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F. E. WELD
SIGNALING SYSTEM

2,685,686

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3 Sheets-Sheet 1

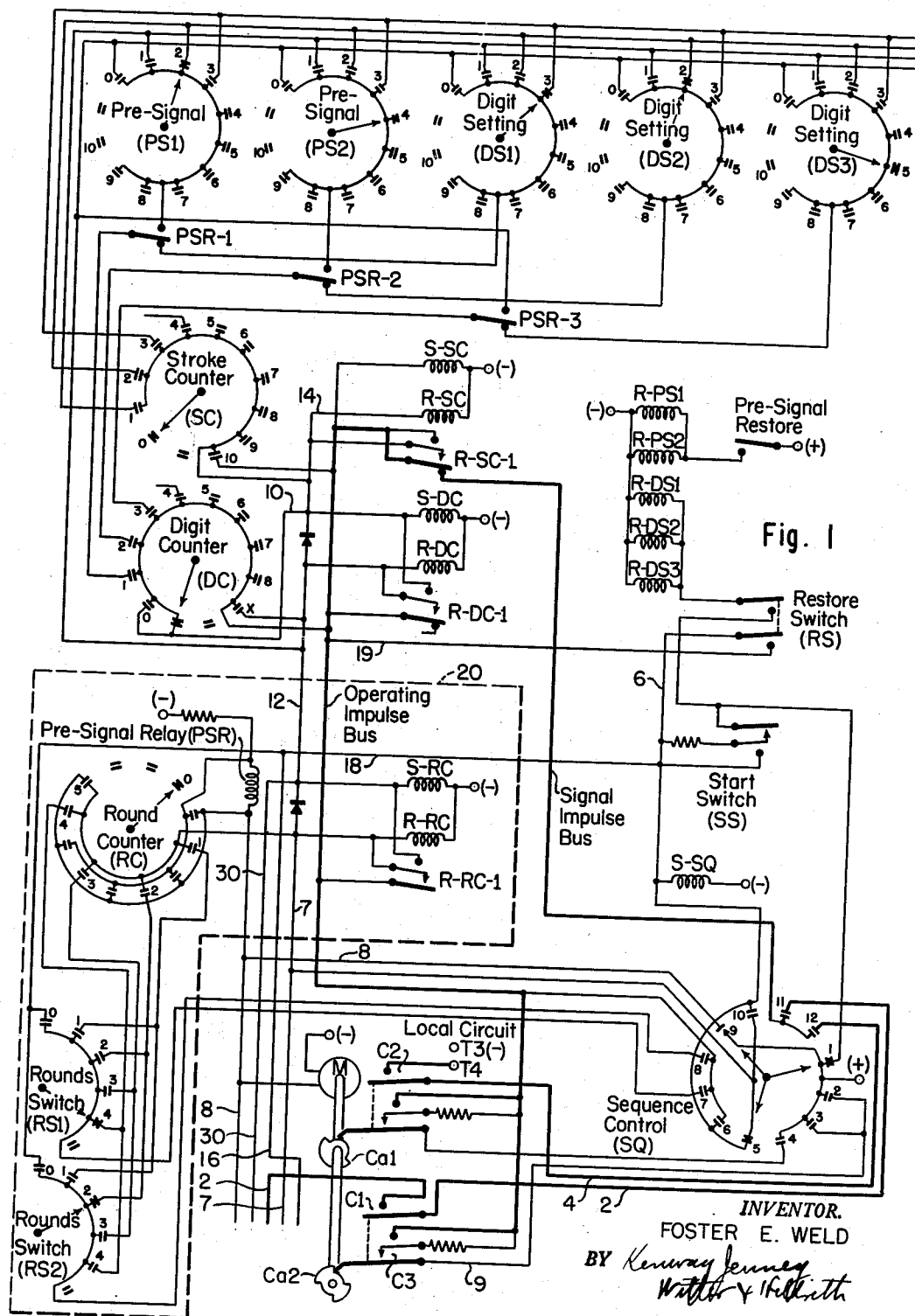


Fig. 1

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3 Sheets-Sheet 2

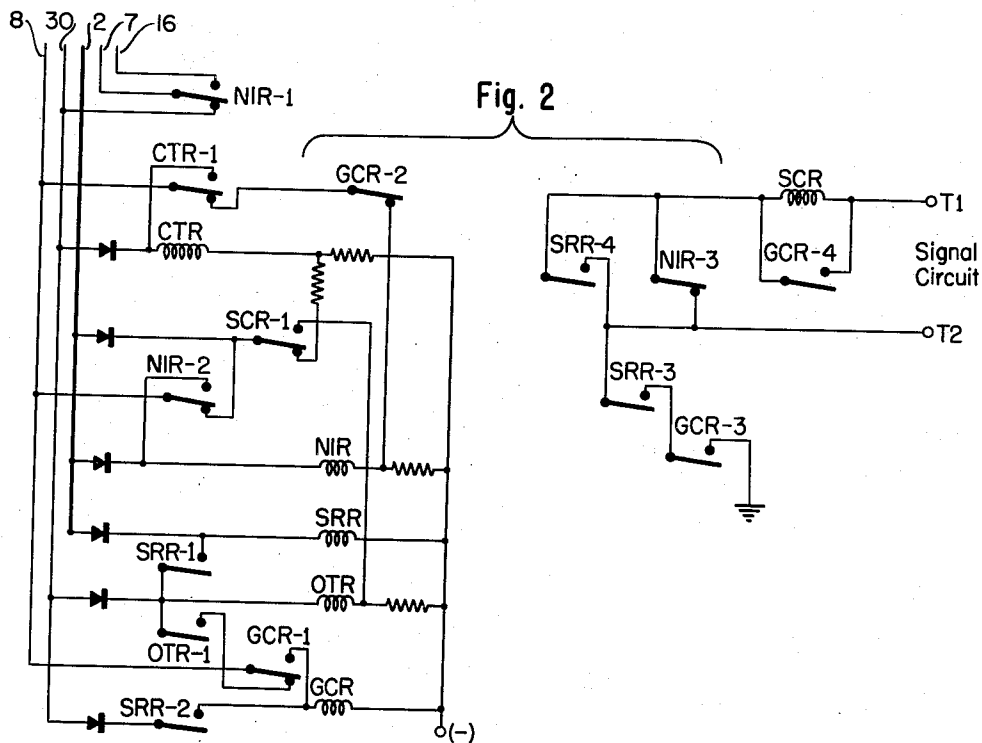
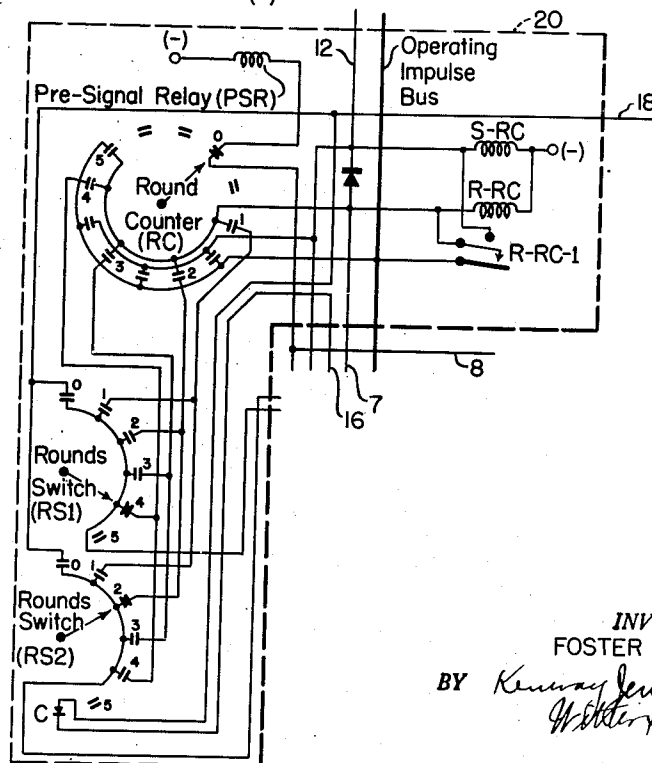


