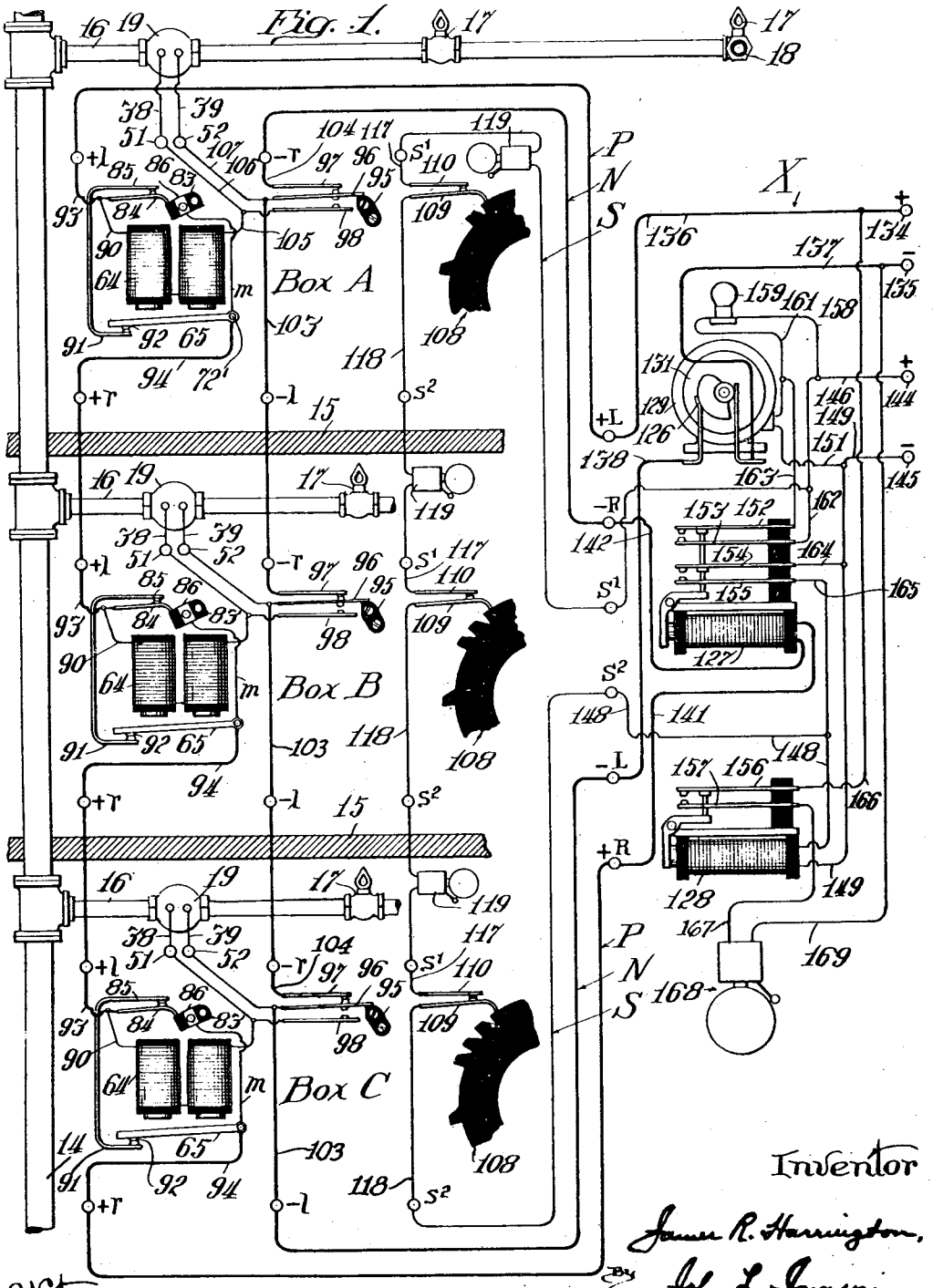
March 6, 1934. J. R. HARRINGTON 1,950,108

ELECTRIC SIGNAL SYSTEM

Original Filed April 13, 1927 4 Sheets-Sheet 1

Fig. 1.



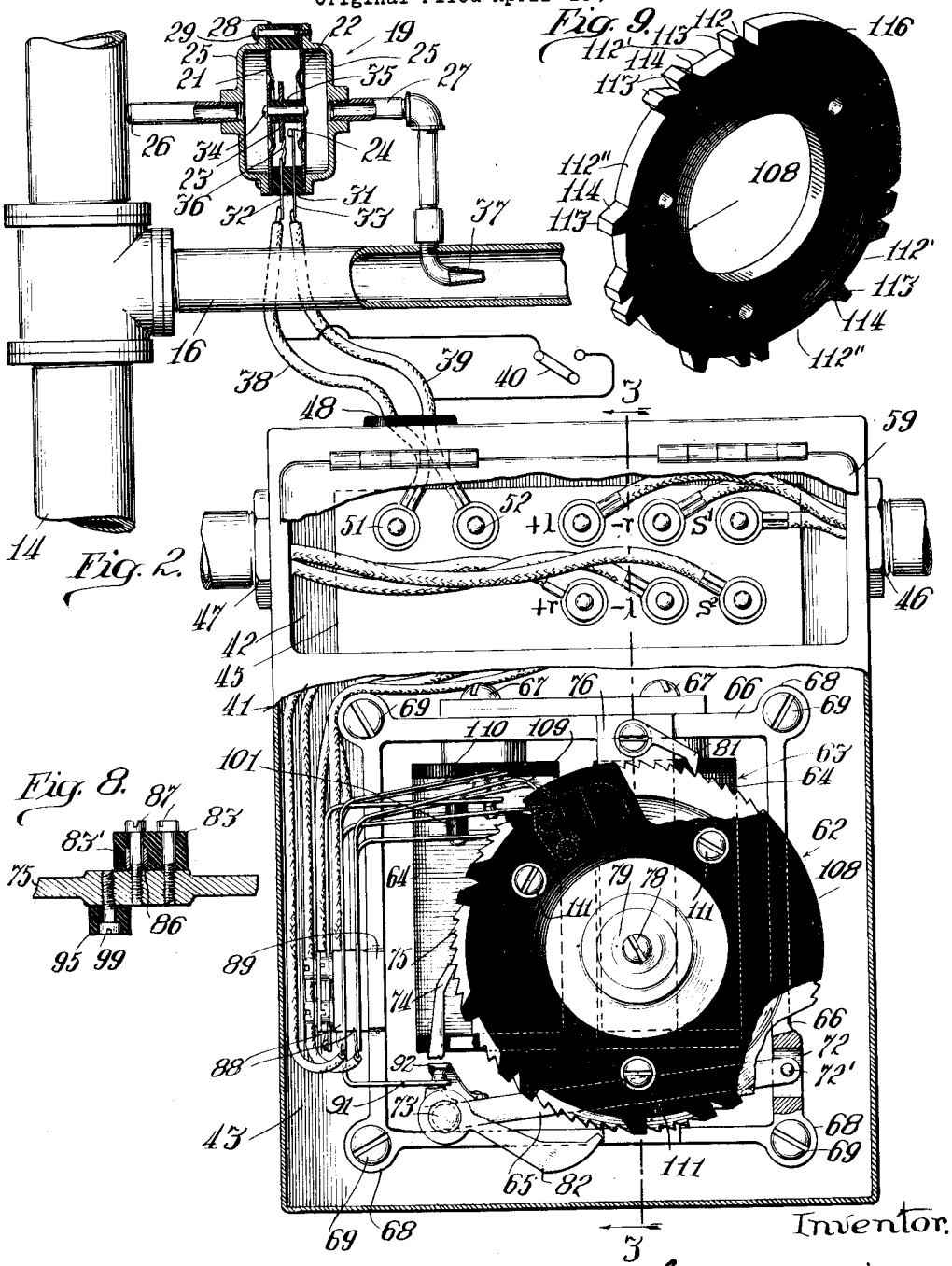
Witness
Milton Lenoir

Inventor
James R. Harrington,
By John L. Jansen.
Attorney.

March 6, 1934. J. R. HARRINGTON 1,950,108

ELECTRIC SIGNAL SYSTEM

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Witness
Milton Lenoir

Inventor.
James R. Harrington,
By John L. Jansen.
Attorney.

March 6, 1934. J. R. HARRINGTON 1,950,108

ELECTRIC SIGNAL SYSTEM

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Fig. 3.

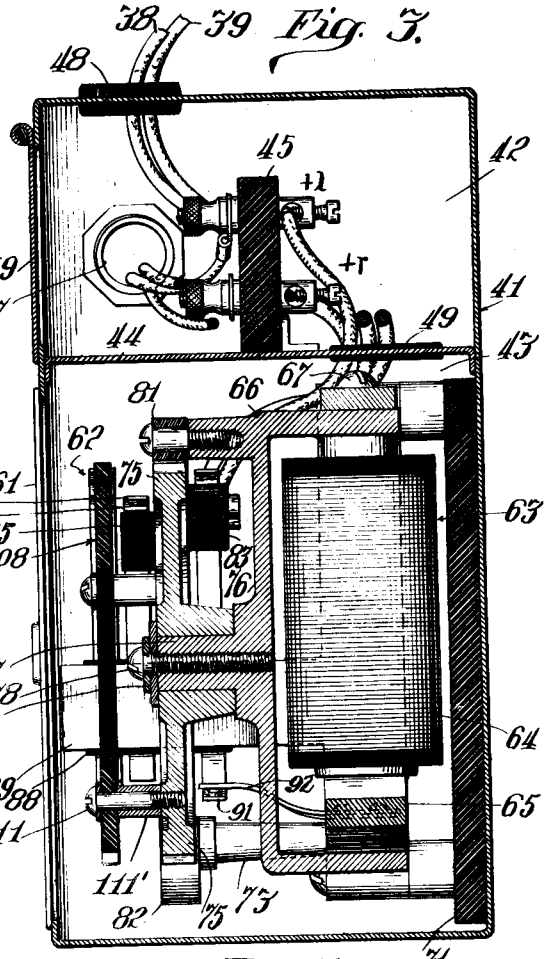


Fig. 4.

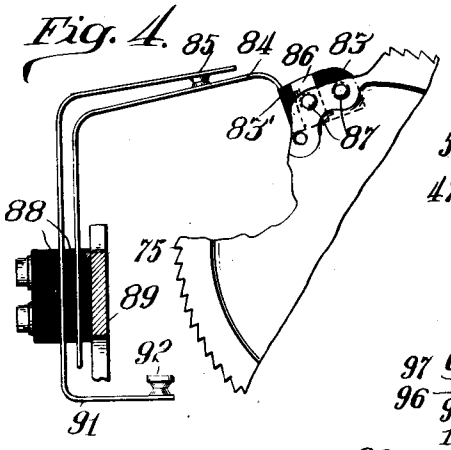


Fig. 5.

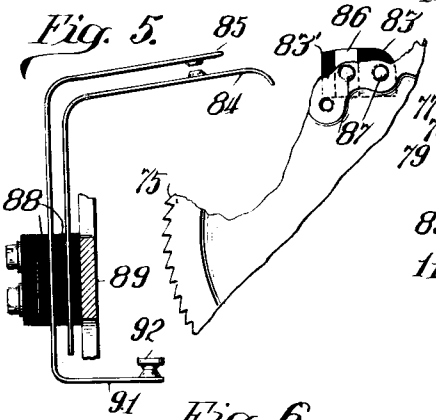


Fig. 6.

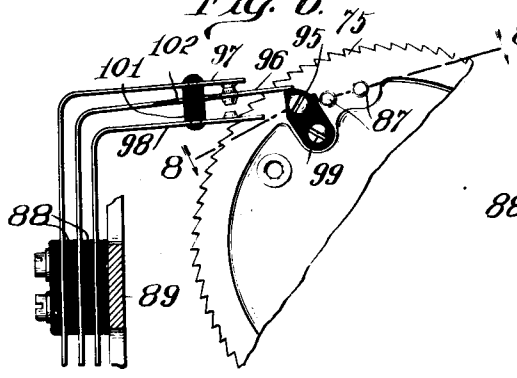
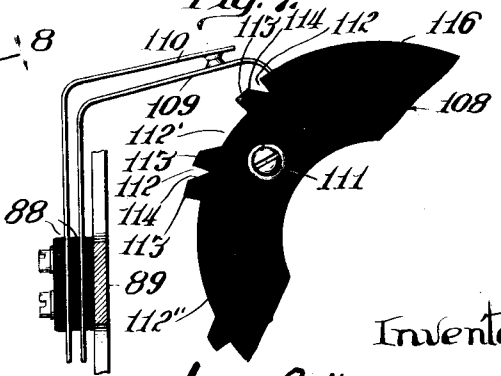


Fig. 7.



