reproduced at a number of stations distantly located from the operator of the system as well as upon a monitor located to be readily and conveniently observed by the operator. Such systems are of use in paging personnel in hospitals, industrial offices, or other commercial buildings, and manufacturing plants. A system of this type is of particular use as a doctor's paging system in a hospital, and in the preferred embodiment of the invention hereinbelow described, for convenience and simplicity, it will be described in terms of such use. However, it is to be understood that the invention is not limited to such specific use, but may be applied to any of the other uses for which it is suitable.

Prior art code signalling and paging systems are subject to many operating disadvantages. For practical use it is necessary that such a system be capable of producing a relatively large number of different visual code symbols at the outlying signal stations. In practice it is desirable to use a flashing indicator at the outlying stations in which a number of digits are arranged in line and a combination of these, always read in the same direction and order, form the code signal. If the digits 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 are arranged at a signalling station in a straight line, either horizontal or vertical, it is obvious that one hundred and twenty different code symbols, such as **123**, **124**, **134**, **145**, etc., may be obtained by using no more than three digits at a time. For most practical purposes this is sufficient, but it is obvious that this number, one hundred and twenty, may be greatly increased by using also code symbols of one digit, two digits, or more than three digits. Although there is no additional mechanical or electrical difficulty in arranging a system of the type herein contemplated to use code symbols of fewer or greater than three digit combinations, experience in practical operation and use of such systems has shown that one limited to producing three digit combinations causes a minimum of confusion and error among those using the system.

It is highly desirable that code symbols for more than one person can be set up on the system and can be shown at the signal stations at practically the same time, that is, one following the other in rapid succession. Here again experience has taught that in most installations it is sufficient if the code symbols for three persons can be set up on the system simultaneously. In some installations it may be desirable to have a system on which more than three code symbols can be set up simultaneously, but such instances are the exception.

2

Accordingly, in the following discussion of the prior art and its deficiencies and in the description of an embodiment of the present invention, a system using combinations of three digits for its code symbols and capable of producing three code symbols simultaneously will be considered, but it is to be understood that when so desired the present invention is readily applicable to a system employing other combinations of digits for code symbols and producing more or less than three code symbols simultaneously.

In order to accomplish these two desired results, that is, a relatively large number of code symbols and the presentation of more than one code symbol at a time, there has been required in the prior art systems very expensive and complicated selecting and operating devices. These have included commutator devices having at least one pole for each individual signal circuit and which are driven continuously during the operation of the system and cause contact of every pole each revolution, relay-operated contacts for each light flashed, and at least one timing relay for each set of code symbols set up on the system. Such complicated devices have numerous disadvantages. The use of a continuously driven commutator causes wear on all moving parts whether the corresponding code symbols are being exhibited or not, thus causing excessive noise and requiring frequent replacement. Every make-and-break commutator contact and relay contact point causes sparking with resultant pitting and sticking of such contact points, thus requiring frequent replacement or maintenance. The commutators that have been employed are extremely complicated in design and thus are costly, as are the multi-pole relays and multiple contact relays which have been used.

These objections to and disadvantages of the prior art systems are overcome in a system constructed in accordance with the present invention which eliminates the use of a commutator with a large number of poles and reduces the number of relays in the control circuits of the system to one single contact relay located for each digit employed in forming the code symbol combinations.

It is thus an object of the present invention to provide a system in which one or more coded visual and audible signals can be set up and flashed intermittently and in sequence at distant signal stations and in which no part is being driven when the system is not in operation, and in which the number of contacts at which electric current is made and broken during operation of the system is reduced to a minimum.

It is a further object of this invention to provide such a system in which the number of parts subject to wear and to the effect of sparking is reduced to a minimum.

It is a further object of this invention to provide such a system in which all the control elements and connections are arranged to be contained in a housing which is adapted to serve also as an operating switchboard and monitor.

It is a further object of this invention to provide such a system which is positive and dependable in operation and can be manufactured economically.

Another object is to provide a signalling system of the above-mentioned general type in which efficient use is made, for signal transmission, of each successive portion of a complete cycle throughout the operation of the system, particularly where the number of code symbols to be transmitted during any one cycle is less than the full capacity of the particular cycle of the system; another object is to carry out this object in a practical, inexpensive, and dependable manner.

Another object is to provide a signalling system of the just-mentioned type in which each of the successive portions of a complete cycle is automatically caused to function for signal transmission even though the full capacity per cycle to transmit different code symbols is not utilized.

Another object is to achieve, in a dependable, inexpensive, and efficient manner, the automatic allocation for signal transmission of such of the successive portions of a complete signalling cycle as are idle or unallocated so long as one or more of them is otherwise functioning and allocated for selective signal transmission.

The invention accordingly consists in the features of construction, combinations of elements, and arrangements of parts as will be exemplified in the structure to be hereinafter described and the scope of the application of which will be indicated in the following claims.

Various other objects, advantages, and features of the invention will become apparent from the following detailed description taken in conjunction with the appended drawings, in which—

Fig. 1 is a perspective view of the control box showing the arrangement of the control keyboard and indicating monitor which shows, in a diagrammatic way, one of the outlying signal stations;

Fig. 2 is a schematic drawing of the electric devices and their associated circuits employed in the operation and control of the system; and

Fig. 3 is a schematic circuit diagram showing the manner in which the lamps and buzzers at the outlying signal stations are operated by the relays in the control circuits.