Fig. 3



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3 Sheets-Sheet 3

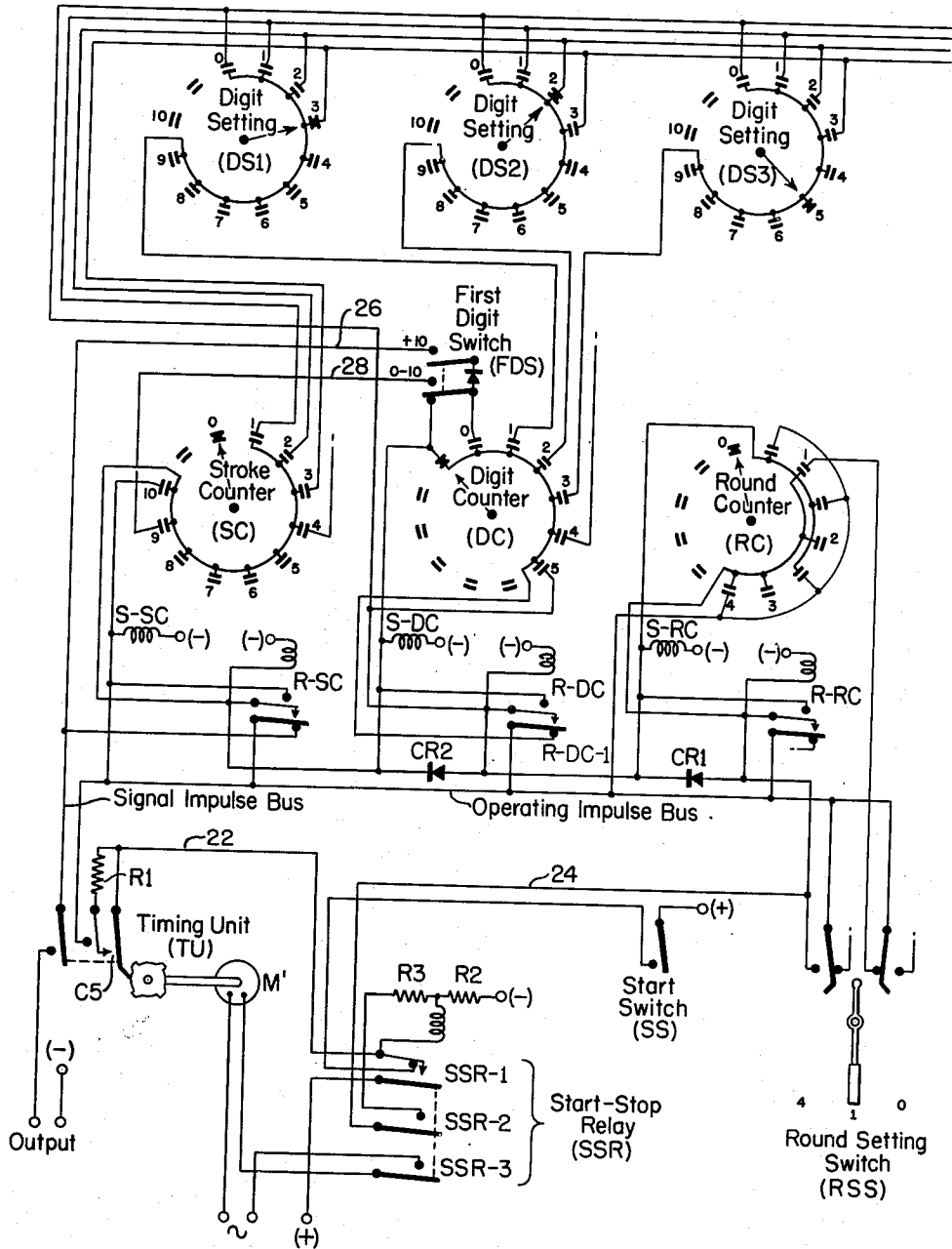


Fig. 4

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SIGNALING SYSTEM

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Application February 26, 1952, Serial No. 273,450

7 Claims. (Cl. 340—359)

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The present invention relates to signaling systems, and more particularly to a transmitter comprising a system of stepping-type switches for sending coded pulses to one or more transmission lines.

This type of apparatus has particular utility in the central offices of fire or police signaling networks where the primary function is usually the sending of numbers corresponding, for example, to alarm box numbers. The transmission line is ordinarily a metallic circuit connecting a number of receiving stations, such as engine houses or the like. In such applications each digit is transmitted in the form of a corresponding number of evenly spaced pulses, or "strokes." The transmitter is usually provided with a number of hand-set switches, one for each digit of the number to be transmitted. Other switches permit selection of the number of "rounds," or successive, complete repetitions of the selected number. The system in certain applications may require more than one transmission line, or output circuit into which the numbers are sent. These separate lines may require different speeds of transmission, as for example where slow speed devices such as alarm bells, as well as faster devices such as tape punches are operated from the same transmitter. Also, as hereinafter explained, one line may be a normally open circuit, while the other may be normally closed.

Apparatus suitable for the above functions, as well as certain special functions hereinafter noted, has long been known to the art. However, such apparatus has been unsatisfactory as respects versatility and adaptability to various conditions of use in different types of signaling systems where it is employed. In the mechanical forms the design is so intimately related with the assumed maximum number of digits per number that a requirement for a greater number of digits in a particular application necessitates a completely different design. Moreover, in these forms as well as in the known electrical forms the complexity of the apparatus increases rapidly with the number of digits and the special demands of the particular application.

A primary object of the present invention is to provide an electrical type of transmitter operating upon a principle permitting a similar design to be employed regardless of the required maximum number of digits per number.

A second object is to provide a transmitter of the stated type adaptable for sending the selected numbers at two or more speeds for operation of various types of responsive apparatus.