Witness
Milton Lenoir

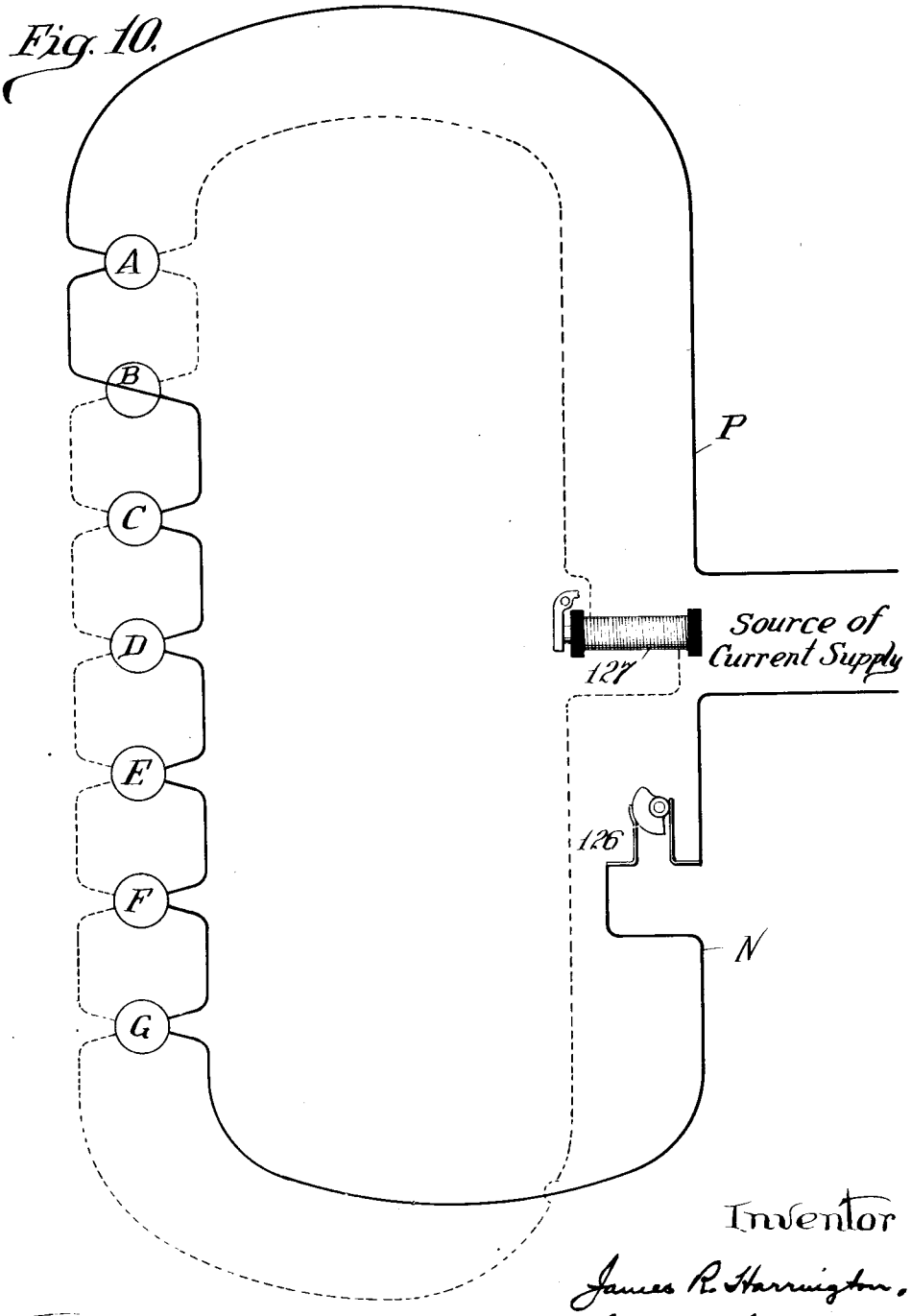
Inventor:
James R. Harrington,
By John L. Jackson.
Attorney.

March 6, 1934. J. R. HARRINGTON 1,950,108

ELECTRIC SIGNAL SYSTEM

Original Filed April 13, 1927 4 Sheets-Sheet 4

Fig. 10.



Witness
Milton Lencio

By

Inventor
James R. Harrington.
John L. Jackson.
Attorney

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UNITED STATES PATENT OFFICE

1,950,108

ELECTRIC SIGNAL SYSTEM

James R. Harrington, Oak Park, Ill., assignor to Howe Manufacturing Company, Chicago, Ill., a corporation of Illinois

Application April 13, 1927, Serial No. 183,478
Renewed August 22, 1932

88 Claims. (Cl. 177—360)

The present invention relates to electric signal systems of the type characterized by a plurality of control boxes interposed at different points in a connecting circuit and so arranged that when a particular condition arises in the vicinity of one of these boxes, or when one of these boxes is manually or otherwise operated, the system will be energized to give an alarm or signal indication, which signal indication will also designate the box which has been operated or caused to operate.

Apparatus of the above type has application to fire alarm systems, burglar alarm systems, sprinkler alarm systems, and other analogous systems where it is desired that a certain condition or operation occurring at any one or more points along the circuit shall give an alarm or signal indication, or shall effect a supervisory or regulating control on apparatus associated with the signal system. The system forming the subject-matter of the present application embodies certain improvements which particularly adapt it to sprinkler alarm installations, and accordingly I shall describe the invention in such adaptation, but it will be understood that the fundamental features of the invention can be embodied in any of the systems above mentioned.

Referring now to the more specific objects of the invention, one of these objects is to provide a system in which interference between different boxes is positively avoided. Thus, in the event that two boxes should be started simultaneously, or in the event that one box should start to operate while another box is operating, no interference results between such boxes, but instead the two boxes take the line successively, one completing its alarm indication on the circuit and the other box awaiting its turn and thereafter starting and completing its alarm indication on the circuit. This successive, non-interfering operation will occur no matter how many boxes are started either simultaneously or in overlapping sequence.

A further object of the invention is to provide a system wherein the boxes are successively operating and continuously-repeating. Thus, in a long series of boxes, if box A should first be set into operation and box B should then attempt to operate, the latter would be compelled to await its turn until box A had completed its cycle of alarm indication, when box B would begin operation and complete its cycle of alarm indication; and if the condition which started the operation of box A had not been corrected up to such time, box A would again take up operation and complete a second cycle, and, similarly, if the condition which initiated the operation of box B had not been corrected up to this time, box B would again take up operation and complete a second cycle,—this successive, continuously-repeating operation continuing indefinitely, or until the system is shut off or the abnormal conditions at the boxes corrected. Moreover, such successive, continuously-repeating operation will occur irrespective of the number of boxes entering into operation and irrespective of the location of the boxes in the series, represented for example, by boxes A, C and D, or B, E, F and G, etc. This continuously repeating characteristic is of decided importance in safeguarding the system against all contingencies. For example in prior systems where the alarm is only sounded once or a limited number of times, if the watchman is absent from the building for only a short time and the alarm should occur during this interval the protective value of the system is nullified.

A further object of the invention is to provide an improved system wherein the movable signal transmitting element in each box is electrically driven. Heretofore, in all of the alarm systems with which I am familiar, this signal wheel or like transmitting element has been driven by clock-work mechanism. Such mode of operation imposes definite limitations on the system. For example, the box cannot have a continuously repeating function because the clock spring motor runs down in a comparatively short time. Furthermore in the majority of these prior systems, after an operation of the system, the clock spring of each box which has operated must be rewound immediately to restore the system to its former protective condition, which is an obvious disadvantage. According to the present invention, the signal transmitting element in each box is driven by power derived from an electric circuit passing through all of the boxes. Such circuit supplies energy to an electromagnetic motor element in each box which functions to drive the signal element through repeated cyclical movements as long as the alarm condition continues at this box.

A further object of the invention is to provide a system in which a synchronized or timed relation is maintained throughout the system, so that all box operations having to do with non-interference, successive repeating and signalling are compelled to occur in a synchronized or timed relation. In the preferred embodiment of my invention, this is accomplished by a combination of

apparatus including a timing device which is common to all of the boxes, such timing device transmitting current impulses or a variable current to the boxes, with which the boxes keep in step. Hence, no one or more boxes can run faster or slower than other boxes, which is always a potential source of unreliability in the case of clock spring boxes having escapement mechanisms and the like for controlling the speed of the boxes. This synchronized or timed relation is also of decided advantage when the system is arranged to operate a recorder.

A further object of the invention is to provide a system which will be of much simpler construction and arrangement, and of much lower cost than the prior signal and alarm systems with which I am familiar. One factor contributing to this end is the employment of the above described electric motor device in each box for driving the signal element. The use of clockwork mechanism for the performance of this driving operation in prior boxes has required a complicated arrangement of gears, pawls, etc., which have added considerably to the cost of each box.

Another object of the invention is to provide an improved construction of flow responsive switch adapted for use in connection with the sprinkler alarm embodiment of my invention. One of these switches is associated with each floor branch main or stringer relative to which an alarm function is desired. Upon the establishment of a flow of water in this branch main or stringer, such as would result from the opening of a sprinkler head mounted thereon, the switch is caused to operate to energize its associated signal box and thereby operate the alarm system. This switch comprises an improved construction of movable element having pressure responsive surfaces arranged to respond to the pressure differential which is set up between the main supply pipe and the branch pipe upon a flow of water being established in the latter, this pressure differential resulting in movement of the pressure responsive surfaces, and through such movement effecting the operation of the switch.

Other objects and advantages of my invention will appear in the following description wherein I have described a typical sprinkler alarm system embodying the invention. In the drawings accompanying this description:

Figure 1 is a circuit diagram illustrating the various units and circuit connections of the present signal system in association with a typical sprinkler installation, the operating parts of each signal box being spread out schematically for clarity of illustration.

Fig. 2 is a front elevational view of one of the signal boxes, this figure also illustrating in section one of my improved flow responsive switches.

Fig. 3 is a transverse sectional view through the signal box, taken approximately on the plane of the line 3—3 of Fig. 2.

Fig. 4 is a fragmentary sectional view showing the spring contacts and cooperating cam for controlling one side of the box operating circuit in each box.

Fig. 5 is a similar view showing another position of these same spring contacts and cooperating cam.

Fig. 6 is a fragmentary sectional view showing the other set of spring contacts and cooperating cam for controlling the other side of the box operating circuit in each box.

Fig. 7 is a fragmentary sectional view showing the contacts and cooperating signal wheel for controlling the signal or alarm circuit in each box.

Fig. 8 is a detail sectional view through the ratchet wheel, taken on the plane of the line 8—8 of Fig. 6, and showing the two cams in section.

Fig. 9 is a perspective view of the signal wheel removed from the rotary element of the box, and

Fig. 10 is a schematic circuit diagram made for the purpose of showing the return interrupting operation of the several boxes.

Referring first to Figure 1, the main operating units of the system consist of a series of signal boxes A, B, C, etc., and a control panel or unit X. While I have illustrated only three boxes A, B and C, it will be understood that any number of boxes may be included in the system depending upon the number of locations or operating stations from which an alarm indication is to be had. The entire group of boxes is connected in series relation in a circuit consisting of three conductors P, N and S. It will be noted that these conductors loop back from both ends of the circuit, or from both ends of the series of boxes, to the control panel X.

I shall first describe the structural details of the flow responsive switch, the signal box and the control panel, and shall then take up the various circuit connections extending between these units. The explanation of the various contact mechanisms in each box will be simplified, however, by first assuming for the time being certain conditions of polarity or directions of current feed in the circuit wires P and N, these circuit wires representing the box operating circuit. It will therefore be assumed that direct current is being used for the operation of the system and that current of a positive polarity is being supplied from an outside source of current supply to the terminal designated +L ("positive line") of the control panel X and thence down through the conductor P in a direction extending through boxes A, B and C, in the order named and back to the terminal +R ("positive return") of the control panel X. It will be observed that this corresponds to a counterclockwise direction of flow in the particular circuit connections illustrated. It will also be assumed that the negative polarity from this same outside source of current supply is being placed on the opposite end of the conductor N through negative line terminal —L on the panel, so that this polarity is being fed up through the series of boxes C, B, and A, in the order named, and is being returned to the negative return terminal —R on the panel. It will be observed that this corresponds in the diagram to a clockwise direction of impressed polarity. The positive and negative returns +R and —R are connected to the high resistance winding of a controlling and testing relay on the panel X, which relay I shall hereinafter describe, and hence under normal conditions a small current flow is being passed continuously through the conductors P and N. The direction of current flow or relative polarities of the ends of the signal conductor S are of no particular significance, it sufficing to say that under normal conditions a testing current is being passed continuously through this conductor from an outside source of current supply having connection with the terminals S^1 and S^2 on the control panel.

Referring now to the general arrangement of a typical sprinkler system, the riser of such a system is indicated at 14 in Fig. 1. This riser ex-

tends up through the different floor levels of the building, such floor levels being indicated at 15, and serves to conduct the water to horizontally extending floor branch mains 16 which extend out from the riser below the ceiling of each floor level. These floor branch mains may have the conventional sprinkler heads 17 mounted thereon, although most generally they connect to various "stringers" 18 radiating out in different directions, which stringers have these sprinkler heads mounted thereon. As is well known, these sprinkler heads are designed to open automatically in the event of fire to produce a sprayed discharge of the water over the fire area. In a building of even moderate size there are usually several risers 14 from which radiate floor branch mains 16 at each floor level. The present invention contemplates associating an individual signal box A, B, etc., with each floor branch main leading from each of such risers, so that when any sprinkler head in the system begins operating such fact is indicated by the alarm system, and the location of this particular head is also signaled in the alarm, as by a code which designates the particular riser and the floor branch main with which this head is associated. Similarly, if different heads in different parts of the building commence operating either simultaneously or in sequence the alarm signal will designate the different sections of the building in which these heads are located. This feature of announcing or signaling the exact location of the operating head or heads is obviously of great advantage as it enables the fire to be located at once, which is of extreme importance in large or widely scattered buildings; and moreover in the event of a head opening accidentally, it enables this head to be located promptly before great water damage can be done. As will hereinafter appear, the designation of the particular floor branch main is effected by an individual code in which the alarm is sounded. If desired, separate signal boxes might also be associated with each stringer 18, but this is not usually necessary.