Referring to Fig. 1, C is the control box which is located conveniently near the operator of the system and which contains all of the control apparatus and control circuits of the system, the arrangement and functioning of which will be more fully explained hereinbelow. Control box C may be of any suitable shape and size to provide for the housing of the necessary devices and their associated circuits. Preferably it has top face 10 which is mounted at an angle so that, as the operator faces it, it slants downward toward the operator. It is secured to the rest of the control box by hinge 11 and screws 12. Thus, by removing screws 12, top face 10 may be swung forward and down so that all the operative parts of the system are readily accessible for inspection, adjustment, or repair. All of the operating keys and the indicating monitor are mounted on top face 10. The indicating monitor 13 may be formed by inserting in top face 10 a piece of opaque material, such as coated glass, with the characters 1, 2, 3, 4, 5, 6, 7, 8, 9, and 0 etched thereon in such a manner that these characters form translucent portions through which small incandescent bulbs can throw their light when they are illuminated. It is to be understood that these characters may be formed in any other suitable way, as by having a strip of material into which they have been cut underlying a pane of glass or translucent plastic material. Below indicating monitor 13 there are arranged three rows of selector keys or push buttons K_1 to K_{10}, K_{11} to K_{20}, and K_{21} to K_{30}, respectively. The selector keys in each row bear numbers 1 to 9 and 0. At each end of each row of selector keys are placed additional keys or push buttons, one group of three S_1, S_{11}, and S_{21} at the right, as viewed in Fig. 1, are starting keys, and one group of three SS_1, SS_{11}, and SS_{21} at the left, as viewed in Fig. 1, are stopping keys. Starting and stopping keys S_1, S_{11}, S_{21}, SS_1, SS_{11}, and SS_{21} each control multiple contact switches, the operation of which will be described in more detail hereinbelow. The selector keys are arranged so that the numbers thereon are directly in line with the corresponding numbers on indicating monitor 13, and starting keys S_1, S_{11}, and S_{21} are placed directly below the word "Start" and SS_1, SS_{11}, and SS_{21} directly below the word "Stop" etched or otherwise shown on indicating monitor 13 at the ends of the row of digits shown thereon. A switch, preferably a toggle switch, A is mounted in an escutcheon 14 which is marked "on" and "off" to show the respective position of switch A and is located below the above-described rows of keys or in any other suitable location. Switch A controls the operation of audible signalling devices such as buzzers.

The detailed mode of operation of the system will be explained at greater length hereinbelow, but at this point it appears desirable to explain briefly the mode of operation from the operator's standpoint.

If it is desired to call a doctor whose code symbol, say, is "146," the operator depresses selector keys K_1, K_4, and K_6 and then depresses starting key S_1 on the same row as selector keys K_1, K_4, and K_6. The selector keys and starting keys operate switches of conventional design which are of the lock type, that is to say, remain in their depressed positions until released. This action causes the proper lamps L'_1, L'_4, L'_6, L''_1, L''_4, L''_6, etc., to light and flash "146" at the various outlying signal stations, such as D, and also to appear on indicating monitor 13. This flashing both at the outlying stations and on the indicating monitor will continue until the operator depresses stopping key SS_1, which releases the switches actuated by selector keys K_1, K_4, K_6 and starting key S_1, thus stopping the flashing of the signal.

If at any time during the flashing of a signal

the operator desires to produce an audible signal in addition to the visual signal, he may do so by pulling switch A to its "on" position. This will cause an intermittent audible signal to be produced at each outlying signal station D, while switch A remains in that position.

Should the operator desire to call a second doctor at the same time that the doctor whose code symbol is "146" is being called, the procedure described above for calling the doctor whose code symbol is "146" having been followed, the operator depresses selector keys in the second row representing the second doctor's code symbol, say "257"—that is, K_{12}, K_{15}, and K_{17}—and depresses starting key S_{11}. Both code symbols "146" and "257" will flash at the outlying signal stations D and on indicating monitor 13 in a sequence hereinbelow described.

Likewise, the call for a third doctor whose code symbol is, say, "670," may be added by the operator depressing selector keys K_{26}, K_{27}, and K_{30} and starting key S_{21}. This will result in all three code symbols "146," "257," and "670" being flashed intermittently and in sequence at the outlying signal stations D and on indicating monitor 13.

When it is desired to stop flashing the code symbol of any one doctor when more than one is being paged, without interrupting the paging of the others, this may be done merely by depressing the proper stopping key SS_1, SS_{11}, or SS_{21}. For example, should the doctor whose code symbol is "257" answer the call of the operator, the flashing of that code symbol may be stopped by the operator depressing stopping key SS_{11}.

Likewise, it is to be understood that the creation of an audible signal is entirely dependent on the position of switch A and that such signal can be started or stopped at any time during the flashing of one or more code symbols by operating switch A.

The foregoing has explained the general mode of operation from the standpoint of one operating the system and of the end results. It now remains to explain how this is accomplished in a direct, simple, foolproof, and efficient manner by the use of simple devices associated in novel circuits to accomplish this end.

The signals may be arranged at the outlying signal stations D in any manner desired so long as a visual indication of a number of combinations of one or more digits or similar characters is possible. The usual arrangement is to have a column of incandescent lamps arranged in separate compartments in a housing with a numbered translucent window for each lamp. These lamps may be supplied with current from the usual house lighting or power supply circuit of the usual voltage of 115 or 230 volts, and which is usually A. C., and are connnected to such circuit in any convenient manner either permanently or by a wall plug 15 and cable 16 as shown in Fig. 1. Their respective circuits are preferably relay-controlled. It is to be understood that there may be as many outlying signal stations D as desired.