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A third object is to provide a transmitter of the stated type having provision for use with other transmitters on the same transmission line, whereby, in the event of simultaneous operation of more than one transmitter, they will not interfere but will send their signals to the line successively.

Another object is to provide a transmitter which may be used for signaling by means of transmission lines either normally open or normally closed through the transmitting station. In the latter case the lines should be opened only when the transmitter is in control of the line and sending its signals thereto.

Another object is to provide a transmitter normally operative in an all-metallic circuit, but having means for using a ground connection in event of circuit failure or other abnormalities.

Other objects are to provide for sending numbers having first digits of more than ten strokes, and "pre-signal" numbers to be transmitted before the first round or before each round, to provide special coded designations independently of the rest of the transmitted numbers.

With the above objects in view a feature of the present invention comprises a network of stepping type switches in a novel arrangement especially adapted to the above requirements.

Other features of the invention comprise certain novel arrangements, connections, and forms of construction adapted to satisfy the above objects and other objects hereinafter described. These features will become more evident in the light of the following description, and are specifically defined in the claims.

In the drawings, Fig. 1 is a schematic circuit diagram of a network of stepping-type switches forming an embodiment of the invention; Fig. 2 is a schematic circuit diagram of a group of auxiliary relays operative in conjunction with the circuit of Fig. 1 to control the signal output to the transmission line; Fig. 3 is a diagram showing a variant of the pre-signal relay connections; and Fig. 4 is a schematic circuit diagram of a second embodiment of the invention.

General description

The described embodiments of the invention are direct-current operated. Except for a special case dealt with below under the heading "First digit switch," they have a capacity for transmitting numbers up to eight digits in length, with a maximum of ten strokes per digit. For reasons which will presently appear these limits are not inherent in the system employed and may be extended by providing more switches and more

steps or contacts on each switch. The timing of the signals is based on an assumed interval between digits represented by the withholding of one stroke from the transmission, and an interval between rounds of longer duration than the interval between digits. The length of the latter interval varies in a manner hereinafter described according to the embodiment and the operating conditions, but is independent of the number of digits transmitted.

In the embodiment of Figs. 1 and 2 transmissions are sent over two transmission lines, first over a signal circuit which is normally closed and which operates at a relatively high speed, and second over a local circuit, operating at a slower speed. The single output in the embodiment of Fig. 3 is connected to a normally-open external circuit.

Referring to Figs. 1 and 2, the general structure and operation of one embodiment of the transmitter is next described. Since the embodiment of Fig. 3 is in many respects merely a simplified form of this circuit, the application of the description thereto may easily be inferred by one skilled in this art.

A group of digit setting switches, represented by the switches DS1, DS2 and DS3 are set up manually with the digits of the number to be transmitted, for example a fire alarm box number. Pre-signal switches, represented by the switches PS1 and PS2 in the drawing, are set up similarly with separate coded numbers to be transmitted either at the beginning of the first round of each transmission only, according to the variant shown in Fig. 3, or at the beginning of each round, as in the embodiment of Figs. 1 and 2. A pair of round setting switches RS1 and RS2 are used to set up manually the number of rounds to be transmitted over each of the two transmission circuits. The digit setting switches, pre-signal setting switches and round setting switches are also each provided with means for visually indicating positions for which they are set.

Electrically operated switches of similar construction include a stroke counter SC, which counts and controls the number of pulses or strokes transmitted for each digit, a digit counter DC, which controls the order of digit transmission, a round counter RC, which counts and controls the number of rounds transmitted, and a sequence control switch SQ, which operates as an overall sequence control and causes the transmission to occur first over the signal circuit and second over the local circuit.

The transmission procedure is conveniently described in terms of successive steps of the sequence control. In the described embodiment there are four sequence steps which are initiated by a manually operated, momentary-contact, push start switch, after the pre-signal, digit and round setting switches have been set up.

After the first step of the sequence control switch from its "off" position it causes the electrically operated stepping switches (SC, DC and RC) to be restored to their initial positions, and starts a motor M which controls two sets of timing contacts for producing the signal impulses. One contact set is actuated by a cam producing pulses of appropriate duration for the local circuit, while the other is actuated by a second cam that produces pulses of appropriate duration for the signal circuit.

After the second step of the switch SQ the transmission of the selected number is initiated at the appropriate pulse speed over the signal

circuit, the number of rounds being determined by the setting of the round setting switch RS1.

After the third step the selected number is transmitted at a different pulse speed over the local circuit, the number of rounds being determined by the setting of the switch RS2.

After the fourth step the sequence switch is returned to its starting position.

The general sequence of relay movements after the sequence control completes the second step (transmission to the signal circuit) is the same as the sequence after the third step (transmission to the local circuit). To transmit the first digit, operating impulses are supplied both to the stroke counter and to the output circuit, each impulse causing the stroke counter to advance one step, until it reaches a position which is supplied by impulses from the selected position of the first pre-signal or digit setting switch selected by the digit counter. Upon reaching this position the stroke counter interrupts the signals to the line, causes the digit counter to move one step, and returns to its initial, or "restored" position.

Succeeding digits are transmitted in the same manner, with the digit counter moving one step each time the stroke counter is restored, thus causing each of the pre-signal and digit setting switches to cooperate with the stroke counter successively to control the number of impulses, or strokes, per digit.

The digit counter continues to step in the above manner until it reaches a position corresponding to the last available digit setting switch, or reaches any pre-signal or digit setting switch which has been left in the restored position. In either case the digit and stroke counters are then both returned to their restored positions and the end of the round is indicated by the stepping of the round counter to its next round position.

When the round counter has stepped in the above manner to a position corresponding to the setting of one of the round setting switches RS1 or RS2 the round counter is also restored and the sequence control is moved to its next position.

A more detailed description of the above operations is given hereinafter in terms of specific circuit connections and sequences of operation.

In addition to the units heretofore mentioned, the transmitter of Figs. 1 and 2 includes a number of auxiliary relays, all but one of which are shown in Fig. 2. These are of the familiar transfer contact type and are used mainly to control the transmission of the signals to the line according to the line conditions at the time of transmission.

A manually operated, momentary-contact, push restore switch is provided for simultaneously returning all digit setting switches to their restored positions. As hereinafter shown, operation of this switch during transmission immediately terminates transmission and causes restoration of all electrically operated stepping switches as well as all of the digit setting switches. Transmission is also automatically terminated when the round setting switch in use during a transmission is returned to its "0" position.

Stepping-type switches and auxiliary relays

As in the preceding discussion, the following description is made in reference to the embodiment of Figs. 1 and 2. The applicability of the

description to the embodiment of Fig. 3 may be readily inferred therefrom.

An important economy of the invention is in the feature that all of the rotary switches may be constructed from a single basic design which permits a high degree of interchangeability of parts. These switches may be classified structurally into four groups; first, the pre-signal and digit setting switches; second, the round setting switches; third, the stroke, digit and round counters, and fourth, the sequence switch. All of the switches are of the twelve-index rotary type, utilizing standard relay type contact springs, preferably having silver points. The contacts are preferably arranged in pairs in a circle, with insulation between the pairs as well as between the contacts of each pair. A rotatable shaft in the center and parallel with the contact springs has an actuating member fixed thereto for actuating the respective contacts.