The signal box associated with each floor branch main is made responsive to the flow of water in such main through a suitable flow-operated switch, which I have illustrated diagrammatically at 19 in Fig. 1. My invention contemplates the use of any suitable switch of this type. For example, the alarm valve ordinarily interposed between the "underground" or main supply pipe and the lower end of each riser is typical of a flow responsive switch which may be employed in each branch floor main for performing this box controlling operation. These prior alarm valve switches, however, are bulky and very expensive. Accordingly, I have devised an improved form of flow responsive switch, which because of its smaller size, lower cost and greater sensitivity, is particularly adapted for use in conjunction with the present alarm system. Such a switch is indicated in the upper portion of Fig. 2. It comprises two pressure actuated surfaces 21 and 22 which are connected to be subjected respectively to the pressures in the riser 14 and in the branch main 16. These two surfaces respond to any difference of pressure between the riser and branch main and transmit operating motion to contact mechanism as soon as any such difference of pressure develops. In the particular construction shown, I have illustrated these pressure actuated surfaces as being two spaced diaphragms, but it will be obvious that these surfaces might consist of the opposite sides of a single diaphragm, or the end heads of a movable piston. However, by constructing such surfaces in the form of two spaced diaphragms I am enabled to dispose the two switch contacts 23 and 24 between the diaphragms, thus avoiding any moving joint and avoiding the necessity of disposing any operating parts in the water. The outer sides of the diaphragms are closed by shells or heads 25 forming diaphragm chambers which communicate through pipes 26 and 27 with the riser 14 and branch main 16 respectively. An annulus 28 is interposed between the inner sides of the diaphragms, and bolts or screws 29 pass through the flanges of the end heads and through said annulus. An insulating bushing 31 extends inwardly through this annulus for supporting terminals 32 and 33 extending in to the switch mechanism. The diaphragms are joined centrally by a rivet or bolt 34 on which is mounted an insulating bushing 35. The movable switch contact 23 consists of a disc or finger carried by the insulating bushing 35. This contact is connected through a flexible conductor 36 with the electrode 32 which passes out through the insulating bushing 31. When there is no water flow through branch main 16, equal pressures are effective against both diaphragms, and hence the latter assume a balanced position with the contact 23 separated from the contact 24. A static pressure is normally maintained on the entire piping system from an overhead storage tank or from an air reservoir. As soon as one of the sprinkler heads releases a rapid flow is set up in the associated branch main, which results in a slight difference of pressure being created between the branch main and the riser, with the higher pressure existing in the latter. This difference of pressure, acting on the comparatively large surfaces of the diaphragms, will flex such diaphragms to the right, as viewed in Fig. 2, thereby bringing the movable contact 23 into engagement with the stationary contact 24. The latter contact is a spring finger which can yield slightly with the movement of the contact 23 in its direction. If desired, the end of the pipe 27 entering the stringer 16 may be provided with a nozzle portion 37 facing in the direction of flow through the branch main, for giving a Pitot tube action to augment the pressure differential. Connecting with the two terminals 32 and 33 of the switch are wires 38 and 39 which extend to the associated signal box, preferably located nearby.

It will be seen from the foregoing that the flow responsive switch 19 functions as a circuit closer for the circuit 38—39 leading to the signal box. Where the invention is embodied in a fire alarm call-box system, a burglar alarm system, or the like, any suitable switch may be substituted for the flow responsive switch 19. As illustrative of the latter I have shown a manually operated switch 40 connected across the two wires 38—39.

Referring now to the construction of the signal boxes, the operating parts of all of these boxes are duplicates, with the single exception of the code or signal wheel. Hence a description of one box will suffice for all. Each box comprises a housing 41 divided into upper and lower compartments 42 and 43 by a transverse partition 44. Suitably supported in the upper compartment is an insulating panel 45 on which the several binding posts or terminals of the box are mounted. The circuit wires of the alarm system enter and leave the box through conduit openings 46 and 47 in the side walls of the upper compartment, and the two wires 38 and 39 leading from the

alarm switch also enter this compartment, such as through the opening 48 in the top wall of the compartment. The wires which extend from the connector terminals on the panel down to the contact mechanism in the lower compartment pass through an opening 49 in the transverse partition 44. Mounted on the panel 45 is an upper group of three terminals $+l$, $-r$ and s^1, to which are connected the three circuit wires P, N and S which enter the box. Mounted below this upper group is a second group of terminals $+r$, $-l$ and s^2, to which are connected the circuit wires P, N and S which leave the box. Also mounted on the panel 45 is a pair of connector terminals 51 and 52 to which are connected the wires 38 and 39 leading from the flow-actuated switch 19. Convenient access is afforded to the upper compartment 42, for making these connections to the terminals, through a hinged door 59 which closes the front of the compartment. The lower compartment is closed by a removable plate 61 which is preferably screwed or bolted in place to prevent tampering with the operating parts and contact mechanism disposed in this lower compartment.

These operating parts comprise in the main a rotating element 62 and an electrically operated motor device 63 for driving the rotating element. For cheapness and simplicity of construction, the motor device preferably consists of a pair of electromagnets 64 which intermittently attract an armature 65 and through it impart a step-by-step rotary motion to the moving element 62. It will be evident, however, that a rotating armature type of motor might be employed to drive the rotary element 62, in which event suitable speed reducing gearing would be interposed between the armature shaft of the motor and the rotary element. As best shown in Fig. 2, the two electromagnets 64 are supported in an open rectangular frame 66 by screws 67 which pass down through the upper cross bar of the frame and tap into the ends of the magnet cores. Bosses 68 are formed at the corners of the frame to receive screws 69 which fasten to a back panel 71 of insulation, suitably secured to the back wall of the box. This mounting of the frame insulates the same from the box, which is desired, as one of the circuits is continued through this frame. The armature bar 65 is disposed below the lower ends of the cores and has one end entering a slot 72 in one of the vertical side bars of the frame, where it has pivotal connection on a pivot pin 72'. A stud 73 projects laterally from the free end of the armature, and pivotally mounted on this stud is a pawl 74. The rotary element 62 comprises a ratchet wheel 75, to which the pawl 74 imparts advancing movement in the intermittent operation of the armature. As will hereinafter appear, when the system is energized to give an alarm signal, the control panel X sends out an intermittent current to the electromagnetic motor device 63 of the operating box, so that this motor device is intermittently energized to advance the ratchet wheel 75 with a step-by-step motion.

Referring to Fig. 3, the motor frame 66 comprises a vertical bar 76 extending between the top and bottom of the frame, intermediate the sides thereof. Projecting forwardly from this bar is a pivot boss 77 on which is journaled the ratchet wheel 75, the latter being held thereon in any suitable manner, as by screw 78 and washer 79. A dog 81 is pivotally supported on the upper portion of the intermediate bar 76 to engage in the ratchet wheel and prevent back-throw thereof. Extending from the advancing pawl 74 is another dog 82 which is adapted to move into the teeth of the ratchet wheel on the up stroke of the armature, and thereby prevent overthrow of the wheel.

Secured to the rear side of the ratchet wheel is a cam 83 which is adapted to cooperate with a pair of contact springs 84 and 85 supported at one side of the wheel, see Figs. 4 and 5. This cam consists of a block of insulation, the leading edge of which has a gradual cam slope and the trailing edge of which has a quick drop. In the movement of this cam past the downwardly curved end of the lower spring contact 84 the latter will be forced up against the upper contact 85, (Fig. 4), and then allowed to spring downwardly out of engagement with this upper contact as the cam moves away, (Fig. 5). Recessed in the cam is a metallic contact segment 86, the upper surface of which projects slightly from the outer surface of the cam so as to make contact with the contact spring 84 at one point in the cycle of movement of the ratchet wheel. The parts are so proportioned and arranged that at the termination of one advancement of the ratchet wheel the contact spring 84 will rest on the segment 86, and at the termination of the next advancement the contact spring will rest on the heel portion 83' of the cam. Two screws 87 secure the cam to the side of the ratchet wheel, and one of the screws passes through the contact segment 86 so as to insure the grounding of the latter to the ratchet wheel.

The fixed ends of the contact springs 84 and 85 have mounting between insulating strips 88 which are secured to an arm 89 extending forwardly from one side of the frame 66. The upper contact spring 85 extends down below the arm 89 and has a laterally bent contact portion 91 projecting under a contact spring 92 carried by the armature 65. As shown in Fig. 3, this latter contact spring is suitably secured to the free end of the armature and extends forwardly therefrom over the contact 91, whereby when the armature is in its lower or normal position the contacts 91 and 92 are in engagement.

The two sets of contacts 84—85 and 91—92 constitute two switches connected in series and interposed in series relation in the positive wire P leading through the box. Referring to box A in Fig. 1, it will be seen that a wire 93 extends down from the positive line terminal $+l$ of the box to the spring contact 84. Under normal conditions, this contact is resting on the heel portion 83' of the cam and hence is in engagement with the upper contact 85. Therefore the circuit continues down through this contact to contact 91. Under normal conditions, the armature is down and hence the circuit continues through contact 92, armature 65 to frame 66, and thence by wire 94 to the positive return terminal $+r$ of the box. Thus the positive feed impressed on conductor P enters the box at $+l$, passes through the two switches 84—85 and 91—92 in series and leaves the box at $+r$ for entry into the next box B. Here the positive line passes through the same pair of series switches and on to the next box C, etc. Within each box, a wire 95 extends from one end of the electromagnet windings and connects to the wire 93 or to the terminal $+l$ thus placing the electromagnets in permanent connection with the entering positive wire on the "line" side of the two series switches 84—85 and 91—92. The electrical connection between the

contact segment 86 and the frame 66 is represented in Fig. 1 by the connection *m*. It will be obvious that in the energization of the box the contacts 91 and 92 will have a pronounced lead over the contacts 84—85, i. e. with the initial movement of the armature as it starts to actuate the ratchet wheel these contacts 91—92 will be opened. The lead which this switch has over the other switch 84—85 provides the non-interfering action which will be presently described.

Secured to the front side of the ratchet wheel 75 is a cam or pin 95 which is adapted to cooperate with three spring contacts 96, 97 and 98 (Fig. 6), controlling the other side of the box operating circuit. This cam is also composed of insulation and is secured to the ratchet wheel in any suitable manner, as by screws 99. The end of the lower contact spring 98 projects into the path of the cam 95 so that as the cam moves under such contacts in its clockwise direction of rotation towards its normal position it will press this lower contact spring upwardly. The end of the middle contact spring also projects into the path of the cam so that as the cam moves past the end of the lower contact spring, allowing the latter to snap downwardly, it will engage and press the middle contact spring upwardly against the upper contact spring 97. In the normal position of the parts the ratchet wheel stands with the cam holding the middle contact spring up against the upper contact spring, as shown in Fig. 6. The parts are so proportioned that as the ratchet wheel is approaching the end of its cycle the cam 95 engages and forces the lower contact spring upwardly, in a one-step advancement of the wheel; the middle contact spring, which is then engaging the lower spring, being forced upwardly therewith, and the upper spring also moving upwardly in spaced relation to both. In the next one-step advancement the cam moves past the end of the lower contact spring, allowing the same to snap downwardly, and moves the middle contact spring up against the upper contact spring. As above remarked, the cam is now in its normal position. With the next cycle of operation, the cam moves past the middle contact spring, allowing the latter to snap down into engagement with the lower contact spring, at the same time breaking circuit with the upper contact spring. An insulating pin or strut 101 extends between the upper and lower contact springs, passing through an enlarged hole 102 in the intermediate contact spring, so as to maintain the upper and lower springs at a definite spacing for securing the above operation. The three contact springs are mounted between the insulating strips 88 on the supporting arm 89.

Referring again to box A in Fig. 1, it will be seen that the intermediate contact 96 is connected through wire 103 with the negative line terminal $-l$ of the box, whereby this negative polarity entering the box at $-l$ is fed to this contact. With the cam 95 normally holding the latter contact up in engagement with the upper contact 97, this polarity is fed up through the upper contact and through wire 104 to the negative return terminal $-r$ communicating with the conductor N leading from the box. This also applies to all the other boxes. A wire 105 connects the lower contact 98 to the other end of the windings of the electromagnets 64. The flow-responsive switch 19 is connected in shunt across the contacts 96 and 98 through wires 106 and 107 which extend down from the terminals 51 and 52 to these contacts. The flow responsive switch is normally open and hence at such time the negative conductor N has no connection with the electromagnets.