Referring to Fig. 3, the manner in which lamps L'_1, L'_2, etc., L''_1, L''_2, etc., and L'''_1, L'''_2, etc., are connected to the power supply, is shown. These lamps are connected across the terminals of such a supply with a relay-operated switch, such as RC_1, in the circuit of each group of lamps L'_1, L''_1, L'''_1, etc., of the same digit. All lamps of the same digit are preferably parallel to each other. Thus, when one of these relay-operated switches, such as RC_1, is closed, as will be more specifically described hereinbelow, the lights at all the outlying signal stations corresponding to that particular digit will be lighted. Likewise, the audible signal devices such as buzzers, as shown at B', B'', and B''', at the outlying signal stations are connected across the same supply as lamps L'_1, L''_1, L'''_1, etc., and controlled by a relay-operated switch ARC.

In Fig. 2 there is shown in a schematic manner the wiring of the control circuits contained in control box C. For a clear understanding of the invention, it should be noted at the outset that the series of relays R_1 to R_{10}, inclusive, close contacts RC_1 to RC_{10}, inclusive, shown in Fig. 3, and relay AR closes contact ARC, also shown in Fig. 3, when current is running through the respective relay windings. Therefore, when current is flowing through any one or more of relays R_1 to R_{10}, inclusive, or relay AR, respective lamps L'_1, etc., are lighted at the outlying signal stations and an audible signal is produced at those stations by buzzers B', B'', and B'''. With this understanding in mind, it is unnecessary to describe further the functioning of the lamps at the outlying signal stations D, and the description may be simplified by writing it in the terms of the functioning of the pilot lamps P_1 to P_{10}, inclusive, in the indicating monitor 13 which are in parallel with the respective coils of the relays R_1 to R_{10}, inclusive. Generally in installations the relays R_1 RC_1 to R_{10} RC_{10}, AR ARC and the supply transformer T (where the system is to be operated by alternating current) are not actually contained in control box C, since no particular purpose would be accomplished thereby and to so include them would unnecessarily increase the size of the control box.

The primary of a step-down transformer T is connected across the input terminals 18. As above stated, transformer T is conveniently located remotely from the control box C, and in the usual installation the circuits included in control box C start with the terminals of secondary 19 of transformer T. The control circuits are connected across this secondary 19. Although transformer T may be designed to give any desired low voltage for operation of the control circuits, it has been found in practice that a potential of 24 volts is adequate for proper operation of the control circuits and is sufficiently low to prevent any detrimental effect in the few make-and-break points in the control circuits. Further, when only a direct current source of supply is available, transformer T may be replaced by a suitable potentiometer, or, if of proper voltage, such supply may be directly connected. The only other change required in the system for direct circuit operation would be the replacement of the synchronous or other suitable type of A. C. motor hereinbelow described by a suitable direct current device.

The control circuit for the audible signals is connected across secondary 19 of transformer T and comprises, in series, switch M_A, the opening and closing of which is determined by a synchronous motor-driven impulsing unit I, in a manner to be described hereinbelow; switch A, the position and physical form of which are shown in Fig. 1; and the winding of audible signal relay AR, whose armature or contact ARC (see Fig. 3) functions to close the audible signal circuits in the 110-volt line across which the buzzers B', B'', B''', etc., of the outlying signal stations D are connected. It is thus seen that

the winding of audible signal relay AR is energized and the circuit operating buzzers B', B'', B''', etc., is closed only when both switches M_A and A are closed.

There are three sets or banks of visual signal control circuits, one set for each row or bank of selector keys K_1, K_{11}, K_{21}. Each of these sets or banks of circuits includes pilot lights P_1, P_2, P_3, etc., and the respective windings of visual signal relays R_1, R_2, R_3, etc., which are conveniently in shunt with their respective pilot lights and the contacts RC_1, RC_2, RC_3, etc., of which (see Fig. 3) operate the circuits to light the signal lamps at the outlying stations D. There is also included in each of these sets of control circuits a switch M_1, M_{11}, or M_{21} operated by impulsing unit I which, as above stated, also operates switch M_A, a switch E_1, E_{11}, or E_{21} operated by starting keys S_1, S_{11}, or S_{21}, and stopping keys SS_1, SS_{11}, or SS_{21}, respectively, in a manner to be described hereinafter, and a series of selector switches k_1, k_2, etc., k_{11}, k_{12}, etc., or k_{21}, k_{22}, etc., operated by a correspondingly numbered selector key (see Fig. 1). It is to be understood that there is one impulsing switch, such as M_1, and one switch, such as E_1, for each group or bank of control circuits, and one selector switch, such as k_1, for each circuit in each group of circuits. Thus, referring to Fig. 2, the three banks or groups of selective circuits having respectively the selector switches k_1, k_2, etc., k_{11}, k_{12}, etc., and k_{21}, k_{22}, etc., have normally allocated to them, respectively, the pulsing switches M_1, M_{11}, and M_{21} which, as later explained, are successively actuated during each cycle, each for a certain fraction of the cycle, and the groups of selective circuits may be subjected to the control of their respectively allocated impulsing switches M_1, M_{11}, and M_{21} by the switches E_1, E_{11}, and E_{21}, respectively. However, as later explained, I provide means for automatically re-allocating the impulse switch (M_1, M_{11}, or M_{21}) in response to idle or deenergized condition of its group of selector switches, to the additional pulsing of the circuit of an active or energized group of selector switches. In each circuit, between the selector switch, such as k_1, and the corresponding pilot lamp P_1 and relay R_1, there is interposed a one-way current device V_1, such as a metal oxide half-wave rectifier, which allows passage of current in the one direction, that is, selector switch to pilot lamp, but prevents the passage of current in the opposite direction, thus preventing the establishment of current paths for undesired currents in that direction.