The pre-signal and digit setting switches are each preferably provided with a manually rotatable twelve-index locating wheel, cooperating with a fixed, spring tensioned locating lever. The twelve contact pairs are normally open. Actuator means are provided for closing only a single pair of contacts for each position of the switch. The position at any moment is represented schematically in Fig. 1 by an arrow. Stops are provided to limit the shaft to eleven positions, numbered for purposes of illustration from "0" to "10." An indicator is preferably provided to display the switch positions. A restore spring fixed at one end to the switch frame and at the other end to the locating wheel tends to rotate the wheel toward the restored position, but is normally prevented from doing so by the engagement of the locating lever with the wheel. A release magnet is provided to lift the lever away from the wheel, thus allowing the switch to return to the restored position automatically when the magnet is energized. In the drawing, the release magnets are shown at the right of the figure, and are designated as R-PS1, etc. where "R" stands for release, and the rest of the designation is the same as that for the corresponding switch.

Thus, the pre-signal and digit setting switches can be set up manually in any order and can be manually restored to zero at any time. However, as indicated below under the heading "Normal transmission," the transmission always follows the same order, for example from left to right as in the described embodiments. Also, if any digit setting switch is left in its restored position, i. e. not set, transmission of each round will be terminated when that switch is reached, regardless of the setting of any switches to the right of such switch.

The round setting switches are preferably set up and restored manually; hence, they do not require the restoring magnet. They do, however, have the locating wheel and lever. Stops are provided to limit rotation of the shaft to five normally-open contact positions. A pointer may be provided to indicate positions "0" through "4." Actuator means close only a single pair of contacts for each switch position, as in the digit setting switches. As hereinafter explained, the returning of a round setting switch to "0" position during a transmission will immediately terminate the transmission. If transmission is initiated with the round setting switches in "0" position, no number will be transmitted, regardless of the setting of the digit setting switches.

The stepping switches for counting strokes, digits, and rounds are both stepped and restored by magnets. They are each preferably provided with twelve normally-open contact pairs, actuator means for closing only a single pair of contacts for each switch position, and a ratchet-stepping mechanism including a twelve-index ratchet wheel, a spring tensioned ratchet retaining pawl and a stepping magnet for advancing a stepping pawl one index interval upon each deenergization of the stepping magnet. A release magnet is provided to move the retaining pawl out of engagement with the ratchet wheel when the release magnet is energized. A restore spring similar to those used in the digit setting switches is provided. Thus when both the stepping magnet and release magnet are simultaneously energized, but not otherwise, the switch is moved back to its restored position. A stop limits the rotation of the shaft to twelve positions. Deenergization of the stepping magnet subsequently to the restoring of the switch automatically advances the shaft one step by reason of the assumed structure of the ratchet mechanism. The position which the switch then reaches is its initial position at the start of each transmission. In the drawing the counters are all shown in their initial positions. The stepping and release magnets are represented in Fig. 1 as S-SC, R-SC, etc., where "S" stands for stepping, "R" stands for releasing and the rest of the designation in each case is the same as that for the corresponding switch.

It will be noted from the drawing that a contact spring group, such as R-SC-1 for example, is associated with each of the release magnets on the counter switches. The designations of these contact groups are the same as for the corresponding release magnets, except that they are each followed by a numerical suffix.

The sequence control stepping switch has no stops or restore springs, and is adapted to move in one direction only under the control of stepping mechanism similar to that used in the counter switches. This switch has three equally spaced switch-contact actuators. Thus, three contact pairs are actuated in each switch position, and the "off" position of this switch is reached on every fourth step. The switch also has eleven pairs of normally-open contacts and one normally-closed pair, the latter being designated in Fig. 1 at the position "9" by a distinctive triangular contact symbol.

The auxiliary relays are of conventional two-position construction. In Fig. 1 a pre-signal relay PSR is associated with a contact pair on the round counter RC. This relay has three transfer contact groups shown immediately below the pre-signal and digit setting switches and designated as PSR-1, PSR-2, and PSR-3. The function of this relay is described below under the heading "Pre-signals."

The remaining relays are shown in Fig. 2. These include a closed circuit test relay CTR, having a single transfer contact group CTR-1, a non-interference relay NIR, having two transfer contact groups NIR-1 and NIR-2 and a normally-closed contact pair NIR-3, a signal repeat relay SRR, having four normally-open contact pairs SRR-1, SRR-2, SRR-3 and SRR-4, an open circuit test relay OTR, having a single transfer contact set OTR-1, and a ground connection relay GCR, having one transfer contact set GCR-1, one normally-closed contact pair

GCR-2, and two normally-open contact pairs GCR-3 and GCR-4.

It will be noted from the above description and from the drawings that the relay contacts are shown in the positions which they occupy when the corresponding relays are deenergized, that is, in the "normal," or in the "down" position.

Further description of the relays shown in Fig. 2 is given below, especially under the headings "Positive, non-interfering and successive transmission," and "Grounded transmission."

Normal transmission

The description herein of specific circuitry, except where otherwise indicated, relates to the embodiment of Figs. 1 and 2.

In view of the several different conditions under which the circuit of Figs. 1 and 2 may be operated, the description under this heading assumes certain conditions and settings of the circuits, switches and relays. Under subsequent headings dealing with specific settings and conditions the variations are dealt with largely in reference to the basic description under this heading.

Therefore, it is here assumed that the pre-signal setting switches PS1 and PS2 are in their restored positions (contacts "0" closed), and that the signal circuit is closed through a circuit including this and other transmitters, in series with a direct current power supply.

Referring first to Fig. 2, the signal circuit is connected at terminals T1 and T2, and is normally closed through the transmitter by a pair of contacts NIR-3. When the transmitter is to be operated under the assumed line conditions, the contacts NIR-3 are held open for the duration of the transmission, and a pair of contacts SRR-4 are closed and opened once for each stroke to be transmitted.

Thus, transmission to the signal circuit is effectuated by the energization of the relay SRR once for each stroke. Energization of the relay SRR is brought about by application of plus battery impulses to a lead 2. This lead is also shown in Fig. 1. The pulses reach the lead 2 from a "signal impulse bus" through contacts C1 operated by a fast-time cam Ca2 and contacts 11 of the sequence control. In another position of the sequence control, impulses from this bus may also be directed through the contacts 12 and a local circuit lead 4 to a terminal T4. The local circuit is assumed to be normally-open and connected to negative battery at a terminal T3.

The three contact actuators of the sequence control SQ are shown in Fig. 1 in their normal positions for the initiation of a signal transmission.