Mounted on the front side of the ratchet wheel 75 in spaced relation thereto is a signal wheel 108 which cooperates with two spring contacts 109 and 110, shown in Fig. 7. The signal wheel is secured to the ratchet wheel by screws 111 which pass through spacing sleeves 111′ interposed between the wheels, whereby the signal wheel is spaced forwardly from the ratchet wheel to accommodate the cam 95 and spring contacts 96, 97 and 98. The screws 111 are set inwardly at a smaller radius than the cam 95 and hence do not engage the contact spring 96. The periphery of the signal wheel is formed with alternating notches 112 and teeth 113, with which engages the downwardly curved end of the contact 109. The two contacts 109 and 110 are mounted between the insulating strips 88 on the arm 89, similarly to the contacts above described. Referring to Fig. 9, it will be seen that the leading edge of each tooth 113 has an inclined cam slope 114 which serves to cam the contact 109 up on to the top of the tooth, at which time this contact is flexed upwardly into engagement with the upper contact 110. The trailing edge of each tooth has a relatively sharp drop for securing a quick opening of the contacts. The span of the top of each tooth 113 equals a one step advancement of the ratchet wheel, and similarly the span of the sloping cam surface 114 between closely disposed teeth equals a one step advancement of the ratchet wheel. Thus, when the contact 109 drops into one of the notches 112 the next succeeding impulse of the ratchet wheel will move the signal wheel the length of the sloping surface 114, causing the contact 109 to be flexed upwardly immediately into circuit closing position.

The teeth and notches on each signal wheel are arranged to close the contacts 109 and 110 in predetermined succession, corresponding to a code individual to that particular signal box. For example, the signal wheel illustrated in Figs. 7 and 9 is intended to give a code call of 1:2. That is to say, beginning with the starting point on the signal wheel, a single tooth 113 is followed by a relatively long notch 112′, at the end of which are two closely spaced teeth 113 again followed by a still longer notch 112″. This relation of teeth and notches may be repeated numerous times around the periphery of the wheel. In the rotation of such wheel, it will be evident that each alarm bell in the system will first be given one stroke, or will be energized for one short period of time, followed by a dwell, and then two strokes or two short periods of operation followed by a longer dwell. A code call of 1:2 may for example, designate riser No. 1, second floor, or first floor branch main, second stringer, etc. It will be understood that each signal box will be provided with a different signal wheel coded to designate the operation of that box. The signal wheels may be readily removed for substitution by simply removing the screws 111. These screws are located unsymmetrically with reference to the wheel so that in the mounting of each wheel it can only be secured to the ratchet wheel in one angular relation. In its normal position the signal wheel stands with the contact 109 engaging on the trailing end of a relatively long raised dwell 116. Thus the signal circuit is normally completed through the contacts 109 and 110, and at the conclusion of one cycle of rotation of the

signal wheel the contact 109 is caused to ride up on this relatively long dwell 116 for again closing the signal circuit.

Referring again to box A in Fig. 1 it will be seen that the upper contact 110 is connected through wire 117 with the signal terminal s^1 of the box, and the lower contact 109 is connected through wire 118 with the other signal terminal s^2. The alarm bells 119 are preferably connected directly in series in the signal conductor S, there being one of these bells at each floor level and at any other desired points inside or outside of the building. Other signaling devices such as sirens, lamps, etc., may be employed in lieu of or in conjunction with the bells, and similarly other circuits effecting other controls such, as the operation of the fire pump, may be arranged to be responsive to the signalling energization of the signal circuit. Normally a relatively small testing current is flowing continuously through the signal conductor S and through all of the signalling devices, but this current is not sufficient to operate the signals. Where bells are employed they are preferably of the single stroke type.

The control panel X may be located at any supervisory point in the building, where the watchman is stationed, such as in the boiler room, or in the room in which is located the fire pump and the sprinkler control valves, etc. As shown in Fig. 1, the principal elements of this panel consist of a motor driven contactor 126, a testing and controlling relay 127 for the box operating circuit P—N, and a relay 128 for the signal circuit S. The contactor 126 is driven by a small electric motor 129 through suitable reduction gearing enclosed in a housing 131. When the system is operating this contactor functions to open and close the box operating circuit at a predetermined frequency suitable for the actuation of the electromagnetic motor elements in the boxes. Such frequency is preferably between 50 and 100 interruptions a minute. This motor driven contactor constitutes the aforementioned timing device, common to all of the boxes, functioning in the nature of a pulsator or oscillator, for maintaining a synchronized or timed relation of the non-interfering, repeating and signaling functions of the system. In the particular construction shown this contactor employes a wiper cam adapted to engage with a stationary contact spring, but obviously any arrangement of stationary and movable contacts may be employed, such devices being typically represented by flasher switches for signs, etc.

Tracing the positive and negative line sides of the box operating circuit through the panel, the outside source of current supply for the box circuit is connected to power terminals 134 and 135 on the panel. From the positive terminal 134 a wire 136 extends directly to the +L terminal of the panel connecting with the "line" end of the conductor P. From the negative terminal 135 a wire 137 extends to one contact of the interrupting switch 126. This contacting switch is normally closed and hence this negative polarity is continued through wire 138 leading therefrom to the —L terminal of the panel, where this negative polarity is impressed on the "line" end of conductor N. The box operating circuit being normally completed through the entire series of boxes as before described, these positive and negative polarities are carried back through the "return" ends of conductors P and N to the two "return" terminals +R and —R on the panel. These two terminals are connected respectively through wires 141 and 142 with the ends of the high resistance winding of the relay 127. Thus a small testing current normally flows through the conductors P and N for maintaining the circuit under continuous test, this current keeping the relay 127 energized. The winding of said relay 127 also constitutes resistance means, which, acting together with the source of current supply, establishes or maintains a potential difference between those portions of the two parallel conductors P and N extending through the several signal boxes or stations A, B, C, etc. Fig. 10 schematically illustrates the relative directions of impressed polarities or current feed through the two conductors P and N. Any break occurring in the continuity of these two conductors will deenergize the relay immediately and result in an alarm operation of the system, as will presently appear. The rotary contactor 126 may be interposed in either the positive or negative feed side of the box operating circuit.

Referring now to the current supply for the signal conductor S, the two terminals 144 and 145 on the panel represent an outside source of current supply for this circuit. Wire 146 leads from the terminal 144 directly to the terminal S^1 of the panel. The polarity impressed thereon passes through the entire signal circuit, which is normally closed at each box, and returns to the terminal post S^2 on the panel. From here a wire 148 leads to one end of the high resistance winding of the signal relay 128. From the other end of this winding, wire 149 leads back to the other supply terminal 145. Thus a complete circuit is normally maintained through the signal conductor S, whereby a testing current flows continuously therethrough. This testing current is kept at a low value by the high resistance winding of the relay 128.

The first relay 127 comprises an upper pair of contacts 152—153 and a lower pair of contacts 154—155. The movable contacts of each pair respond to the motion of a pivoted armature which has mechanical connection with such contacts through an insulating rod, as will be well understood. The contacts tend to close, but are held open by the normally energized condition of the relay. The other relay 128 comprises a similar pair of contacts 156—157, normally held separated by the energized condition of this relay.

The electric motor 129 is preferably operated from the signal circuit voltage effective on the terminals 144 and 145. A wire 151 leads from wire 149 and connects directly to one terminal of the motor. The wire 146 leading from the other supply terminal 144 connects through wire 158 with one side of a small electric light bulb 159, and from the other side of the bulb a wire 161 leads down to the other terminal of the motor. Thus under normal conditions a closed circuit is maintained through the motor, but the current flow therein is cut down so low by the resistance of the bulb 159, which is in series with it, that the motor cannot operate. The bulb thus serves as a testing element for the motor, indicating by its illumination that the circuit through the motor is complete and that the motor is in condition to operate. This bulb also serves as a testing element for the source of signal supply current impressed on terminals 144 and 145. The two upper contacts 152—153 are connected in shunt across the light bulb 159 through wires 162 and 163. Thus when the

relay 127 is deenergized, consequent upon an alarm condition arising in the system, the two contacts 152—153 close and establish a shunt across the bulb, permitting full voltage to be transmitted to the motor and resulting in its operation. Simultaneously therewith, the other two contacts 154—155 close and these contacts establish a shunt across the high resistance winding of the relay 128 through wires 164 and 165. By placing this shunt across the latter relay the full signaling voltage is transmitted to the terminals S^1 and S^2 for operation of the alarm bells under the control of the code wheels in the boxes. The act of placing the shunt across the relay 128 deenergizes the same and hence its two contacts 156—157 are closed substantially simultaneously with the other contacts. These two contacts complete a circuit through wires 166 and 167 leading from the positive line wire 136 down to an alarm or trouble bell 168. The other side of the bell is permanently connected to the negative line wire 137 through wire 169, and hence the closure of contacts 156—157 causes this bell to sound an alarm.

The explanation of the entire circuit will be most easily understood if we assume the system to be operating on direct current, as this will enable the circuits to be traced through with respect to positive and negative. However, the same operation occurs when the system is operating on alternating current, and accordingly it will be understood that where I refer to "positive" and "negative" in this description and in the appended claims I am not using these terms in a limitative sense, but only for the purpose of differentiation. Similarly, the system may be operated throughout on high voltage, such as 110 volts, or it may be operated on low voltage, such as 20 or 30 volts; or the box operating circuit may be operated on one voltage and the signal circuit on a different voltage. I have illustrated the latter type of installation, the two terminals 134 and 135 corresponding to connections to a low voltage current supply for the box operating circuit, and the two terminals 144 and 145 corresponding to a high voltage current supply for operating the bell or signal circuit.

It will be understood from the foregoing description that during the entire normal or non-signalling condition of the system the electromagnetic motor elements of all boxes have connection to the positive side P of the circuit, but they do not have connection to the negative side N because the intermediate contact 96 of each box is normally held out of engagement with the lower contact 98. Assume now that through the opening of a sprinkler head, the flow responsive switch 19 associated with box B is caused to close. This immediately establishes a shunt across contacts 96 and 98 of this box so that the negative side of the circuit is connected to the electromagnets 64 of the box. Within box B the following operations then occur. With the energization of the electromagnets, the armature 65 moves upwardly, first separating the contacts 91 and 92 and thereafter imparting a one-step advancement to the ratchet wheel of the rotary element. This initial movement of the ratchet wheel causes the contact 84 to drop off the cam 83 and thus to break circuit with the contact 85; it causes the contact 96 to drop off the cam 95 and thus to break circuit with the contact 97 and to make circuit with the contact 98; and it causes the contact 109 to drop off the long dwell 116 and thus to break circuit with the contact 110. The result of these switching operations is that the positive conductor P is interrupted at box B so that there is a change of potential in that portion of conductor P extending downwardly from box B, i. e., no positive polarity is transmitted to the succeeding boxes C, D, E, etc., nor to the panel X; similarly, the negative conductor N is interrupted at box B so that there is a change of potential in that portion of conductor N extending upwardly from box B, i. e., no negative polarity is transmitted to box A nor to the panel X.

This condition of the box operating circuit is illustrated in Fig. 10, the full lines representing the feed of opposite polarities to box B over conductors P and N, and the dotted lines representing the interrupted return portions of these conductors. It will be noted from this diagram that no other box in the series is capable of operating at this time as no other box has both polarities. At the same time that the returns of the box operating circuit are opened the signal circuit S is also opened at contacts 109—110.

The opening of the returns to +R and —R on the panel X results in the relay 127 being deenergized. Immediately the contacts 152—153 close, shunting out the lamp 159 and applying full voltage to the motor 129, resulting in its operation. Concurrently therewith the contacts 154—155 close, establishing a shunt across the high resistance winding of the relay 128, and thereby placing the full signal voltage on the ends of the signal conductor S at S^1 and S^2. The deenergization of the relay 123 also closes the contacts 156—157 and starts the trouble bell 168 to ringing. With the operation of the rotary contactor 126, the box operating circuit is made and broken at a predetermined frequency, resulting in the ratchet wheel of box B being rotated with a step-by-step motion.

Tracing this box operating circuit, it will be seen that the positive polarity will be conducted from supply terminal 134 over wire 136, positive line terminal +L, wire P, box terminal $+l$ and wire 93 to contact 84 of box A. Contacts 84—85 and 91—92 in box A are closed at this time and hence the positive polarity is conducted down through these contacts to the armature 65 and thence through wire 94, positive return terminal $+r$ of box A, positive line terminal $+l$ of box B and through wire 93 to contact 84 of this latter box. Inasmuch as the operation of this box has been initiated, contacts 84 and 85 are separated at this time. The positive polarity is continued, however, through the electro-magnet 64 of such box and through wire 105 to the contact 98. At this time the cam 95 of box B has moved away from contact spring 96, allowing the same to engage with contact spring 98. Hence, the circuit will be continued through contact spring 96 down through the negative line and through terminals $-l$ and $-r$ of boxes B and C respectively to the contact spring 97 of box C. Said contact spring is in engagement with the companion contact spring 96 at this time and hence the circuit is continued down through box terminal $-l$ of box C and through negative line N to the negative terminal —L on the panel X. From here the circuit continues thru wire 138, contact mechanism 126 and wire 137 to the negative supply terminal 135. As previously remarked, the rotation of

the contact mechanism 126 intermittently makes and breaks the box operating circuit just traced, resulting in the ratchet wheel of box B being rotated with a step-by-step motion. During such rotation of the ratchet wheel, as each tooth 113 on the signal wheel moves under contact 109 the latter is flexed up into engagement with contact 110, thereby completing the signal circuit S and resulting in a single stroke of the alarm bells, or in a single operating interval of whatever signaling means is employed. As above described, each signal wheel is coded to designate the particular box with which it is associated, and hence the alarm is sounded in this code to designate box B. This code call may be repeated several times in a single revolution of the signal wheel. It is opportune to remark at this point that the closing of contacts 96 and 98 establishes a shunt across the flow responsive switch 19, so that if through cessation of water flow or through some other circumstance the flow operated switch was caused to open shortly after the starting of the box, the ratchet wheel would nevertheless continue to revolve and would complete its cycle of one complete revolution.