A motor, preferably a constant-speed motor, shown in Fig. 2 at SM, is used to drive impulsing unit I. It is preferably a synchronous motor of any suitable form and need not be described in detail here since the design and characteristics of such motors are well known to those skilled in the art. Suffice it to say that a synchronous motor is chosen to have the proper number of revolutions per minute for the voltage and frequency used to cause impulsing unit I associated therewith to open and close switches M_A, M_1, M_{11}, and M_{21} the desired number of times per minute. Synchronous motor SM is connected across secondary 19 of transformer T, but switches F_1, F_{11}, and F_{21} are interposed in that circuit so that synchronous motor SM will run only when one or more of these switches is closed. Switches F_1, F_{11}, and F_{21} are mechanically connected to starting keys S_1, S_{11}, and S_{21} and stopping keys SS_1, SS_{11}, and SS_{21}, respectively.

In the present embodiment, where three code symbols can be set up on the keyboard at once, switches M_1, M_{11}, and M_{21} preferably are arranged so that one of them is closed for each 120° portion of a cycle of operation of the system and are closed in the order stated. If the system is to accommodate more or less than three code symbols at the same time, the arrangement and number of these successively operated switches would be altered so each one would still close once for each cycle of operation of the system and the number of groups of selector circuits and starting switches correspondingly changed. In the present embodiment, switch M_A closes once for each cycle of operation of the system but, if desired, switch M_A may readily be designed to close each time one of the switches M_1, M_{11}, or M_{21} closes, that is, three times each cycle. However, it is not generally considered desirable in systems of this type to have the audible signal repeated every time a visual signal is flashed; therefore switch M_A, in most installations, is arranged to close only once for each cycle of operation although three visual signals are flashed during that time.

All of the starting and stopping switches E_1, E_{11}, and E_{21} and F_1, F_2, and F_3 are preferably and conveniently of similar construction. Depression of starting key S_1 closes motor-circuit switch F_1 and closes group-selector switch E_1 at contact b_1 of the latter, thus putting the corresponding group of selective circuits (the upper group, in Fig. 2) in active condition where it can be energized under the control of the impulsing unit; the normally at-rest position of these switches F_1 and E_1, which can be single-pole switches, is open, being closed upon depression of the starting key S_1 and opened upon depression of the stopping key SS_1, (Fig. 1). In similar manner, depression of starting key S_{11}, after the desired selector keys are depressed, in the second row or bank in Fig. 1, and thus closing corresponding switches (k_{11}, k_{12}, etc.) in the second bank of Fig. 2, closes normally open starting switches F_{11} and E_{11}. Similarly, depression of starting key S_{21}, in the third bank or row of Fig. 1, effects closure of normally open starting switches F_{21} and E_{21}. These switches, as indicated, may be single-pole switches, and when all three group-selector switches E_1, E_{11}, and E_{21} are closed, the corresponding groups of selector switches are connected in circuit, respectively, with the impulse switches M_1, M_{11}, and M_{21} normally respectively allocated thereto.

Provision is made, however, in case all of the groups of selective circuits are not placed in activated condition, to re-allocate, in response to idle or de-activated condition of the inactive group or groups, the pulsing switch or switches normally allocated to them and during the cycles make such pulsing switch or switches effective to repeat the signalling effected through an active group or bank of selective circuits. A convenient means for this purpose comprises the provision of a back contact for each of the switches E_1, E_{11}, and E_{21}, shown in Fig. 2 at c_1, c_{11}, and c_{21}, respectively, with circuit connections respectively leading therefrom to the pulsing switches other than those normally allocated to the respective groups of selective circuits, these back contacts and circuit connections becoming effective according as their respective groups of circuits are de-activated, as by opening of switch E_1 or E_{11} or E_{21}. Thus a conductor 27 leads from back contact c_{21} of starting switch E_{21} of

the third group of circuits to the contact of pulsing switch M_1 which is normally allocated to the first group of circuits; a conductor **26** leads from the back contact c_{11} of the second group-selector or starting switch E_{11} to the contact of pulsing switch M_{21} which is normally allocated to the third group; and, as shown, a conductor leads from the back contact c_1 of the first group-selector or starting switch to the switch contact of pulsing switch M_{11} which normally serves the second group of selective circuits. How this arrangement responds to different conditions is later described in detail. While the sequence of direct electrical connections from the group-selector switches E_1, E_{11}, and E_{21} to the contacts of the sequence switching devices M_1, M_{11}, and M_{21} is in the order just named, the electrical connections from the back contacts c_1, c_{11}, c_{21} are in the sequence c_1, to M_{11}, c_{11} to M_{21}, and c_{21} to M_1, being in effect a phase displacement of one time interval (illustratively, 120°) of the cycle.

As above stated, starting keys S_1, etc. (see Fig. 1), and selector keys K_1, etc., when depressed, remain in that position until released. This release is accomplished by depressing the respective stopping key SS_1. When stopping key SS_1 is depressed, starting key S_1 and whichever of selector keys K_1, etc., had been depressed are released, and the corresponding selector switches k_1, etc., are opened and switch E_1 returns to its normal position, breaking the circuit from a_1 to b_1 and closing the circuit from a_1 to c_1. Likewise, switch F_1 is opened and synchronous motor SM stops, unless energized through one of the other switches F_{11} or F_{21} that may be in a closed position.