Assuming that the digit setting switches DS1, DS2, DS3, etc., and the round setting switches RS1 and RS2 have been set up for the required signal and number of rounds for each of the output circuits, transmission is initiated by depressing the momentary push-type start switch SS. Contacts "1" of the sequence control SQ being closed, plus battery is applied to a lead 6 through the start switch SS, thus actuating the stepping magnet S-SQ of the sequence control switch. Contacts "5" of SQ being closed, plus battery is applied through the lead 6 and contacts "5" to a lead 7, actuating the stepping and release magnets of the stroke, digit and round counters. This immediately returns the three counters to their restored positions if they

are not already restored, but does not move the sequence control.

When the start switch is released, deenergization of the stepping magnet S-SQ causes the sequence control to step to its next position. In the next position the contact pairs "2," "6" and "10" are closed. The movement of the sequence control also close its "9" contacts and applies plus battery over a lead 8 to the motor M and the relay PSR. The opening of the "1" contacts of the sequence control removes the start switch from the circuit. Thus, the remaining operations are purely automatic.

Rotation of the motor turns the two cams Ca1 and Ca2, the slow-time cam Ca1 being assumed to operate its contacts at half the speed of the cam Ca2 for purposes of illustration. Since the sequence control now closes its "2" contacts, plus battery is applied over a lead 9 and through contacts C3 of the cam Ca2 to a lead designated as "operating impulse bus." Thus, as long as the sequence control is in this position the operating impulse bus receives consecutive fast-time impulses.

The first impulse following the starting of the motor merely advances the sequence control switch one more step through its closed contacts "6," thus closing contacts "3," "7" and "11." This step is for the purpose of eliminating the possibility of a short operating impulse to the other switches, which might occur if the motor had previously stopped with the contacts near the drop-off point of the cam. The operating impulses now continue to reach the bus by connection of plus battery through contacts "3" of the sequence control. Closure of the "11" contacts connects the signal impulse bus to the lead 2. The first operating impulse, in addition to energizing the magnet S-SQ as above, also passes through the closed contacts "10" of the sequence control, thus energizing the stepping and release magnets of the stroke, digit and round counters over the lead 7.

The second operating impulse advances the digit counter one step by connection over a circuit to the magnet S-DC from the operating impulse bus through the contacts shown as closed in the digit counter DC and a lead 19 connected thereto. The same impulse energizing the stepping magnet S-DC also energizes the release magnet of the stroke counter R-SC. Since the relays R-SC and S-SC are both energized by the same impulse the stroke counter is not stepped to its next position.

The third impulse advances the digit counter an additional step through a circuit to the lead 10 similar to that of the preceding impulse except that it passes through the "0" contacts of the digit counter DC.

Upon the termination of the third impulse, the digit counter advances to its "1" contacts, preparing a circuit from the operating impulse bus to a lead 12, through the "1" contacts, the transfer contacts PSR-1, and the "0" contacts of the pre-signal switch PS1.

The fourth impulse passes through the circuit thus prepared to the lead 12, energizing the stepping magnet of the round counter S-RC and restoring the digit and stroke counters. Upon the termination of this impulse the round counter closes its contacts midway between "0" and "1," short-circuiting the relay PSR.

The fifth impulse, like the second, steps the digit counter to its "0" contacts through a circuit from the operating impulse bus to the lead

10, through the digit counter contacts shown as closed. The stroke counter is not stepped by this impulse.

The sixth impulse, like the third, steps the digit counter to its "1" contacts. On the termination of this impulse the digit counter advances to its "1" contacts, preparing a circuit from the operating impulse bus, through contacts "1," the normally-closed contacts PSR-1 and the set-up contact pair of the switch DS1 ("3," in the figure) to the corresponding contacts of the stroke counter.

The seventh impulse steps the stroke counter to its "1" contacts by energization of the magnet S-SC. This is the first impulse which fails to energize the magnet R-SC, and therefore the operating impulse bus and the signal impulse bus are connected together through the normally-closed contacts R-SC-1. The operating impulse reaches the lead 2 through the "11" contacts of the sequence control and contacts C1 of the cam Ca2. For reasons hereinafter explained, the contacts C1 are set to close somewhat after the contacts C3. Thus, the leading edge of the signal impulse is actually fixed by closure of the contacts C1.

In a similar manner the eighth operating impulse, which becomes the second impulse to the lead 2, steps the stroke counter to its "2" contacts.

The ninth operating impulse similarly becomes the third signal impulse. On the termination of this impulse the stroke counter is advanced to its "3" contacts, preparing a circuit from the operating impulse bus to a lead 14, through contacts "1" of the digit counter, normally-closed contacts PSR-1, the set-up contacts of the switch DS1 ("3" in the drawing), and contacts "3" of the stroke counter.

The tenth operating impulse energizes the magnets R-SC and S-DC over the above circuit, and also the magnet S-SC through its direct connection to the bus. The digit counter is thus advanced one step and the stroke counter is restored. This impulse does not reach the signal impulse bus because the contacts C1 of the cam Ca2 are set to close after the contacts C3, which results in the energization of the magnet R-SC and the opening of the contacts R-SC-1 in the signal impulse bus before the contacts C1 are closed to connect the signal impulse bus to the lead 2. To insure the continued energization of the magnet R-SC throughout the impulse, two blades of the contacts R-SC-1 close to connect the lead 14 and the operating impulse bus directly for the remainder of the impulse.

The net result of the above connections is the transmission of three signal impulses to the signal circuit, corresponding to the assumed setting of the digit setting switch DS1. The next operating impulse, like the seventh, steps the stroke counter to its "1" contacts and the cycle is repeated as for the succeeding strokes, except that the digit counter contacts "2" now select the switch DS2 through the normally-closed contacts PSR-2, causing the next digit to have the number of strokes determined by the setting of the switch DS2. It will be noted that the group of impulses corresponding to the second digit is separated from that of the first digit by one stroke, corresponding to the 10th operating impulse in the example given.

Similar groups of impulses corresponding to the setting of the successive digit setting switches are transmitted, until either of two con-

ditions arises to terminate the round. The first of these conditions occurs when the digit counter is advanced to its "x" contacts by an operating impulse which, like the tenth impulse described above, also restores the stroke counter but does not reach the signal impulse bus. When this happens, the following operating impulse finds a circuit to the lead 12 through the "x" contacts, steps the round counter and restores the digit and stroke counters. This impulse is also disconnected from the signal impulse bus by energization of the magnet R-SC. Energization of the magnet R-DC closes a direct circuit through its contacts R-DC-1 connecting the lead 12 and the operating impulse bus.

The second condition producing a similar result occurs when the digit counter is advanced to a contact pair connected with a digit setting switch in the "0" position. In this case the particular digit setting switch completes the circuit which on the succeeding impulse energizes the lead 12.

The stepping of the round counter upon the happening of one of the above conditions opens the contacts short-circuiting the relay PSR, thereby causing this relay to be energized. Assuming that the rounds switch RS1 is set for more than one round, the succeeding operating impulse is a repetition of the second impulse heretofore described. The digit counter is advanced to its "0" contacts. It will therefore be seen that a total of seven strokes are withheld from the signal impulse bus between the last stroke of a round and the first stroke of the succeeding round.

