

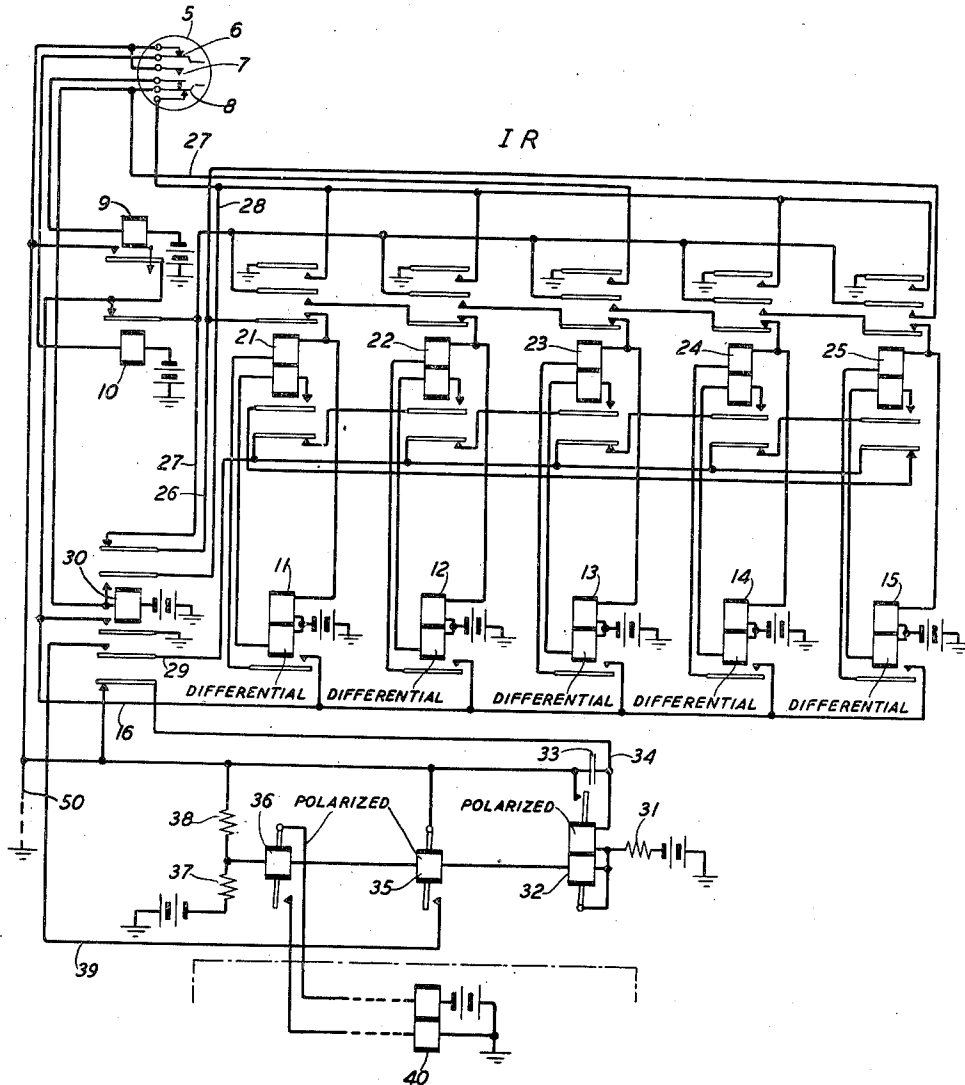
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SIGNALING SYSTEM

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SIGNALING SYSTEM

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This invention relates to signaling and switching systems and particularly to systems in which selective signaling is effected by the transmission of impulses in an electrical circuit.

Objects of the invention are to improve the reliability of selective impulse transmission and to increase the efficiency of regenerative impulse repeaters.

A feature of the invention is a regenerative impulse repeater adapted to transmit outgoing impulses at a fixed accurately controlled rate independent of variations in the rate or number of the incoming impulses and to transmit outgoing impulses while incoming impulses are being received.

Another feature of the invention is an impulse repeater in which the transmission of outgoing impulses at a fixed accurately controlled rate begins when a predetermined number of incoming impulses have been received, this number being determined by the particular rate at which impulses are received and the particular rate at which outgoing impulses are transmitted.

Another feature of the invention is an impulse repeater comprising a plurality of sets of counting relays successively operable responsive to incoming impulses, one set by each impulse in a train, the number of sets of counting relays being less than the maximum number of impulses in a train, the transmission of outgoing impulses, one for each incoming impulse of a train being initiated when a predetermined number of sets of counting relays have been operated responsive to incoming impulses.

Another feature of the invention is an impulse repeater comprising a plurality of sets of counting relays successively operable responsive to incoming impulses, one set by each impulse in a train, the transmission of outgoing impulses being initiated when a predetermined number of sets of counting relays have been operated responsive to incoming impulses, the operated sets of counting relays being released successively in the order in which they are operated during the transmission of the outgoing impulses, one set for each impulse transmitted.