As the ratchet wheel nears the completion of its cycle the contact segment 86 moves into engagement with the contact 84, thus completing the positive return down to boxes C, D, E, etc. The purpose of thus completing the positive conductor down to these succeeding boxes arises in connection with "concurrent energization" of two or more boxes, which will be presently described. It will therefore be assumed for the time being that the ratchet wheel of box B moves through the next succeeding step of bringing the heel 83' of the cam under the contact 85. Simultaneously therewith the cam 95 will move the contact 96 up into engagement with contact 97, to complete the negative return up to box A. During this latter part of the movement of the ratchet wheel, signal contact 109 is riding on the long dwell 116 and hence is in engagement with contact 110. If the flow responsive switch 19 has opened, the box will cease operating, with the ratchet wheel in its original position, this resulting from the fact that the separation of contacts 96 and 98 has broken the connections from the negative conductor N to the electromagnetic motor element. What is more likely to be the case, however, is that when the ratchet wheel completes its one cycle of revolution it will find the flow responsive switch still closed, it being an abnormal condition for this switch to open shortly after operation. Hence with the flow responsive switch still closed, when the ratchet wheel reaches its original position and opens the contacts 96 and 98, the electromagnetic motor device will still receive the negative polarity through the flow responsive switch 19 and the ratchet wheel will therefore continue to rotate, starting a new cycle and repeating the code alarm previously sounded. These repeated cycles of the box will continue indefinitely, sounding a continuous alarm, until the water supply has been shut off or the alarm system disconnected.

With the restoration of the sprinkler system to normal condition and the opening of flow responsive switch 19, the ratchet wheel of box B will complete the cycle in which it is then moving and come to rest in its normal position with the contacts 84—85, 96—97 and 109—110 closed. This completes the returns of conductors P and N back to the control panel and hence the relay 127 is energized, opening the shunts across the bulb 159 and across the winding of the relay 128. Inasmuch as the signal conductor S is now complete at box B, the latter relay will be energized and the circuit of the alarm bell 168 will be opened. Thus the entire system will be restored to its original condition. It will be observed that the motor 129 can only stop with the rotary contactor in closed position. This will be evident from the fact that the relay 127 can only be energized to open the shunt across the lamp 159 when the box operating circuit is complete through the rotary contactor, i. e. as soon as the contactor closes the box operating circuit the relay 127 is energized and the motor is stopped with the contactor in its closed position.

I shall now describe the operations which occur when two or more boxes are concurrently energized. In my reference to a box which has been "energized" concurrently with another box I means the establishment of a condition at the former box which will result in its taking the circuit as soon as both polarities are given it. By "concurrently" I means that simultaneously with the "energization" of one box another box is "energized" or during the cyclical "operation" of one box another box is "energized". Assume now that during the operation of box B, as above described, the flow responsive switch 19 of box C is caused to close, through the flow of water in the corresponding floor branch main. While box B is operating the contacts 84 and 85 are separated and hence the feed of positive polarity to box C is interrupted. Therefore, even though the closing of the associated flow responsive switch has given the negative polarity to the electromagnetic motor element of box C, this box cannot "operate" because it does not have the positive polarity from conductor P. As the ratchet wheel of box B approaches its normal position the contact segment 86 moves under contact spring 84, this occurring one step in advance of the completion of the cycle as before described, and before the cam 95 has caused the contact 96 to come into engagement with contact 97. The engagement of segment 86 with contact 84 places a shunt across contacts 84—85 and 91—92, thus transmitting the positive polarity down to box C. Inasmuch as the electromagnetic motor element of this box has negative polarity at such time, it is immediately operated. With the first up stroke of its armature it moves the cam 95 of this box out from under the contact 96, allowing the latter to separate from contact 97 and thus opening the negative conductor N leading to boxes B and A. The above described operations of—(1) advancing the contact segment 86 of box B under the contact spring 84; and (2) causing the upstroke of the armature of box C with the consequent separation of contacts 96 and 97—both occur on the same impulse of current from the pulsator or oscillator 126. Inasmuch as the transmission of negative polarity to box B is now interrupted such box will remain in its above described position with the segment 86 engaging with contact 84. Box C will now start to operate, interrupting the signal conductor S according to its individual code wheel. It should be stated at this point that when positive polarity was reestablished through box B towards box C (through segment 86 and contact 84) the initial up stroke of the armature of box C separated the contacts 91—92 and thus in-

terrupted the transmission of positive polarity down to the succeeding boxes D, E, etc. If any one of these succeeding boxes has been placed in condition to operate through the closing of its individual flow responsive switch, the electromagnetic motor element of such box will also be momentarily energized, but before its armature can move upwardly any appreciable degree the positive polarity to such box will be interrupted at the contacts 91—92 of box C. Thus if boxes C, D, E, etc., have been standing in an energized condition, awaiting the chance to operate pending the completion of the cycle of box B, box C will be the first in turn to take the circuit. This is because the separation of contacts 91, 92 of box C does not interrupt the energization of the electromagnets 64 of box C but only interrupts the energization of the electromagnets 64 of the other boxes D, E, etc.; viz: each pair of contacts 91, 92 is on the "return" side of the circuit with respect to the electromagnets in its individual box, as distinguished from the "line" side. That is to say, under the above stated condition with boxes C, D, E, etc. standing energized and ready to take the line, the armatures 65 of all of these boxes can move upwardly a slight degree, from the very brief energization of their respective electromagnets, but the separation of contacts 91, 92 of box C instantly interrupts the supply of positive polarity down to boxes D, E, etc. and therefore the armatures of these boxes drop down again without having moved sufficiently far to effect any advancement of their respective ratchet wheels. However, this separation of contacts 91, 92 of box C has not interrupted the supply of positive polarity to box C, and therefore the energization of its electromagnets is completed, the armature of this box moving through its full stroke.

Box C will now go through the same operation as described of box B until contact segment 86 comes into engagement with contact 84, which is the position one step short of the completion of the cycle. Assuming that no boxes beyond C are energized, the ratchet wheel of box C will continue through this final step to its normal position, closing contacts 96—97 and transmitting negative polarity back to box B. This box has positive polarity at this time and hence it will immediately start to operate. With the first movement of the armature of box B the contacts 91—92 are opened, which interrupts the transmission of positive polarity to box C and leaves the latter box in its original position. Box B will now operate until the segment 86 of its ratchet wheel engages with contact 84, when box C will immediately start operating taking its turn on the line and interrupting the transmission of negative polarity back to box B.

Assume now that while box C is operating, box D is energized by the closing of its flow responsive switch 19. Under such conditions when the segment 86 of box C engages contact 84 the positive polarity is transmitted down to box D which already has the negative polarity. Hence this box begins to operate and in its initial movement opens contacts 96—97 and interrupts the transmission of negative polarity up to box C, which leaves box C in the same position as box B with the segment 86 engaging contact 84 and with contacts 96—97 still open. Assuming that no other boxes subsequent to box D have been energized, this box will complete its full cycle, closing contacts 84—85 and 96—97. With the closing of contacts 96—97 of this box the negative polarity will be transmitted back to box C and inasmuch as it already has the positive polarity it will operate through the final step of its cycle, causing the segment 86 to move out of engagement with contact 84 and opening contacts 91—92 which interrupt the transmission of positive polarity down to box D leaving it in normal position. This same final movement of the ratchet wheel in box C closes contacts 96—97 and thus transmits the negative polarity up to box B which already has the positive polarity. Hence box B operates through the final step of its first cycle, separating the segment 86 from contact 84 and opening contacts 91—92 which interrupts the transmission of positive polarity down to box C. This final step of box B closes contacts 96—97, as described above of the other boxes D and C. If in the meantime box A has become energized it will immediately begin operating upon receiving the negative polarity consequent upon the closing of contacts 96—97 of box B. The initial operation of box A interrupts the transmission of positive polarity down to box B through the opening of contacts 91—92 of box A. Box A proceeds to operate through its cycle until segment 86 engages with contact 84, when box B will begin operating, cutting out box A at contacts 96—97. Box B will then go through this same movement bringing segment 86 of this box into engagement with contact 84, whereupon box C will take its turn on the line, cutting out box B. Similarly box D will take its turn on the line, cutting out box C. From this point on the boxes will repeat as before described in the same sequence as long as their flow responsive switches 19 remain closed. Any other box becoming energized in the meantime will take its place on the line in the sequence of its position. The previously described step-up operations of causing the ratchet wheel of box C to move through its final step for transmitting negative polarity back to box B, and of causing the ratchet wheel of this latter box to move through its final step for transmitting negative polarity to box A, are all performed on the same impulse of current from the control panel.

Attention is directed to the fact that the system is also protected against such contingencies as the breaking of one of the conductors P, N and S. If either or both of the box operating conductors P and N should be broken, the relay 127 would be immediately deenergized, thus shunting out the high resistance winding of the relay 128 and placing the full voltage on the signal circuit for a single stroke of all of the alarm bells. Simultaneously with the shunting out of the relay 128 the contacts 156—157 thereof will close the circuit of the trouble bell 168. Thus it will be seen that any opening of the box operating circuit whether it be normal or abnormal, will be indicated by the system, i. e. a normal opening resulting from the energization of one of the boxes will cause the signaling system to call in code the location of the box, and an abnormal opening resulting from the accidental breakage of one of the conductors P and N will cause the trouble bell 168 to operate and will also cause a single stroke of all of the alarm bells. In either event the motor driven circuit breaker or pulsator 126 begins operating. In the event of an abnormal opening of said circuit, assuming no box to be in an energized condition, such operation of the circuit breaker 126 merely results in the idle transmission of pulsations with no consequent actuation of any step-by-step motor ele-

ment because no motor element is connected to both sides of the box operating circuit to receive these pulsations. However, if, at this time, any box or boxes on the line side of the break in the conductor P or N should be energized, such box or boxes will still be capable of going through their same cycles of operation hereinbefore described. If the signal conductor S should be broken, the relay 128 will be deenergized, causing the trouble bell 168 to operate.

While I have illustrated an embodiment of my invention which I consider to be the preferred embodiment, it will be understood that such is merely exemplary of the essence of my invention and that various modifications and rearrangements may be made therein without departing from the invention.

What I claim as my invention and desire to secure by Letters Patent, is—

1. In a signal system, the combination of a series of three or more signal boxes, each of said boxes comprising an electric motor element, signal means responsive to the operation of said motor elements, a supply circuit for said motor elements comprising a pair of parallel conductors extending in series through said boxes, with said boxes disposed in bridging relation between said two conductors, one of said conductors being connected to one side of a source of current supply at one end of the series of boxes, and the other of said conductors being connected to the other side of said source of current supply at the other end of said series of boxes, and means effective upon the operation of any one box for interrupting the continuity of one of said conductors in one direction beyond said box and the other conductor in the other direction beyond said box.

2. In a signal system, the combination of a series of signal boxes each comprising an electromagnetic motor element and signal contact mechanism operated thereby, signal means responsive to said signal contact mechanisms; a supply circuit for said motor elements comprising a first conductor extending in series through said boxes and connected to one side of a source of current supply at one end of the series, a second conductor extending in series through said boxes and connected to said source of current supply at the other end of said series, means effective upon the operation of any one box for interrupting the continuity of both of said conductors in opposite directions beyond said box, and means effective during the operation of said box for completing the continuity of one of said conductors before said box is restored to its original condition.

3. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors extending through said series of boxes and energized with opposite polarities at opposite ends of said series, operating means in each box, a first pair of contacts controlled thereby for interrupting the continuity of one of said conductors in one direction from said box, and a second pair of contacts controlled thereby for interrupting the continuity of said latter conductor in the same direction from said box, one of said pairs of contacts having a lead of operation over the other pair.

4. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors extending through said series of boxes and energized with opposite polarities at opposite ends of said series, operating means in each box, a first pair of contacts controlled thereby for interrupting the continuity of one of said conductors in one direction from said box, a second pair of contacts controlled thereby for interrupting the continuity of said latter conductor in the same direction from said box, one of said pairs of contacts having a lead of operation over the other pair, and a third pair of contacts controlled by said operating means for interrupting the continuity of the other of said conductors in the opposite direction from said box.

5. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, a rotary element in each box, an oscillating armature for driving said rotary element, a first pair of contacts controlled by said rotary element for interrupting the continuity of one of said conductors in one direction from said box, and a second pair of contacts controlled by said armature for interrupting the continuity of the other of said conductors in the opposite direction from said box.

6. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, an electromagnetic motor element in each box comprising an oscillating armature, a rotary element driven by said armature, a first pair of contacts controlled by said rotary element for interrupting the continuity of one of said conductors in one direction from said box, a second pair of contacts controlled by said armature for interrupting the continuity of said latter conductor in the same direction from said box, and a third pair of contacts controlled by said rotary element for interrupting the continuity of the other of said conductors in the opposite direction from said box.

7. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, a rotary element in each box, a pair of contacts controlled by said rotary element for interrupting the continuity of one of said conductors beyond said box, and contact means responsive to said rotary element for establishing a shunt across said first named contacts for completing the continuity of said conductor beyond said box.

8. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, a rotary element in each box, a pair of contacts serving to interrupt the continuity of one of said conductors beyond said box, said rotary element normally holding said contacts closed, and shunting means made operative in the rotation of said rotary element just prior to the return of the latter to normal position for establishing a shunt across said pair of contacts to transmit the polarity of said conductor to the next succeeding box in the series.

9. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, an electromagnetic motor element in each box adapted to draw current from said conductors, said motor element comprising an oscillating armature, a rotary element driven thereby, a first pair of contacts

controlled by said armature, a second pair of contacts controlled by said rotary element, said two pairs of contacts being connected in series and serving to interrupt the continuity of one of said conductors beyond said box, and a contact segment moving with said rotary element and operative to establish a shunt across both of said pairs of contacts when said rotary element is approaching its normal position.

10. In a signal system, the combination of a series of boxes each comprising an electromagnetic motor element, a code producing element operated by said motor element, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, means in each box for interrupting the continuity of one of said conductors beyond said box, and means responsive to the interrupting of one of said conductors for transmitting an intermittent current over said conductors.

11. In a signal system, the combination of a series of boxes each comprising an electromagnetic motor element and a signal contact mechanism operated thereby, a signal circuit responsive to said contact mechanisms, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, means in each box actuated by said motor element for interrupting the continuity of one of said conductors beyond said box, and means responsive to the interrupting of said conductor for applying a signalling voltage to said signal circuit.

12. In a signal system, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two parallel conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, an electric motor element in each box deriving its operating current from conductors P and N, contact mechanism in each box actuated by said motor element and operative to interrupt the continuity of conductor P beyond the energized box toward the C end of the series of boxes and to interrupt the continuity of conductor N beyond the energized box toward the A end of the series, and signal means responsive to the operation of said boxes.

13. In a signal system, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two parallel conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, an electric motor element in each box deriving its operating current from conductors P and N, when the box is energized, contact mechanism in each box actuated by said motor element and operative upon the energization of the box to interrupt the continuity of conductor P beyond the energized box toward the C end of the series of boxes and to interrupt the continuity of conductor N beyond the energized box toward the A end of the series, a signal circuit, extending in parallel relation to said box operating circuit for connection with the boxes in the series, means in each box for controlling the current flow over said signal circuit, and relay apparatus controlled by both of said circuits.

14. In a signal system, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two parallel conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, an electric motor element in each box deriving its operating current from conductors P and N, contact mechanism in each box actuated by said motor element and operative to interrupt the continuity of conductor P beyond the energized box toward the C end of the series of boxes and to interrupt the continuity of conductor N beyond the energized box toward the A end of the series, a current actuated device, conductor P extending from the C end of the series of boxes to one side of said current actuated device, conductor N extending from the A end of the series of boxes to the other side of said current actuated device, circuit breaking means responsive to said current actuated device for intermittently interrupting the current flow through one of the conductors of said box operating circuit, and signal means responsive to the operation of said boxes.

15. In a signal system, the combination of a series of three or more signal boxes A, B, C, etc., a metallic box operating circuit comprising two parallel conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, an electric motor element in each box connected to one of said conductors, box energizing means adapted to connect said motor element to the other of said conductors, contact mechanism in each box actuated by said motor element and operative to interrupt the continuity of conductor P beyond the energized box toward the C end of the series of boxes and to interrupt the continuity of conductor N beyond the energized box toward the A end of the series, rotary contactor mechanisms in each of said boxes actuated by said motor elements, a metallic signal circuit separate from said box operating circuit extending in series through all of said boxes and controlled by said rotary contactor mechanisms, an alarm bell in said signal circuit, a box operating circuit relay, conductor P extending from the C end of the series of boxes to one end of the relay winding and conductor N extending from the A end of the series of boxes to the other end of the relay winding, an electric motor, circuit breaking means driven thereby and connected in said operating circuit for transmitting intermittent current impulses therethrough, a circuit for said electric motor, an electric light included in series in said latter circuit, contact means closed by the deenergization of said relay for establishing a shunt across said electric light, a signal cir-

cuit relay having its winding connected in series with said signal circuit, contact means responsive to the deenergization of said box operating circuit relay for establishing a shunt across the winding of said signal circuit relay, a trouble bell, and contact means responsive to the deenergization of said signal circuit relay for energizing said trouble bell.

16. In a signal system, the combination of a series of three or more signal boxes A, B, C, etc., relay apparatus, a first conductor extending from said relay apparatus and passing serially through said boxes A, B, and C in the order named, a second conductor extending from said relay apparatus and passing serially through said boxes C, B and A in the order named, the opposite ends of said two conductors being connected to a source of current supply, circuit breaking means in one of such conductors responsive to said relay apparatus, electric motor elements in said boxes, box energizing means adapted to place said motor elements in circuit with said conductors, contact means actuated by said motor elements for controlling the continuity of said conductors beyond said boxes, and signal means responsive to the operation of said motor elements.

17. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, a signal circuit extending in series through said boxes, and signal means responsive thereto, each of said boxes comprising a first pair of contacts for interrupting the continuity of conductor P behind the box toward the C end of the series, a second pair of contacts for interrupting the continuity of conductor N ahead of the box toward the A end of the series, and means actuated by the motor element of the box for operating said contacts.

18. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, each of said boxes comprising a first pair of contacts for interrupting the continuity of one of said conductors behind the box with respect to the series, a second pair of contacts for interrupting the continuity of said latter conductor in the same direction from the box, a third pair of contacts for interrupting the continuity of the other of said conductors ahead of the box with respect to the series, and means actuated by the motor element of the box for operating said contacts.

19. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, each of said boxes comprising a first pair of contacts for interrupting the continuity of one of said conductors in a direction toward one end of the series of boxes, a second pair of contacts for interrupting the continuity of said latter conductor in the same direction with respect to the series, one of said pairs of contacts having a lead of operation over the other pair, a third pair of contacts for interrupting the continuity of the other of said conductor in the opposite direction with respect to the series of boxes, and means actuated by the motor element of the box for operating said contacts.

20. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station con-

nected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, each of said boxes comprising a first pair of contacts for interrupting the continuity of conductor P behind the box toward the C end of the series of boxes, a second pair of contacts for interrupting the continuity of conductor P in the same direction from the box, contact means for establishing a shunt across said first and second pairs of contacts, a third pair of contacts for interrupting the continuity of conductor N ahead of the box toward the A end of the series, and means actuated by the motor element of the box for operating said pairs of contacts and said contact means.

21. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, each of said boxes comprising a first pair of contacts for interrupting the continuity of one of said conductors in a direction toward one end of the series of boxes, a second pair of contacts for interrupting the continuity of said latter conductor in the same direction from the box, contact means for establishing a shunt across said first and second pairs of contacts, a third pair of contacts for interrupting the continuity of the other conductor in the opposite direction from the box with respect to the series of boxes, and means actuated by the motor element of the box for operating said pairs of contacts and said contact means.

22. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, each of said boxes comprising a first pair of contacts for interrupting the continuity of one of said conductors beyond the box in a direction toward one end of the series of boxes, an oscillating armature comprising part of the motor element of the box, a second pair of contacts controlled by said armature for interrupting the continuity of said latter conductor in the same direction from the box, a third pair of contacts for interrupting the continuity of the other conductor beyond the box in the opposite direction with respect to the series, and means actuated by the motor element of the box for operating said first and third pairs of contacts.

23. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay apparatus for controlling said circuit breaker, each of said boxes comprising a first pair of contacts for interrupting the continuity of one of said conductors beyond the box toward one end of the series of boxes, an oscillating armature constituting part of the motor element of the box, a second pair of contacts controlled by said armature for interrupting the continuity of said latter conductor beyond the box in the same direction, contact means for establishing a shunt across said first and second pairs of contacts, a third pair of contacts for interrupting the continuity of the other conductor beyond the box in the opposite direction toward the other end of the series, and means actuated by the motor element of the box for operating said first and third pairs of contacts and said contact means.

24. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted

in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay means connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay means for controlling said circuit breaker, each of said boxes comprising a pair of contacts for interrupting the continuity of one of said conductors beyond said box, contact means for establishing a shunt across said contacts for completing the continuity of said conductor beyond said box, and means actuated by the motor element of the box for operating said pair of contacts and said contact means.

25. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay means connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, means responsive to said relay means for controlling said circuit breaker, each of said boxes comprising a rotary element driven by the motor element in the box, a pair of contacts serving to interrupt the continuity of one of said conductors beyond said box, said rotary element normally holding said contacts closed, and shunting means made operative in the rotation of said rotary element just prior to the return of the latter to normal position for establishing a shunt across said pair of contacts to transmit the polarity of said conductor to the next succeeding box in the series.

26. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, each of said boxes comprising an oscillating armature and a rotary element driven thereby constituting parts of the motor element in the box, a first pair of contacts controlled by said armature, a second pair of contacts controlled by said rotary element, said two pairs of contacts being connected in series and serving to interrupt the continuity of one of said conductors beyond said box, and a contact segment moving with said rotary element and operative to establish a shunt across both of said pairs of contacts when said rotary element is approaching its normal position.

27. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, each of said boxes comprising an oscillating armature and a rotary element driven thereby constituting parts of the motor element of the box, a first pair of contacts controlled by said armature, a second pair of contacts controlled by said rotary element, said two pairs of contacts being connected in series and serving to interrupt the continuity of one of said conductors beyond said box, a contact segment moving with said rotary element and operative to establish a shunt across both of said pairs of contacts when said rotary element is approaching its normal position, and a third pair of contacts controlled by said rotary element for interrupting the continuity of the other of said conductors beyond said box in the opposite direction with respect to the series of boxes.

28. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, each of said boxes comprising contact means actuated by the motor element in the box for interrupting the continuity

of both of said conductors beyond said box, and means operating to reestablish the continuity of one of said conductors to the boxes in a direction towards one end of the series of boxes before the continuity of the other of said conductors is reestablished to the boxes in the direction towards the other end of the series.

29. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, a relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, each of said boxes comprising an oscillating armature and a rotary element driven thereby constituting parts of the motor element of the box, intermediate and top and bottom contacts, means on said rotary element normally holding said intermediate contact in engagement with said top contact, the intermediate and top contacts being interposed in series in one of said conductors and adapted upon separation to interrupt the continuity of said conductor through the box, a connection between said motor element and said bottom contact, a box controlling circuit connected in shunt across said intermediate and bottom contacts, and signal means responsive to the operation of said boxes.

30. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, each of said boxes comprising a rotary element driven by the motor element in the box, intermediate and top and bottom contacts, means on said rotary element normally holding said intermeidate contact in engagement with said top contact, the intermediate and top contacts being interposed in series in one of said conductors, and a connection between said electric motor and said bottom contact.

31. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, a signal circuit connecting with said boxes, and signal means responsive thereto, each of said boxes comprising a rotary element driven by the motor element of the box, one of said conductors being normally disconnected from said motor element, contact mechanism responsive to said rotary element and operative to interrupt the continuity of said latter conductor beyond said box and to connect said conductor to said motor element and contact mechanism responsive to said rotary element for controlling said signal circuit.

32. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes, and connected to conductor N at the A end of the series, for controlling said circuit breaker, each of said boxes comprising a movable element driven by the motor element of the box, and contact mechanism responsive to said movable element and operative to interrupt the continuity of one conductor beyond said box and to connect said conductor to said motor element.

33. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating

current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, a signal circuit connecting with said boxes, and signal means responsive thereto, each of said boxes comprising a movable element driven by the motor element of the box, contact mechanism responsive to said movable element and operative to interrupt the continuity of one conductor beyond said box and to connect said conductor to said motor element, contact mechanism responsive to said movable element and operative to interrupt the continuity of the other conductor in the opposite direction beyond said box, and contact mechanism responsive to said movable element for controlling said signal circuit.

34. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means controlled by the current flow in one of said conductors for controlling said circuit breaker, and signal means responsive to the operation of the motor elements in said boxes, each of said boxes comprising an oscillating armature associated with the motor element of the box, and contact means opened by the oscillation of said armature for interrupting the continuity of one of said conductors beyond said box.

35. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means controlled by the current flow in one of said conductors for controlling said circuit breaker, and signal means responsive to the operation of the motor elements in said boxes, each of said boxes comprising means controlled by the motor element thereof for interrupting the continuity of both of said conductors in opposite directions beyond said box.

36. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means controlled by the current flow in one of said conductors for controlling said circuit breaker, signal means responsive to the operation of the motor element in said boxes, and means controlled by said motor element for interrupting the continuity of one of said conductors beyond said box.

37. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means controlled by the current flow in one of said conductors for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, each of said boxes comprising a driven rotary element, and contact mechanism responsive thereto for interrupting the continuity of one of said conductors beyond said box.

38. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, and means controlled by the current flow in one of said conductors for con-

trolling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, and means in each box for interrupting the continuity of one of said conductors in one direction beyond said box and of the other conductor in the other direction beyond said box.

39. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, and means controlled by the current flow in one of said conductors for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, and means in each box for interrupting the continuity of one of said conductors beyond said box.

40. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means for controlling the current flow in one of said conductors when the box is energized, means controlled by the current flow in one of said conductors for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, and means in said boxes, cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes, for causing a plurality of concurrently energized boxes to operate successively in the order of their sequence in the series and for causing said boxes to repeat in the order of their sequence in the series.

41. In a system of the class described, the combination of a series of three or more signal boxes, A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means associated with the box for controlling the current flow through one of said conductors when the box is energized, means controlled by the current flow in said latter conductor for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, each of said boxes comprising a control circuit for energizing the same, a rotary element driven by the motor element of the box, said rotary elements being adapted to revolve through approximately one complete revolution in completing a signalling cycle, and means, cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes, for causing the rotary element of any one energized box to revolve through repeated revolutions in an alternating sequence with the rotary element of any other energized box as long as the control circuits of said energized boxes remain closed.

42. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means associated with each box for interrupting the current flow in one of said conductors when the box is energized, means controlled by the current interruption in said latter conductor for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, each of said boxes comprising controlling means for energizing the box, a movable element in each box adapted to move through a complete cycle for performing a signalling operation, and means for causing said movable element to move through repeated cycles as long as said latter controlling means maintains said box energized.

43. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for

imparting step-by-step advancement to the motor element of the energized box, means associated with each box for controlling the continuity of one of said conductors in one direction from the box when the box is energized, means controlled by the current flow in said latter conductor for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, each of said boxes comprising a control circuit responsive to an alarm condition adjacent to said box for energizing the motor element therein, and means for compelling each box to repeat its signalling operation as long as the control circuit associated with such box remains closed.

44. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, one of said conductors having a return end controlled by the energized box and extending back to said control station, means controlled by the current flow in said return end for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, controlling means for each box responsive to an alarm condition adjacent to said box, and means, cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes, for compelling any two concurrently energized boxes to repeat their signalling operations continuously and successively as long as the controlling means associated with said boxes remain in an alarm condition.

45. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for controlling the current flow in a portion of one of said conductors, means controlled by the current flow in one of said conductors for controlling said circuit breaker, signal means responsive to the operation of the motor elements in said boxes, and means, cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes, for causing said boxes to repeat their signalling operations successively.

46. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for causing said circuit breaker to operate, signal means responsive to the operation of the motor elements in said boxes, and means for causing any two concurrently energized boxes to operate successively and in repetition as long as alarm conditions continue at said boxes, said latter means comprising contacts at the boxes for interrupting the continuity of one of said conductors beyond the box.

47. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for causing said circuit breaker to operate, signal means responsive to the operation of the motor elements in said boxes, and means, cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes, for causing any two concurrently energized boxes to operate successively and in repetition.

48. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conduc-

tors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for causing said circuit breaker to operate, signal means responsive to the operation of the motor elements in said boxes, and means, cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes, for compelling any two concurrently energized boxes to operate successively.

49. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for causing said circuit breaker to operate, signal means responsive to the operation of the motor elements in said boxes, controlling means for each box responsive to an alarm condition adjacent to said box, means for compelling each box to repeat its signalling operation as long as the alarm condition continues at said box, and means operated by the step-by-step motor element of an operating box and cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes for preventing interference between the boxes.

50. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for causing said circuit breaker to operate, signal means responsive to the operation of the motor elements in said boxes, and means for causing said boxes to repeat their signalling operations successively, said latter means comprising contacts at the boxes for interrupting the continuity of both of said conductors in opposite directions beyond the energized box.

51. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, means responsive to the energization of a box for causing said circuit breaker to operate, signal means responsive to the operation of the motor elements in said boxes, and means for causing any two concurrently energized boxes to operate successively and in repetition as long as alarm conditions continue at said boxes, said latter means comprising means for interrupting the continuity of both of said conductors in opposite directions beyond the motor element of the energized box and also comprising means to reestablish the continuity of one of said conductors to the boxes in a direction toward one end of the series of boxes before the continuity of the other of said conductors is reestablished to the boxes in the direction toward the other end of the series of boxes.

52. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a code signaling element actuated by said motor element, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, and contact means in each of said boxes for controlling the continuity of both of said conductors in opposite directions beyond the box.

53. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a signaling code wheel in each box actuated by the motor element of the box, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit

intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, contact means in each of said boxes for controlling the continuity of one of said conductors in one direction beyond the energized box and of the other conductor in the other direction beyond the energized box, and means responsive to the interrupting of one of said conductors for causing said circuit breaker to operate.

54. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, contact means in each of said boxes for controlling the continuity of one of said conductors, and cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes for preventing interference between the boxes, signal contacts in each of said boxes responsive to the motor element therein, a signal circuit controlled by said signal contacts, relay apparatus responsive to said signal circuit and said box operating circuit, and alarm means controlled by said relay apparatus.

55. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, contacts operated by the step-by-step motor element of an operating box and cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes for preventing interference between the boxes, means responsive to the energization of one of said boxes for causing said circuit breaker to operate, signal contacts in each of said boxes controlled by the motor element therein, a signal circuit connected to said signal contacts, and relay apparatus responsive to said signal circuit, and said box operating circuit.

56. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus at said control station connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, for controlling said circuit breaker, and means responsive to the energization of one of said boxes for causing said relay apparatus to operate to start said circuit breaker while maintaining an operating circuit for the step-by-step motor at the energized box.

57. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box, relay apparatus connected to conductor P at the C end of the series of boxes and connected to conductor N at the A end of the series, an electro-magnetic device responsive to said relay apparatus for operating said circuit breaker, and means for maintaining an operating circuit between said circuit breaker and the electric motor element of the energized box after said relay apparatus has caused caused said circuit breaker to operate.

58. In a signal system, the combination of a series of boxes each comprising an electromagnetic motor element and a signal contact mechanism operated thereby, signal means responsive to said signal contact mechanisms, a control station, a pair of parallel conductors connected to the opposite terminals of a source of current supply at said control station and feeding current through said series of boxes and returning to said control station, said boxes being arranged in bridging relation between said parallel conductors, the electromagnetic motor element of the energized box deriving its operating current from both of said parallel conductors, a motor driven circuit interrupter at said control station interposed in one of said conductors, and means responsive to the interruption of current flow in one of the conductor returns to said control station for causing said motor to operate.

59. In a system of the class described, the combination of a series of signal boxes, a box operating circuit comprising two conductors extend-

ing through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on one conductor at one end of the series of boxes and to impress at the same instant the opposite polarity on the other conductor at the other end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from said conductors when the box is energized, means operated by the motor element of an operating box and cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes for preventing interference between the boxes, signal means controlled by said motor elements, a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the motor element of the energized box and means responsive to the energization of a box for causing said circuit breaker to operate, said source of current, when said circuit breaker is inactive, continuously transmitting current over said conductors to said boxes, said last named means including relay means for preventing said circuit breaker from stopping in a circuit breaking position at the end of a signalling operation.

60. In a system of the class described, the combination of a series of signal stations, a pair of conductors feeding current through said series of stations and energized with opposite polarities at opposite ends of said series, an electric motor element at each signal station adapted to derive its operating current from both of said conductors, a circuit breaker connected to one of said conductors remote from said signal stations and adapted, in operation, to transmit intermittent current impulses over said conductor, means for causing said circuit breaker to operate automatically when one of said signal stations is energized, and means comprising contacts at said signal stations for interrupting the continuity of said conductors in opposite directions beyond the energized box for preventing interference between any two or more signal stations attempting to transmit signals at the same time.

61. In a system of the class described, the combination of a series of three or more signal stations each comprising an electric motor and a signal controlling mechanism actuated thereby, a motor operating circuit comprising two parallel conductors connecting with each of said signal stations for supplying operating current to the motors thereof, a signal circuit connecting with the signal controlling mechanisms of each station, means at each station for transmitting successive code impulses over said signal circuit during the cyclical operation of an energized station, means responding to said code impulses for audibly designating the energized station, means responsive to the energization of one of said stations for transmitting motor operating current over said motor operating circuit, and means at an operating station to disconnect said conductors from said other stations and thereby avoid interference.

62. In a signaling system, the combination of a series of signal boxes each comprising a step-by-step electric motor, a signal controlling mechanism actuated thereby, a box operating circuit comprising two current paths connecting with said signal boxes for supplying operating current to the electric motors thereof, means responsive to the interruption of one of the current paths of said box operating circuit for transmitting intermittent current impulses over said box operating circuit for the actuation of the electric motor of the energized box, and contact mechanism in each box actuated by the electric motor thereof and operating solely through said box operating circuit for preventing interfering operation of the signal controlling mechanisms of two or more boxes.

63. In a signal system, the combination of a series of signal boxes A, B and C, each of said boxes comprising a rotary motor actuated device, signal means responsive to said devices, a control circuit for said motor actuated devices comprising a first conductor feeding one electrical polarity to the motor actuated devices of boxes A, B and C in the order named, and another conductor feeding the opposite electrical polarity to the motor actuated devices of boxes C, B and A in the order named, and means effective upon the operation of any one box for interrupting the continuity of one of said conductors in one direction beyond said box and the other conductor in the other direction beyond said box.

64. In a signal system, the combination of a series of signal boxes, a pair of parallel conductors feeding current through said series of boxes and energized with opposite polarities at opposite ends of said series, a motor element in each box, means for connecting said motor element between said parallel conductors, contact means actuated by said motor element for interrupting the continuity of one of said conductors in one direction beyond said box and the other conductor in the other direction beyond said box, and means operating to reestablish the continuity of one of said conductors to the boxes in a direction towards one end of the series of boxes before the continuity of the other of said conductors is reestablished to the boxes in the direction toward the other end of the series of boxes.

65. In a signal system, the combination of a series of boxes each comprising an electromagnetic motor element, a control panel, a pair of parallel conductors connected to a source of current supply at said control panel and feeding current through said series of boxes and energized with opposite polarities at opposite ends of this series, and returning to said control panel, means for connecting said electromagnetic motor elements in bridging relation between said parallel conductors, an electrically operated circuit interrupter at said control panel interposed in one of said conductors, and means responsive to the interruption of current flow in one of the conductor returns to said panel for causing said circuit interrupter to operate.

66. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box-operating circuit comprising two conductors P and N extending through said series of boxes, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor for imparting step-by-step advancement to the

motor element of the energized box, contact means in each of said boxes responsive to the motor element thereof for controlling the continuity of one of said conductors, said contact means cooperating with the aforementioned feeding of opposite polarities in opposite directions through the series of boxes for preventing interference between the boxes, means controlled by the current flow in one of said conductors for controlling said circuit breaker, a signal circuit connecting with each of the boxes, means in each box responsive to the motor element thereof for controlling the current flow in said signal circuit, relay apparatus controlled by said box-operating circuit, relay apparatus controlled by said signal circuit, and signal means responsive to both relay apparatus.

67. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box-operating circuit comprising two conductors P and N extending through said series of boxes with said boxes arranged in bridging relation between said conductors, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, a control station comprising a circuit breaker connected to one of said conductors and adapted in operation to transmit intermittent current impulses over said conductor imparting step-by-step advancement to the motor element of the energized box, means operative upon the energization of one of said boxes for interrupting the continuity of one of said conductors beyond said box in the normal operation of the system, means controlled by the interruption of said conductor for controlling said circuit breaker, and signaling means controlled by said conductors and operative when the continuity of the aforesaid conductor is interrupted in the normal operation of the system and operative when either one of said conductors has been accidentally broken in an abnormal condition of the system.

68. In a signal system, the combination of a series of signal boxes each comprising an electromagnetic motor element, a supply circuit for said motor element comprising a first conductor extending in series through said boxes and connected to one side of a source of current supply at one end of the series, a second conductor extending in series through said boxes and connected to said source of current supply at the other end of said series, said source of current supply normally passing a continuous testing current over both of said conductors, means effective upon the operation of any one box for interrupting the continuity of one of said conductors beyond said box in the normal operation of the system, means responsive to said interruption of said conductor for transmitting intermittent current impulses over one of said conductors, and means for indicating the interruption or opening of either of said conductors for any reason other than the normal operation of one of said boxes.

69. In a system of the class described, the combination of a series of three or more signal boxes A, B, C, etc., a box operating circuit comprising two conductors P and N extending through said series of boxes, a supply circuit connected to impress at any given instant one polarity on conductor P at the A end of the series of boxes and to impress at the same instant the opposite polarity on conductor N at the C end of the series of boxes, a step-by-step electric motor element in each box deriving its operating current from conductors P and N when the box is energized, each electric motor element comprising an oscillating armature and contacts made and broken by the oscillation of said armature, said contacts being interposed in one of the conductors of said circuit to thereby disconnect another box attempting to operate at the same time, and a device responsive to the energization of one of said boxes for transmitting intermittent current impulses over said circuit independently of the making and breaking of said contacts.