Upon the termination of the number of rounds for which the switch RS1 is set, for example, four rounds, the impulse energizing the lead 12 steps the round counter to close its "4" contacts. This prepares a circuit from the operating impulse bus to the stepping magnet of the sequence control S-SQ, through the "7" contacts of the sequence control, the "4" contacts of the switch RS1, the "4" contacts of the round counter, the lead 7, the normally-open contacts NIR-1 (assumed to be closed; see Fig. 2), a lead 16 and a lead 18. The next impulse, like the first impulse discussed above, steps the sequence control to close its contacts "4," "8" and "12" and restores the round, digit and stroke counters. Energization of the magnet R-RC closes a direct circuit through its contacts R-RC-1 connecting the lead 7 and the operating impulse bus and by-passing the contacts through the sequence control, the rounds switch RS1 and the round counter for the remainder of the impulse.

Transmission is next directed to the local circuit. The signal impulse bus is connected through the "12" contacts of the sequence control and the contacts C2 of the cam Ca1 to the terminal T4. The number of rounds is determined by the setting of the switch RS2.

Upon the completion of the transmission to the local circuit the sequence control steps into the fourth position, opening its "9" contacts and shutting off the motor M. This terminates the transmission.

The effect of closing the restore switch RS at any time during the transmission will now be evident. If the switch is held closed for a sufficient period, the succeeding operating impulses find a circuit over a lead 19 to the lead 6 and cause the sequence switch to step around to its starting position, where its "1" contacts connect plus battery to the release magnets of the digit

setting switches. Transmission is immediately terminated.

A similar result is produced if the rounds setting switch associated with the circuit then receiving the transmission is turned to its "0" contacts, except that the release magnets of the digit setting switches are not energized. The succeeding operating impulses then find a circuit to the lead 6 through the contacts "7" or "8" of the sequence control, the "0" contacts of the associated rounds setting switch and the lead 13.

From the foregoing description certain features of the circuit of Fig. 1 will be appreciated. For example, no contacts on any of the setting or stepping switches either make or break a closed circuit, with but one exception: the contacts "9" of the sequence control close and open the circuit from plus battery to the motor M. But the current drain of the circuit in this case is no greater than 0.1 ampere for a suitable 24 volt motor. The advantage of this feature is in the elimination of arcing at the contacts of the setting and stepping switches.

The start switch SS and the cam-actuated contacts are the only ones which make and break circuits through the stepping magnets. In order to eliminate serious arcing in these contacts, each group consists of three normally-open contacts, arranged to close and open consecutively. A fixed resistance is connected between the two contacts which close last and open first in each group. This resistor reduces the current flowing at the time the circuit is opened by the third contact of the group.

Pre-signals

The discussion under the heading "Normal transmission" assumes that the pre-signal setting switches are set to "0." For this reason the impulse following the first stepping of the digit counter to its "1" contacts at the start of each round resulted in energization of the lead 12 through the transfer contacts PSR-1 and the "0" contacts of the pre-signal switch PSI.

If the switch PSI is not set to "0" the following impulse causes the stroke counter to step, and therefore only four impulses are withheld from the signal impulse bus between the last stroke of a round and the first stroke of the pre-signal of the following round. The first impulse restores the stroke counter and steps the digit counter. The second impulse restores both the digit and stroke counters and steps the round counter. The third and fourth impulses step the digit counter around to its "1" contacts. The succeeding impulses will be transmitted.

Similarly, four impulses are withheld from the signal impulse bus between the last stroke of a pre-signal and the first stroke of the number set in the switch DSI.

Variant of pre-signals; continuous transmission

A variant of the circuit of Fig. 1 is represented in Fig. 3 by a circuit 20 enclosed within dotted lines. This circuit may replace the portion of Fig. 1 similarly enclosed within dotted lines and has the feature of transmitting the pre-signal only at the start of the first round.

It will be recalled that at the start of a transmission plus battery is connected to a lead 3 and the motor M through the "9" contacts of the sequence control after the latter has stepped from its starting position. As shown in Fig. 3 this also energizes the pre-signal relay PSR through the "0" contacts of the round counter. The first op-

erating impulse steps the sequence control. The second and third impulses step the digit counter to its "1" contacts, and the fourth impulse becomes the first stroke of the pre-signal.

At the end of the pre-signal an impulse (the second successive impulse not transmitted) reaches the lead 12 to step the round counter. This deenergizes the relay PSR, and the number in the switch DSI is next transmitted after two more impulses for stepping the digit counter to its "1" contacts. Thus, as in the embodiment of Figs. 1 and 2, four impulses are withheld from the signal impulse bus between the pre-signal and the digit in the switch DSI.

At the end of a round an impulse over the lead 12 (again, the second successive impulse not transmitted) steps the round counter to its "1" contacts. If the rounds setting switch then in control is not set for one round, the next two succeeding impulses step the digit counter to its "1" contacts, and the third impulse is transmitted. Thus, four impulses are withheld from the signal impulse bus between the first round and the second round, and no pre-signal is transmitted in the second round.

The intervals between the second and successive rounds now increase by one stroke. Thus, at the end of the second round, the first impulse not transmitted restores the stroke counter and steps the digit counter. The second impulse restores both the digit and stroke counters and steps the round counter to its contacts midway between "1" and "2." This prepares a circuit for the third impulse, which steps the round counter to its "2" contacts and again restores the digit and stroke counters. The fourth and fifth impulses not transmitted step the digit counter to its "1" contacts. Thus, the third round begins after five impulses have been withheld from transmission.

The variant of Fig. 3 is also adapted to cause continuous transmission over the local circuit. For this purpose, a normally-closed contact pair "c" is provided on the rounds switch RS2. These contacts complete the circuit to the stepping magnet of the sequence switch from the lead 16. This lead is usually energized by the lead 7 to step the sequence control when the required number of rounds has been transmitted. If the switch RS2 is set to open its "c" contacts when the round counter starts transmission to the local circuit, five rounds will be transmitted before an impulse reaches the lead 7. When the round counter reaches its "5" contacts a circuit is prepared through these contacts from the operating impulse bus to the lead 7. The succeeding impulse energizes the leads 7 and 16, but does not reach the lead 13 and the stepping magnet of the sequence control. Instead, the stroke, digit and round counters are reset and the cycle repeats itself continuously, or until the switch RS2 is set at some other position.

First digit switch

The simplified circuit shown in Fig. 4 illustrates a feature whereby a total of ten strokes may be added to the setting of the first digit in each round.

The operation of this circuit is first described assuming that a first digit switch FDS is in its position "0-10" as represented in the figure.

Closure of a start switch SS energizes a start-stop relay SSR through normally-closed contacts SSR-1 through connection of a normally-open blade to plus battery.

Closure of the contacts SSR-3 energizes a motor M' by connection to a source of alternating current. Plus battery, now connected by the start-stop relay to a lead 22, is applied through contacts C5 to the operating impulse bus.