To explain the operation of the system and the functioning of the various elements in the control circuits, the same series of examples will be used that were described hereinabove when the operation from the operator's viewpoint was discussed. When the operator desiring to send out the code symbol "146" depresses selector keys K_1, K_4, and K_6, corresponding switches k_1, k_4, and k_6 are closed. The next operation, depressing starting key S_1, closes corresponding switches E_1 and F_1. These manual operations the operator performs in the uppermost or top row of keys as seen in Fig. 1, and in this assumed illustration, since no other code symbols are to be set up and transmitted, the operator leaves the second and third rows or banks of keys (in both Figs. 1 and 2) alone, though they are usable to set up two more code symbols, as will be later pointed out. In the circuit diagram of Fig. 2, with switch E_1 closed, the circuits of the upper bank are placed directly under the control of pulsing switch M_1 which may be said to be normally allocated to that upper bank. When impulsing unit I closes switch M_1, current will pass through pilot lamps P_1, P_4, and P_6 and relay windings R_1, R_4 and R_6. This circuit may be traced as follows: from secondary **19** through leads **20** and **23**, switch M_1, contact a_1 to b_1 of switch E_1 and then in three branches switch k_1, rectifier V_1, pilot lamp P_1, and relay winding R_1; switch k_4, rectifier V_4, pilot lamp P_4, and relay winding R_4; and switch k_6, rectifier V_6, pilot lamp P_6, and relay winding R_6 to return leads **24** and **22** back to secondary **19**. With relays R_1, R_4, and R_6 energized, the corresponding digits making out the coded symbol "146" are flashed at the remote station or stations D, for that portion of the cycle of the system during which switch M_1 remains closed.

As synchronous motor SM rotates, switch M_1 will open and switch M_{11} will close. Though switch M_1 is thus opened and would remain open for the rest of the cycle, a condition which otherwise would maintain relays R_1, R_4, and R_6 de-energized for the rest of the cycle, I make provision for bringing these relays under the control of the next impulsing switch to be closed, which, as just noted, is switch M_{11}, and that becomes allocated to serve the first or upper bank of circuits and therefore activate, or keep energized, the relays R_1, R_4, and R_6, by the addition of the other banks of selective starting keys and circuits; in the illustration, starting switch E_{11} of the second bank and starting switch E_{21} of the third bank are open at their front contacts b_{11} and b_{21} (making the corresponding banks of circuits idle or unallocated), but are closed at their back contacts c_{11} and c_{12}. With switch M_{11} closed for the next succeeding portion of the cycle, a circuit will be established through these same pilot lamps and relay windings which may be traced as follows: from secondary **19** through leads **20**, **23**, and **25** to switch M_{11}, then through contacts a_{11} and c_{11} of switch E_{11}, lead **26**, contacts a_{21} and c_{21} of switch E_{21}, lead **27**, and through switch E_1 as before since the circuits through contacts a_1 to b_1 remain closed.

As synchronous motor SM continues to rotate, switch M_1 remains open, switch M_{11} is opened, and switch M_{21} is closed. While in the circuit of Fig. 2 switch M_{21} might be considered as allocated to the lower or third bank of selective keys and circuits (that lower or third bank being idle), it is now made available for coaction with the first or upper bank for that portion of the cycle during which switch M_{21} remains closed. Under these conditions a circuit will again be established through the same pilot lights and relay windings, which may be traced as follows: from secondary **19** through leads **20**, **23**, **25**, and **28**, switch M_{21}, contacts a_{21} and c_{21} of switch E_{21}, lead **27**, and through switch E_1 which has remained closed.

It is thus seen that when only one code symbol, such as "146," is set up, it is flashed at the outlying signal stations D three times for every cycle of operation of impulsing unit I. Though in the just described illustrative operation the code symbol is initially flashed or transmitted under the control of pulsing switch M_1 during that portion of the cycle allocated to switch M_1, and while the single code symbol is set up on only the one bank of keys and selective circuits, the remaining pulsing switches normally allocated to respective banks of keys and selective circuits, which are idle, become successively allocated by the described switching and circuit arrangements to re-activate or again energize the signals as initially set up in the one bank, and thus full use is made of the otherwise and idle portions of the system cycle.

Let us now proceed to explain the operation when a second symbol, say, "257," is added by the operator depressing, in the second group or bank, selector keys K_{12}, K_{15}, and K_{17} and starting key S_{11} on the switchboard. This operation closes switches k_{12}, k_{15}, k_{17}, E_{11} (so that contacts a_{11} and b_{11} are bridged), and F_{11}. Switches k_1, k_4, k_6, E_1, and F_1 remain in the position they were in before, that is, when only one code symbol "146" was being sent, since the operator has not depressed stopping key SS_1.

When impulsing unit I closes switch M_1, code symbol "146" will be flashed, and the circuits

accomplishing this are the same as those which flashed "146" when only one code symbol was being sent. When, however, switch M_{11} is closed, the flashing of code symbol "146" will not be repeated because the circuit which heretofore accomplished this is open at contacts a_{11}, c_{11} of switch E_{11}, the latter being in the second bank or group, a group which now is not idle in that the second code symbol "257" is set up on it, and the allocation of impulsing switch M_{11} to other than the selected circuits of this second group cannot therefore take place. Accordingly, when switch M_{11} is closed, a circuit will be established from secondary **19** through leads **20**, **23**, and **25** through switch M_{11} from contact a_{11} to b_{11} of switch E_{11}; thence through three branches, switch k_{12}, rectifier V_{12}, lead **102**, pilot lamp P_2, and relay winding R_2; switch k_{15}, rectifier V_{15}, lead **105**, pilot lamp P_5, and relay winding R_5; and switch k_{17}, rectifier V_{17}, lead **107**, pilot lamp P_7, and relay winding R_7 to return leads **22** and **24** back to secondary **19**, thus flashing the code symbol "257" at outlying signal stations D and on monitor **13**.