70. In a signaling system, the combination of a series of signal boxes each comprising an electromagnetic motor element, a box operating circuit connecting with said boxes for supplying current to the motor elements thereof, each of said motor elements comprising an oscillating armature and a pair of contacts adapted to be made and broken by the oscillation of said armature, said contacts having connection with said circuit to thereby disconnect another box attempting to operate at the same time, and means responsive to the energization of one of said boxes for transmitting intermittent current impulses over said circuit for imparting step-by-step advancement to the motor element of the energized box, said latter means transmitting said impulses independently of the making and breaking of said contacts.

71. In a signal system, the combination of a series of three or more signal boxes, electric motor elements in each of said boxes, a box operating circuit connecting with said boxes for supplying current to the motor elements thereof, means responsive to the energization of one of said boxes for transmitting a periodically varying current over said circuit for operating the motor element of the energized box, signal means responsive to said boxes, a pair of control contacts associated with each box and electrically connected therewith to cause energization of said box when said control contacts are in predetermined box energizing condition, and means operative when the pairs of control contacts of any two or more boxes are simultaneously maintained in box energizing condition for causing said two or more energized boxes to repeat their signaling cycles in alternating sequence.

72. In a signal system, the combination of a series of three or more signal boxes, electric motor elements in each of said boxes, a box operating circuit connecting with said boxes for supplying current to the motor elements thereof, means responsive to the energization of one of said boxes for transmitting a periodically varying current over said circuit for operating the motor element of the energized box, signal means responsive to said boxes, a pair of control contacts associated with each box and electrically connected therewith to cause energization of said box when said control contacts are in predetermined box energizing condition, and means cooperating with said box operating circuit for causing a later energized box to start its signaling cycle as soon as an operating box has finished its signaling cycle and while the control contacts of said operating box are still in box energizing condition.

73. In combination, a series of signal boxes,

each of said boxes comprising an electric motor and signal transmitting means controlled thereby, a supply circuit for the motors comprising a pair of parallel conductors extending through said boxes, a source of potential having its opposite terminals connected to said conductors at opposite ends of the series of signal boxes for maintaining said conductors at a potential difference, and switching means at each box for cutting off one conductor beyond one side of the box and the other conductor beyond the other side of the box, and connecting the remaining parts of the two conductors together through the electric motor of said box.

74. In combination, a series of signal boxes, each of said boxes comprising an electric motor and signal transmitting means controlled thereby, said motors having a control circuit, a pair of parallel conductors extending through said boxes, a source of potential having its opposite terminals connected to said conductors at opposite ends of the series of signal boxes for maintaining said conductors at a potential difference, and switching means at each box for cutting off one conductor beyond one side of the box and the other conductor beyond the other side of the box and connecting the remaining parts of the two conductors together through the control circuit of the electric motor of said box.

75. The combination with a control station and a series of secondary stations, of an electric motor at each secondary station, signal transmitting means controlled thereby, a supply circuit for the motors comprising a pair of parallel conductors extending through said secondary stations, a source of potential having its opposite terminals connected to said conductors at opposite ends of said series of secondary stations for establishing a potential difference between said conductors, switching means at each secondary station for cutting off one conductor beyond one side of the station and the other conductor beyond the other side of the station and connecting the remaining parts of the two conductors together through the electric motor of said secondary station, and means at said control station responsive to the operation of said switching means for changing the potential to make the motor of said secondary station operate.

76. The combination with a control station and a series of secondary stations, of an electric motor at each secondary station, signal transmitting means controlled by the cyclical operation of said motor, a supply circuit for the motors comprising a pair of parallel conductors extending from said control station and through said secondary stations, a source of potential having its opposite terminals connected to said conductors at opposite ends of said series of secondary stations for establishing a potential difference between said conductors, switching means at each secondary station for cutting off one conductor beyond one side of the station and the other conductor beyond the other side of the station and connecting the remaining parts of the two conductors together through the electric motor of said secondary station, and means at said control station for transmitting a periodically varying current over said two conductors to the electric motor of said secondary station, said motor only performing its cyclical operation when energized by said periodically varying current.

77. The combination with a control station and a series of secondary stations, of an electric motor at each secondary station, signal transmitting means controlled by the running of said motor, said motor having a control circuit, a pair of parallel conductors extending from said control station through said secondary stations, a source of potential having its opposite terminals connected to said conductors at opposite ends of said series of secondary stations for establishing a potential difference between said parallel conductors, switching means at each secondary station for cutting off one conductor beyond one side of the station and the other conductor beyond the other side of the station and connecting the remaining parts of the two conductors together through the control circuit of the electric motor of said secondary station, and means at said control station for transmitting a periodically varying current over said parallel conductors to the electric motor of said secondary station, said motor only running to complete the full signalling cycle of said signal transmitting means when energized by said periodically varying current.

78. In combination, a series of signal boxes, each of said boxes comprising an electric motor and signal transmitting means controlled thereby, a supply circuit for the motors comprising a pair of parallel conductors extending through said boxes, a source of potential having one terminal connected to one of said conductors at one end of said series of signal boxes and having the opposite terminal connected to the other of said conductors at the other end of said series of signal boxes for maintaining said conductors at a potential difference, switching means at each box for cutting off one conductor beyond one side of the box, switching means at each box, operating in advance of said first named switching means, for cutting off the other conductor beyond the other side of the box, and switching means at each box for connecting the remaining parts of the two conductors together through the electric motor of that box.

79. The combination with a control station and a series of secondary stations, of an electric motor at each secondary station, signal transmitting means controlled thereby, a supply circuit for the motors comprising a pair of parallel conductors extending through said secondary stations, a source of potential having one terminal connected to one of said conductors at one end of said series of secondary stations and having the opposite terminal connected to the other of said conductors at the other end of said series of secondary stations for establishing a potential difference between said conductors, switching means at each secondary station for cutting off one conductor beyond one side of the station, switching means at each secondary station, operating in advance of said first named switching means, for cutting off the other conductor beyond the other side of the station, switching means at each secondary station for connecting the remaining parts of the two conductors together through the electric motor of said secondary station, and automatic means at said control station responsive to the operation of said switching means for changing the potential transmitted over said two conductors to the electric motor of said secondary station for causing said electric motor to operate.

80. The combination with a control station and a series of secondary stations, of an electric motor at each secondary station comprising an electromagnetic element and a rotary element

responsive thereto, signal transmitting means controlled thereby, a supply circuit for the motors comprising a pair of parallel conductors extending through said secondary stations, a source of potential having one terminal connected to one of said conductors at one end of said series of secondary stations and having the opposite terminal connected to the other of said conductors at the other end of said series of secondary stations for establishing a potential difference between said conductors, switching means at each secondary station, responsive to the energization of said electromagnetic element, for cutting off one conductor beyond one side of the station, switching means at each secondary station, responsive to movement of said rotary element, for cutting off the other conductor beyond the other side of the station, said first named switching means having a lead of operation over said second named switching means, switching means for connecting the remaining parts of the two conductors together through the electric motor of said secondary station, and automatic means at said control station responsive to the operation of one of said switching means for changing the potential transmitted over said two conductors to the electric motor of said secondary station for causing said electric motor to operate.

81. The combination with a control station and a series of secondary stations, of an electric motor at each secondary station, signal transmitting means controlled thereby, a supply circuit for the motors comprising a pair of parallel conductors extending through said secondary stations, a source of potential having one terminal connected to one of said conductors at one end of said series of secondary stations and having the opposite terminal connected to the other of said conductors at the other end of said series of secondary stations, and resistance means cooperating with said source of potential and operatively connected with said parallel conductors for establishing a potential difference between said conductors, switching means at each secondary station operable to establish an interconnection between said parallel conductors through the motor of said secondary station, the establishment of said interconnection placing a shunt across said resistance means, and means at said control station responsive to the shunting of said resistance means for transmitting current impulses over said two conductors to the electric motor of said secondary station.

82. The combination with a control station and a series of secondary stations, of an electromagnetic device at each secondary station capable of continued operation solely in response to changes of potential supplied thereto, signal transmitting means controlled by said electromagnetic device, a supply circuit for the electromagnetic devices comprising a pair of parallel conductors extending through said secondary stations, a source of potential having one terminal connected to one of said conductors at one end of said series of secondary stations and having the opposite terminal connected to the other of said conductors at the other end of said series of secondary stations for establishing a potential difference between said conductors, switching means at each secondary station for cutting off one conductor beyond one side of the station, switching means at each secondary station for cutting off the other conductor beyond the other side of the station, one of said switching means being magnetically responsive to the initial energization of said electromagnetic device to have a lead of operation over the other of said switching means, switching means at each secondary station for connecting the remaining parts of the two conductors together through the electromagnetic device of said secondary station, and means at said control station controlling the transmission of current over said two conductors to the electromagnetic device of said secondary station.

83. In combination, a plurality of stations, an electromagnetic device at each station, a signal transmitting device controlled thereby, a supply circuit for said electro-magnetic devices comprising a pair of parallel conductors extending through said stations, a source of potential having its opposite terminals connected to said conductors at opposite ends of the plurality of stations for establishing a potential difference between said conductors, means at each station actuated by the electro-magnetic device of that station for changing the potential in one of said conductors in one direction beyond said station, means at each station for changing the potential in the other of said conductors in the other direction beyond said station, and means at each station for restoring potential in one of said conductors, such as is capable of causing operation of another station in the series, before restoring station operating potential in the other of said conductors.

84. In combination, a plurality of stations, an electric motor at each station, a signal transmitting device at each station actuated by said electric motor, a pair of conductors extending through said stations for supplying current to control the operation of said electric motors, a source of potential having its opposite terminals connected to said conductors at opposite ends of said plurality of stations, means at each station for changing the potential in that portion of one of said conductors extending in one direction beyond said station, said latter means being actuated by the electric motor of that station substantially simultaneously with the inital energization of said device, means at each station for changing the potential in that portion of the other conductor extending in the other direction beyond the station, means at each station for connecting the other portions of said two conductors together through the electric motor of said station, and means at each station for restoring station operating potential in one of said conductors before the station operating potential is restored in the other of said conductors.

85. In combination, a plurality of stations, each station comprising an electric motor and a signal transmitting device controlled thereby, a pair of conductors extending through said stations for supplying current to control the operation of said electric motors, a source of potential having one terminal connected to one of said conductors at one end of said plurality of stations and having the opposite terminal connected to the other of said conductors at the other end of said plurality of stations for establishing a difference of potential between said conductors, means at each station actuated by the electric motor of that station for changing the potential in that portion of one of said conductors extending in one direction beyond said station, and means at each station for changing the potential in that portion of the other conductor extending in the other direction beyond said station, one

of said latter means having a lead of operation over the other.

86. In combination, a series of electrically responsive devices, a source of current, a pair of conductors conducting controlling current from said source of current to said electrically operated devices, said source of current being connected to said conductors at opposite ends of said series of electrically responsive devices, the controlling current for each of said electrically operated devices being derived from both of said conductors, means associated with each of said electrically responsive devices and actuated thereby for changing the potential in that portion of one of said conductors extending in one direction beyond said electrically responsive device, and means associated with each electrically responsive device for changing the potential in that portion of the other conductor extending in the other direction beyond said electrically responsive device, one of said potential changing means remaining in its potential changing position independently of the deenergization of the associated electrically responsive device.

87. In combination, a plurality of stations, an electromagnetic device at each station and signal transmitting means actuated thereby through a predetermined signalling cycle, a pair of parallel conductors extending through said stations for supplying current to said electrically operated devices, a source of potential having one terminal connected to one of said conductors at one end of said plurality of stations and having the opposite terminal connected to the other of said conductors at the other end of said plurality of stations for establishing a potential difference between said conductors, means at each station actuated by the electromagnetic device of that station for changing the potential in that portion of one of said conductors extending in one direction beyond said station, means at each station for changing the potential in that portion of the other conductor extending in the other direction beyond the station, and means at each station for automatically retaining said electromagnetic device connected with both of said parallel conductors during substantially the entire predetermined signalling cycle of that station.

88. In combination, a control station, a series of secondary stations, an electromagnetic device at each secondary station capable of continued operation only in response to the transmission of current impulses thereto, signal transmitting means actuated by said electromagnetic device, a pair of parallel conductors extending from said control station through said secondary stations, a source of potential having one terminal connected to one of said conductors at one end of said series of secondary stations and having the opposite terminal connected to the other of said conductors at the other end of said series of secondary stations, means at said control station for transmitting current impulses over said conductors, means at each secondary station actuated by the electromagnetic device of that station for changing the potential in that portion of one of said conductors extending in one direction beyond said station, means at each secondary station for changing the potential in that portion of the other conductor extending in the other direction beyond said secondary station, and means at each secondary station for connecting the other portions of the two conductors together through the electromagnetic device of said secondary station.

JAMES R. HARRINGTON.