Assume, for example, that a round-setting cam lever switch RSS, which is selectable for 0, 1 or 4 rounds, is turned to its "4" position. The ensuing operations closely follow the pattern of transmission as described in connection with Fig. 1 for four rounds, at the end of which closure of the "4" contacts of the round counter prepares a circuit from the operating impulse bus to a lead 24. The succeeding impulse reaches the lead 24 and short-circuits the coil of the relay SSR, causing it to drop out. It will be noted that this last impulse also restores the stroke, digit and round counters, as in the previously described arrangements.

Next, assume that a transmission is initiated with the first digit switch FDS in its "+10" position. The first operating impulse is unaffected by the change and steps the digit counter to its "0" contacts, while restoring the stroke counter. The second impulse, which normally steps the digit counter, is directed instead over a lead 26 to the signal impulse bus and over a lead 28 to the "9" contacts of the stroke counter. The stroke counter steps to its "1" contacts. The succeeding eight impulses are similarly transmitted and cause the digit counter to step around to its "9" contacts. The next impulse reaches the signal impulse bus over the lead 26 and also finds a circuit to the stepping magnet of the digit counter through the "0" contacts of the digit counter, the lead 28 and the "9" contacts of the stroke counter. This impulse also restores the stroke counter. It will be evident that transmission of the digit in the switch DS1 immediately begins, and that the total strokes transmitted will be ten more than the setting of the first digit switch.

In this variant of the circuit the pause between rounds depends on the position of the switch FDS. If the switch is in its "0-10" position, as shown, five impulses are withheld from the signal impulse bus between the last stroke of a round and the first stroke of the next round. If the switch is in its "+10" position only four impulses are withheld. That is, the round interval is shortened by one impulse.

Positive, non-interfering and successive transmission

The embodiment of the invention shown in Figs. 1 and 2 incorporates a feature whereby the condition of the normally-closed signal circuit is tested before transmission is initiated. If another transmitter is in operation on the same circuit the transmitter waits, tests the line periodically (at the end of each round), and transmits the complete number of rounds for which it is set when the other transmitter has ceased to operate.

The circuit is shown in Fig. 2. Assuming that no other transmitter is in operation at the time transmission is started, the relay SCR is energized, since the signal circuit is closed externally through a battery and internally through the contacts NIR-3.

Closure of the start switch SS (Fig. 1) applies plus battery to the relay CTR through the lead 6, the "5" contacts of the sequence control, the lead 7 and a lead 30. Release of the start switch causes deenergization of the relay CTR.

However, the motor M is started by closure of the "9" contacts of the sequence control. The first operating impulse again energizes the relay CTR through the "6" and "10" contacts of the sequence control and the leads 7 and 30. This time, the relay remains energized by closure of a holding circuit from the lead 8, energizing the motor, through the transfer contacts CTR-1. The relay CTR remains energized subject to being short-circuited on the happening of either of two conditions. First, if the relays NIR and SCR both become deenergized at any time, a circuit is completed from the lead 8 (now connected to plus battery), through the normally-closed contacts NIR-2 and SCR-1 to the negative side of the relay CTR, causing the relay to be deenergized. Second, even if the relay NIR does not become deenergized, the relay CTR may be short-circuited by a signal impulse from the lead 2 through the normally-closed contacts SCR-1.

If neither of the above events occurs on or prior to the sending of the first signal impulse over the lead 2, the relay NIR is energized by this impulse and locks itself up through the transfer contacts NIR-2 connected to the lead 8. The relay NIR now remains energized subject to a short-circuit in the event that the relay CTR becomes deenergized while the relay GCR is also deenergized. This circuit is connected from the lead 8 through the normally-closed contacts CTR-1 and GCR-2. Once the relay NIR has been energized, one of the two above-mentioned short-circuiting conditions for the relay CTR is also eliminated. This relay can now be short-circuited only on a signal impulse from the lead 2 through the normally-closed contacts SCR-1.

The relay SRR is energized on every signal impulse to the lead 2. Assuming that the relay NIR remains energized the contacts NIR-3 in the signal circuit are held open and the contacts SRR-4 close and open for each of the strokes to be transmitted.

The above description assumes that no other transmitter is active in the signal circuit at any time during the transmission. An interval of time extending from the last impulse energizing the digit counter release relay (and the relay CTR) to the first signal impulse on the lead 2 (energizing the relay NIR) constitutes a test period. If at any time during this period the external signal circuit is opened, the transmitter cannot send a signal since its sending contacts remain short-circuited. On the other hand, if the external signal circuit remains closed throughout the test period transmission will be initiated, and may be terminated prior to the number of rounds for which the transmitter is set only under the abnormal condition which arises if a signal impulse occurs at a moment when the relay SCR in the signal circuit remains deenergized. This can occur, for example, if the external circuit is opened at any moment when a signal impulse is transmitted. It is apparent that the condition will not arise if the other transmitters on the signal circuit are equipped with the circuit herein described and the same is in working order.

As indicated earlier, if transmission is interrupted the transmitter will transmit the complete number of rounds for which it is set regardless of the length of time between starting and getting control of the signal circuit. This may be seen by taking an example.

Suppose the transmitter is started and is set for four rounds in the signal circuit, and also

that at the moment of starting another transmitter elsewhere on the signal circuit is transmitting. In this case the contacts SRR-4 of the transmitter already in operation will open the signal circuit one or more times during the test period of the transmitter in question. Therefore, the first round of this transmitter is not transmitted. At the end of the first round a digit counter release impulse reaches the lead 12 (Fig. 1) and the lead 30, energizing the relay CTR and initiating a second test period. Since the relay NIR is assumed to be deenergized at this time the same impulse reaches the lead 7 through the normally-closed contacts NIR-1 (Fig. 2) and the round counter is therefore restored. The impulse restoring the round counter does not step the sequence control since the contacts NIR-1 disconnect it from the lead 16 connected to the sequence control stepping magnet S-SQ. It is therefore evident that no round which fails to be transmitted is counted by the round counter, and therefore the round counter is in its restored position at the start of the first test period indicating that the transmitter has gained control of the signal circuit. The full four rounds will therefore be transmitted.

Grounded transmission

The embodiment of the invention shown in Figs. 1 and 2 also incorporates an additional feature whereby, if the transmitter is started and fails to gain control of the signal circuit, and if the signal circuit remains open for a test interval of one round duration, the transmission is immediately initiated and one terminal of the signal circuit (T2) is grounded during each stroke.

Assume that when the transmitter is started the signal circuit is open-circuited in the line connected to the terminals T1 and T2. The first operating impulse, which reaches the lead 39, energizes the relay OTR as well as the relay CTR. The relay CTR is not locked up, for the reasons given under the preceding heading. However, the relay OTR is locked up by a circuit from the lead 8 through the normally-closed contacts GCR-1 and the normally-open contacts OTR-1. The relay OTR then remains energized subject to being short-circuited if the relay SCR is energized at any time when a signal impulse is present on the lead 2. This short-circuit is connected from the lead 2 through the transfer contacts SCR-1 to the negative side of the relay OTR.