When impulsing unit I closes switch M_{21}, a circuit will be established as before through leads **20**, **23**, **25**, and **28** and switch E_{21} from contacts a_{21} to c_{21}, since this switch has remained in its normal position, through lead **27** to switch E_1 which will again flash the code symbol "146". It is thus seen that when two code symbols are set up on the keyboard, the sequence of flashing will be the signal set up on the first row, that is, set up by keys K_1 to K_{10}; then that set up on the second row, that is, set up by keys K_{11} to K_{20}; next the one on the first again, then the one on the first again, and then the one on the second. In the terms of the example given, the sequence would be "146," "257," "146," "146," "257," "146," and so on.

This illustrates how, with an illustrative capacity of three code symbol transmissions per system cycle, the system utilizes those portions of each cycle which would otherwise remain idle when less than the full capacity of code symbol selection is utilized, for the transmission or repetition of an already selected code symbol.

When a third code symbol, say, "670," is set up on the keyboard, this time on the third or bottom row or group of keys and circuits in Figs. 1 and 2, all of the selector and starting switches connected with the first two rows of keys will remain as above, but switches k_{26}, k_{27}, k_{30}, and E_{21} will be closed; that is, E_{21} will be in the position that closes contacts a_{21}, b_{21}, and opens the circuit from a_{21} to c_{21}. This, of course, is accomplished by the operator depressing keys K_{26}, K_{27}, K_{30}, and S_{21}. The third or bottom group of keys and selective circuits is thus no longer idle, and that condition prevents its normally allocated impulsing switch M_{21} from being allocated to some other bank or group of keys and circuits. When impulsing unit I closes switches M_1 and M_{11}, the action will be as above, that is, first code symbol "146" will flash as a result of operation of its normally allocated impulsing switch M_1, and only during that portion of the cycle allocated to that switch, and then code symbol "257" is flashed under the control of switch M_{11} normally allocated to the group in which the code symbol "257" is set up and for the portion of the cycle allocated to the closure of switch M_{21}. Code symbol "146" will not now flash when switch M_{21} is closed because the circuit accomplishing that is now open from contact a_{21} to contact c_{21}. Instead, when switch M_{21} is closed, a circuit will be established from secondary **19** through leads **20**, **23**, **25**, and **28**, switch M_{21}, and switch E_{21} from a_{21} to b_{21}; thence by three branches, switch k_{26}, rectifier V_{26}, lead **106**, pilot lamp P_6, and relay winding R_6; switch k_{27}, rectifier V_{27}, lead **107**, pilot lamp P_7, and relay winding R_7; and switch k_{30}, rectifier V_{30}, lead **110**, pilot lamp P_{10}, and relay winding R_{10}, through return leads **24** and **22** back to secondary **19**.

In this situation the code symbols flashed at outlying stations D during the cycle will be "146," "257," "670" in that order, and that sequence will be repeated for each succeeding cycle until some change is made in the keyboard.

Let us now consider what will happen when it is desired to stop the flashing of one of the code symbols, say, "257," without disturbing the flashing of the other code symbols. The operator depresses stopping key SS_{11}, which opens switches k_{12}, k_{15}, k_{17}, E_{11} (that is, opens contacts a_{11}, b_{11} and closes contacts a_{11}, c_{11}) and opens switch F_{11}. Motor SM continues to operate to continue the cyclic repetition of its successive closures of switches M_1, M_{11}, M_{21}, for switches F_1 and F_{21} remain closed. Now, when impulsing unit I closes switch M_{11}, the code symbol "257" will not be flashed, but a circuit will be established from secondary **19** through leads **20**, **23**, and **25**, switch M_{11}, open switch E_{11} from contact a_{11} to back contact c_{11}, lead **26** to switch E_{21}, which is closed; that is, contacts a_{21} and b_{21} are bridged, which will cause code symbol "670" to be flashed instead of "257." Code symbol "670," set up in the third bank, is thus repeated in the cycle, by the impulse switch M_{11} which is freed by the now idle second bank (in which "257" had been set up) and which, in response to that idle condition, is now allocated to serve the third bank. Thus the code symbols will be flashed in the following order: "146," "670," "670," "146," "670." A reallocation of the impulsing switches, per cycle, and of the pulses or signalling intervals available in the cycle, has thus taken place.

Recurring to the circuits generating the audible signal, this circuit, as above stated, comprises switch M_A, switch A, and relay winding AR connected across secondary **19**. Switch A is manually operated when an audible signal is desired to be given to call attention in that manner to the actuation of the visual or flashing signals, and the closure of switch A permits the circuit of relay AR to be closed every time impulsing unit I closes switch M_A. In the present embodiment this is illustratively once for every cycle of operation of the system, but may be changed if so desired. No audible signal is transmitted unless at least one of the starting keys S_1, S_{11}, or S_{21} is depressed because, unless that is the case, the motor circuit is open at switches F_1, F_{11}, and F_{21}, which, as above stated, are controlled by starting keys S_1, S_{11}, and S_{21}, respectively.

In Fig. 2 switches F_1, F_{11}, and F_{21} are shown as three switches in parallel and if any one of these is closed, current will be fed to synchronous motor SM and the system will operate in repeated cycles. Although shown in this manner, in actual practice switches F_1, F_{11}, and F_{21} may be either separate switches each operated by starting keys S_1, S_{11}, and S_{21}, respectively, or may be a single switch kept in its closed position whenever any one of the starting keys S_1, S_{11}, or S_{21} is depressed. The mechanical design of

switches F_1, F_{11}, and F_{21} may take any suitable form.

The operation of the system, illustratively described above in connection with an illustrative capacity of three different and successive signal transmissions per cycle, will be seen to be very efficient in that it is possible to avoid waste of time, loss of signal transmission where less than the full capacity of signals is set up on the several rows or banks of digit selecting keys and switches, and that the system automatically achieves determination of what activated or selected signal is to be repeated in those portions of the cycle left idle by a de-activated selector circuit; to the matter of such repetition, the operator need give no concern. Moreover, it will be seen that these advantages can be accomplished with compact, uncomplicated, and inexpensive and long-lasting devices and circuit arrangements. Where large numbers of combinations of digits or the like are to be selectively set up by the utilization of digits common to two or more of the groups of selector circuits, undesirable multiplication of circuit and circuit-makers and breakers can be avoided by the use of unidirectional conductive devices, such as rectifiers, in the circuits, as in the relay winding selector circuits to prevent the undesired return of current from return leads **22** and **24** through the relay windings and pilot lamps. Assuming, for example, that the keyboard is set up to send three code symbols, "146," "257," and "670," that these rectifiers are not in the circuit, and that switch M_1 is closed, circuits will be established from secondary **19** through leads **20** and **23**, switch M_1, and switch E_1 from a_1 to b_1, and thence through the following branches: switch k_1, pilot lamp P_1, and relay winding R_1; switch k_4, pilot lamp P_4, and relay winding R_4; switch k_6, pilot lamp P_6, and relay winding R_6; also through switch k_6, back through lead **106**, through switch k_{26} in the reverse direction, through switch k_{30}, lead **110**, pilot lamp P_{10}, and relay winding R_1, through switch k_{27}, lead **107**, pilot lamp P_7, and relay winding R_7; also from lead **107** through switch k_{17} in the reverse direction, through k_{12}, lead **102**, pilot lamp P_2, and relay winding R_2, and through switch k_{15}, lead **105**, pilot lamp P_5, and relay winding R_5. Thus, without rectifiers in the circuit, the false code symbol "1245670" would be flashed when switch M_1 is closed and similarly when switch M_{11} or M_{21} is closed.

The illustration just given shows the conditions that exist when the full capacity of the system is used, illustratively to transmit in sequence three code symbols set up in the three banks of parallel circuits; the valves or rectifiers, however, serve in similar manner to prevent transmission of false signals when less than the full capacity of the system is employed, in which case, typified in several illustrations earlier above set forth, a signal set up on one bank of selector circuits is also transmitted, and hence repeated during the cycle, at the pulsing switch contact through which the otherwise idle bank of selector circuits would be actuated. In such cases electrical energy, as from the transformer T, is supplied to the active valved or rectifier-containing parallel circuits through the back contact or contacts, and their respective connections, of that one or more group-selector switch that is inactive or in at-rest position, a position in which its back contact takes part in supplying energy to the valved parallel circuits. The valves or rectifiers thus coact also in the energizing circuits that are established at the back contacts of the group-selector switches E_1, E_{11}, E_{21}, etc.

It is thus seen that when two or more code symbols are set up with a common digit, the presence of rectifiers prevents a false signal indication, or transmission, for each closure of each pulsing switch; in this manner complicated commutator systems and multi-pole relays need not be employed.

As many possible embodiments may be made of the above invention and as many changes might be made in the embodiments set forth above, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawing is to be interpreted as illustrative and not in a limiting sense.

I claim:

1. In an electrically-operated paging system for selectively producing cyclically signalling code symbols and for producing one or more of the selected code symbols during each cycle of operation of the system, a plurality of groups of parallel circuits with the groups thereof electrically connected at one end of each through respective normally open group-selector switches to the respective contacts of a means operating in recurring cycles to effect make-and-break at said contacts in sequence whereby to activate said groups in sequence during each cycle upon closure of all of said group-selector switches, each of the latter having a normally closed back contact at which a circuit remains closed if the selector switch is not actuated, said back contacts being connected respectively to said first-mentioned contacts with the connection from the back contact of any one group-selector switch leading to a contact other than that to which said group-selector switch is connected whereby when all of said group-selector switches are closed and the circuits at their respective back contacts are opened each code symbol is produced once, and all of them in sequence, for each cycle and when one or more but not all of said group-selector switches is in open position to effect circuit closure at its back contact, the code symbol produced as the result of a closed selector switch is repeated during each cycle of said system.

2. In an electrically-operated paging system capable of producing on indicators during one cycle of operation of said system at least three code symbols in sequence each of which is made up of a selection from a large number of possible code symbols, a group of parallel circuits for each of said three code symbols, each group of parallel circuits connected at one end to said indicators and at the other ends connected to respective group-selector switches and, through a motor-driven circuit-controlling device that closes and opens sequentially at a plurality of contacts which are respectively allocated to said groups of parallel circuits, to a power source, and means responsive to open-circuit condition of any group-selector switch for connecting the contact normally in circuit with it and its group into the circuit of a closed group-selector switch and its group of parallel circuits whereby when all of said group-selector switches are in closed position, each of said three code symbols is produced once on said indicators during a cycle of operation of said system, when two of said group-selector switches are in closed position and the third in open position, two of said three code symbols are produced on said indicators, one being produced twice and one being produced once, during a cycle of operation of said system, and when

any one of said group- selector switches is in closed position and the others in open position, one of said three code symbols is produced on said indicators three times during a cycle of operation of said system.

3. A switching arrangement for a paging system of the class described comprising a plurality of banks of operating circuits and a plurality of single-pole double-throw switches having each of their closed-position contacts respectively connected to said banks of operating circuits and having each of their fixed contacts connected to the open-position contact of at least one of the other of said switches.

4. A switching arrangement for a paging system of the class described in which three code symbols may be signalled during one cycle of operation of the system comprising three banks of operating circuits and three single-pole double-throw switches having their closed-position contacts connected respectively to said banks of operating circuits and having the fixed contact of the first of said switches connected to the open-position contact of the third of said switches, the fixed contact of the second of said switches connected to the open-position contact of the first of said switches and the fixed contact of the third of said switches connected to the open-position contact of the second of said switches.