If the relay OTR is still energized when the first signal impulse reaches the lead 2 the relay SRR is energized and locked up by the same circuit which locks up the relay CTR, in series with the normally-open contacts SRR-1.

If the relay OTR is not short-circuited at any time during the first round by the energization of the relay SCR the impulse restoring the digit counter, which reaches the lead 30 (see Fig. 1), energizes the relay GCR through the normally-open contacts SRR-2 and locks it up to the lead 8 through the transfer contacts GCR-1.

Energization of the relay GCR opens the short-circuit for the relay NIR at the normally-closed contacts GCR-2. The effect of this is that the first stroke of the succeeding round reaching the lead 2 energizes the relay NIR and locks it to the lead 8 through the contacts NIR-2, regardless of the condition of the relay CTR.

The relay GCR also opens the holding circuit for the relays OTR and SRR at the contacts

GCR-1, short-circuits the relay SCR at the contacts GCR-4 and closes the contacts GCR-3, connected to the ground.

Transmission immediately begins, since the contacts NIR-3 are opened. During the short interval in which each stroke is transmitted the terminal T2 is connected through the contacts SRR-3 to ground.

Having thus described my invention, I claim:

1. Apparatus for sending coded pulses comprising a source of continuous pulses and a plurality of rotary switches, each switch having a number of contact positions, said switches including a number of digit setting switches for presetting a code number to be transmitted, and a number of counter switches, each having a stepping magnet with means adapted to step the counter on each deenergization of the magnet and a release magnet with means adapted to restore the counter to a predetermined position when both of said magnets are simultaneously energized, said counter switches controlling the transmission of the number digit-by-digit according to a predetermined sequence, and a circuit including rectifier means for energizing the stepping and release magnets, whereby the counters are arranged in a consecutive sequence and energization of the release magnet of any counter restores said counter and all preceding counters and steps the succeeding counter.

2. Apparatus for sending coded pulses comprising a source of continuous pulses, a plurality of rotary switches including digit setting switches for presetting a code number to be transmitted and sequentially arranged counter switches, each counter switch having a stepping magnet with means to step the switch on each deenergization of the magnet and a release magnet with means adapted to restore the switch to a predetermined position when both of said magnets are simultaneously energized, said counter switches controlling the transmission of the number digit-by-digit according to a predetermined sequence, and a circuit for energizing said magnets including leads connected in series through rectifiers, at least one of said leads being connected to the release magnet of a counter switch and the stepping magnet of the succeeding counter switch.

3. Apparatus for sending coded pulses comprising a source of continuous pulses, a plurality of rotary switches including digit setting switches for presetting a code number to be transmitted and sequentially arranged counter switches, each counter switch having a stepping magnet with means to step the switch on each deenergization of the magnet and a release magnet with means adapted to restore the switch to a predetermined position when both of said magnets are simultaneously energized, said counter switches controlling the transmission of the number digit-by-digit according to a predetermined sequence, and a circuit for energizing said magnets including leads connected in series through rectifiers, at least one of said leads being connected to the release magnet of a counter switch and the stepping magnet of the succeeding counter switch, and the polarities of the rectifiers being such that energization of the release magnet of any switch simultaneously restores said switch and all preceding switches and steps the succeeding switch.

4. Apparatus for sending coded pulses comprising a source of continuous pulses, a plurality of rotary switches including digit setting switches for presetting a code number to be transmitted

and sequentially arranged counter switches, each counter switch having a stepping magnet with means to step the switch on each deenergization of the magnet and a release magnet with means adapted to restore the switch to a predetermined position when both of said magnets are simultaneously energized, said counter switches including a stroke counter connecting said source to a signal impulse bus and having provision for stepping once for each impulse and for disconnecting said source from the bus upon occurrence of the next impulse after said counter reaches a position corresponding to that of a selected digit setting switch, a digit counter for selecting the digit switches in a consecutive sequence, having provision for stepping after said next impulse, and a round counter for counting the number of repetitions of said consecutive sequence, having provision for stepping at the end of each sequence, and a circuit for energizing said magnets including leads connected in series through rectifiers, at least one of said leads being connected to the release magnet of a counter switch and the stepping magnet of the succeeding counter switch.

5. Apparatus for sending coded pulses comprising a source of continuous pulses, a plurality of rotary switches including digit setting switches for presetting a code number to be transmitted and sequentially arranged counter switches, each counter switch having a stepping magnet with means to step the switch on each deenergization of the magnet and a release magnet with means adapted to restore the switch to a predetermined position when both of said magnets are simultaneously energized, said counter switches including a stroke counter connecting said source to a signal impulse bus and having provision for stepping once for each impulse and for disconnecting said source from the bus upon occurrence of the next impulse after said counter reaches a position corresponding to that of a selected digit setting switch, a digit counter for selecting the digit setting switches in a consecutive sequence, having provision for stepping after said next impulse, and a round counter for counting the number of repetitions of said consecutive sequence, having provision for stepping at the end of each sequence and a circuit for energizing said magnets including leads connected in series through rectifiers, at least one of said leads being connected to the release magnet of a counter switch and the stepping magnet of the succeeding counter switch, and the polarities of the rectifiers being such that energization of the release magnet of any switch simultaneously restores said switch

and all preceding switches and steps the succeeding switch.

6. Apparatus for sending coded pulses, comprising a source of continuous pulses, and a plurality of rotary switches including a stroke counter connecting said source to a signal impulse bus and having a plurality of contact positions and means for stepping once for each impulse, a digit setting switch for each digit to be transmitted having a selectable contact position corresponding to each possible value of said digit, said positions being connected to corresponding positions of the other digit setting switches and the stroke counter, and a digit counter having a contact position corresponding to each digit setting switch to complete a circuit for restoring the stroke counter to an initial position, advancing the digit counter, and opening the connection of said source to the bus, upon occurrence of the next impulse after the stroke counter reaches a position corresponding to the selected position of said corresponding digit setting switch.

7. Apparatus for sending coded pulses, comprising a source of continuous pulses, a plurality of rotary switches including a stroke counter connecting said source to a signal impulse bus and having a plurality of contact positions and means for stepping once for each impulse, a digit setting switch for each digit to be transmitted having a selectable contact position corresponding to each possible value of said digit, said positions being connected to corresponding positions of the other digit setting switch and the stroke counter, and a digit counter having a contact position corresponding to each digit setting switch to complete a circuit for restoring the stroke counter to an initial position, advancing the digit counter, and opening the connection of said source to the bus, upon occurrence of the next impulse after the stroke counter reaches a position corresponding to the selected position of said corresponding digit setting switch, and a circuit to add a fixed digit to that selected by a digit setting switch including a switch for connecting a contact position of the digit counter with a contact position of the stroke counter corresponding to said fixed digit.

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