5. A switching arrangement for a paging system of the class described comprising a plurality of groups of operating circuits, circuit-controlling means having a plurality of circuit-making-and-breaking devices, one for each of said groups of operating circuits, and operating in recurring cycles to actuate said devices in sequence during each cycle, a plurality of group-selector switches, one for each of said groups of circuits, and circuit connections and circuit controlling devices connecting the circuits of said group-selector switches in circuit respectively with said circuit-making-and-breaking devices when all of said group-selector switches are actuated so that said groups of circuits are activated in sequence during each cycle and, when one or more but not all of said group-selector switches are not actuated so as to free one or more of said circuit-making-and-breaking devices, connecting the circuit of an actuated group-selector switch in circuit also with one or more idled circuit-making-and-breaking device and thereby effect activation of the circuit of the actuated group-selector switch more than once during each cycle.

6. In an electrically-operated paging system, a plurality of selectible signalling circuits, a cyclically-operating circuit-controlling device that closes and opens sequentially at a plurality of contacts of which there is one for each of said selectible signalling circuits, and a plurality of selector switches, one for each of said selectible signalling circuits and each having a normally open front contact and a normally closed back contact, said selector switches connecting said signalling circuits respectively to said plurality of contacts of said circuit-controlling device through their respective front contacts whereby when all of said selector switches are actuated to close at their front contacts and open at their back contacts said signalling circuits are activated in sequence during each cycle and said selector switches having their back contacts connected respectively to said plurality of contacts of said circuit-controlling device in phase-displaced order relative to the order of connection thereto of said selector switches whereby when one or more but not all of said selector switches is in unactuated position and is closed at the back contact, the signalling circuit of an actuated selector switch is additionally activated by another one of said plurality of contacts of said circuit-controlling device through a circuit including said closed back contact.

7. In an electrically-operated paging system for selectively producing cyclically signalling code symbols and for producing one or more of the selected code symbols during each cycle of operation of the system, a source of electric energy, a plurality of signalling circuits to be energized thereby and all of them connected at one end to one side of said energy source and to the other ends of which are connected the respective parallel-connected ends of a plurality of groups of selector circuits each of which includes a selector switch and a unidirectionally conductive device, a circuit-controlling device that closes and opens sequentially at a plurality of contacts of which there is one for each of said groups of selector circuits, said circuit-controlling device having means operating it in recurring cycles, means for supplying electrical energy from said source to said signalling circuits through said sequentially-operated contacts comprising a plurality of group-selector switches, one for each group of selector circuits, whereby, upon actuation of all of said group-selector switches, energy is supplied to said signalling circuits sequentially through said groups of selector circuits during each cycle, said plurality of contacts having auxiliary circuit connections leading respectively to said groups of selector circuits with switching means in each, and control means for said switching means adapted to be actuated when a group of selector circuits and its corresponding one of said plurality of contacts are idle, for completing an energizing circuit through said idled contact to an active group of selector circuits whereby the latter is additionally energized during each cycle.

8. In an electrically-operated paging system for selectively producing cyclically signalling code symbols and for producing one or more of the selected code symbols during each cycle of operation of the system, a source of electric energy, a plurality of signalling circuits to be energized thereby and all of them connected at one end to one side of said energy source and to the other ends of which are connected the respective parallel-connected ends of a plurality of groups of selector circuits each of which includes a selector switch and a unidirectionally conductive device, a circuit-controlling device that closes and opens sequentially at a plurality of contacts of which there is one for each of said groups of selector circuits, said circuit-controlling device having means operating it in recurring cycles, means for suppling electrical energy from said source to said signalling circuits through said sequentially-operated contacts comprising a plurality of group-selector switches, one for each group of selector circuits, whereby, upon actuation of all of said group-selector switches, energy is supplied to said signalling circuits sequentially through said groups of selector circuits during each cycle, and a plurality of switching means, one for each of said groups of selector circuits, having circuit connections respectively to said plurality of contacts in phase-displaced order relative to the order in which said plurality of contacts are respectively connected to said groups of selector circuits by their re-

spective group-selector switches, each of said switching means having a control means therefor that is responsive to active and inactive condition of its group of selector circuits whereby, when less than all of said groups are active, thus making idle one or more of said plurality of contacts, an idle contact is connected in circuit with an active group of selector circuits.

9. An electrically-operated paging system comprising a plurality of selectible signalling circuits, a source of electrical energy for energizing said circuits, means for controlling the energization of said signalling circuits from said source comprising a circuit-controlling device that closes and opens the circuit at a plurality of contacts, one for each signalling circuit, in a sequence A^1, A^2, A^3 . . . A^n, said circuit-controlling device having means operating it in recurring cycles for repeating said sequence, a plurality of selector switches, one for each of said signalling circuits and each having a normally open front contact and a normally closed back contact, having their front contacts connected respectively to said signalling circuits and connecting the latter to said plurality of contacts of said circuit-

controlling device for energization, upon closure of all of said selector switches at their front contacts, in the sequence A^1, A^2, A^3 . . . A^n, and electrical connections respectively from the back contacts of said selector switches to said plurality of contacts of said circuit-controlling device and arranged in the sequence A^2, A^3 . . . A^n, A^1.

JOHN E. KREINER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,780,711	Lichter	Nov. 4, 1930
1,795,536	Baker	Mar. 10, 1931
2,302,535	Durbin	Nov. 17, 1942
2,481,269	Welch	Sept. 6, 1949
2,507,744	Welch	May 16, 1950

FOREIGN PATENTS

Number	Country	Date
499,900	Great Britain	Jan. 31, 1939