A clear and complete description of the invention and its features will be facilitated by considering an impulse repeater in which the invention is embodied, one such repeater being represented schematically in the drawing. The invention is, however, not limited in its application to the system and repeater herein disclosed but is generally applicable to any system in which

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signalling is effected by the transmission of trains of impulses.

The drawing which consists of a single figure shows an impulse dial 5, an impulse generator IR for use in testing the operation of an automatic telephone system, and an impulse receiving relay 40. The dial 5 comprises a set of impulse springs 6 and two sets of off-normal springs 7 and 8. The impulse regenerator comprises a slow-to-release relay 9, an impulse receiving relay 10, five pairs of counting relays and three polarized control relays 32, 35 and 36. Relay 32 has two windings which are connected in combination with condenser 33 and resistor 31 to effect its alternate operation and release. The time of operation and time of release are controlled by the capacitance of condenser 33 and the conductance of resistor 31. Relay 32 controls the operation and release of relays 36 and 35 to effect the transmission of impulses to the impulse receiving relay 40 and to effect the release of an operated set of counting relays for each impulse transmitted. The number of sets of counting relays which are required depends on the particular rate at which dial impulses are created and the particular rate at which the outgoing impulses are transmitted. In the arrangement shown, it is assumed that dial impulses are created at the minimum rate of eight impulses per second and that relay 32 is tuned to generate outgoing impulses at the rate of eleven impulses per second, the transmission of outgoing impulses being initiated when three dial impulses have been registered by the operation of the first three sets of counting relays. The impulse receiving relay 40 may be the impulse receiving relay of a register sender or may represent the impulse receiving relay of a selector or connector switch which is directly controlled by dial impulses.

When the testing equipment is prepared for use, ground is connected to conductor 50 thereby closing a circuit through the impulse springs 6 of dial 5 for operating impulse relay 10. The connection of ground to conductor 50 completes a circuit including the lower back contact of relay 30 for energizing the upper winding of relay 32 in the non-operate direction and also completes a circuit through resistor 38, winding of relay 36, winding of relay 35, lower winding of relay 32 and resistor 31. Relays 36 and 35 are operatively energized and the lower winding of relay 32 is energized in the operate direction but is ineffective to operate relay 32 due to the opposing energization of its upper winding. The

operation of relay 35 connects ground to conductor 39 and the operation of relay 36 closes a circuit for operating the impulse receiving relay 40 thereby to prepare this relay for response to dial impulses.

Assume now that the digit 2 is dialed. When the dial moves off-normal, contact 7 closes a circuit for operating the slow to release relay 9 whereby the off-normal ground connected to conductor 50 is further connected through the front contact of relay 9 to conductor 16. When the dial returns to normal, contact springs 6 are actuated to initiate two impulses in succession, each of which effects the release and reoperation of relay 10. The release of relay 10 in response to the first impulse closes a circuit for operating relay 11. This circuit includes grounded conductor 50, the front contact of relay 9, back contact of relay 10, conductor 27, upper back contact of relay 30, conductor 26, inner upper back contact of relay 21 and the upper winding of relay 11. When relay 10 reoperates at the end of the first impulse, relay 11 is held operated and relay 21 is operated by current in a circuit which includes the upper winding of relay 11, upper winding of relay 21, front contact of relay 11, conductor 16, front contact of relay 9 and conductor 50. When relay 10 releases responsive to the second impulse, relay 12 is operated by current in a circuit which includes grounded conductor 50, the front contact of relay 9, back contact of relay 10, conductor 27, inner upper front contact of relay 21, upper back contact of relay 22 and the upper winding of relay 12. When relay 10 reoperates at the end of the second impulse, relay 12 is held operated and relay 22 is operated by current in a circuit which includes the upper windings of relays 12 and 22, front contact of relay 12, conductor 16, front contact of relay 9, and the grounded conductor 50. When the dial reaches normal after transmitting the two impulses, springs 8 close a circuit for operating relay 30 and springs 7 open the operating circuit of relay 9. The circuit for operating relay 30 includes the winding of relay 30, dial springs 8, conductor 28 and the uppermost front contact of each of relays 21 and 22. Relay 30 locks to conductor 28 independent of dial springs 8, disconnects conductor 27 from conductor 26, connects ground to conductor 16 before the slow-to-release relay 9 releases to maintain the energization of the upper windings of relays 11 and 21 and the energization of relays 12 and 22, closes a circuit for energizing the lower windings of relays 21 and 11, and opens the circuit through the upper winding of relay 32. The circuit for energizing the lower windings of relays 21 and 11 is traced from off-normal ground through conductor 50, the front contact of relay 35, conductor 39, outer lower front contact of relay 30, conductor 29, lower back contact of relay 25, lower front contact and winding of relay 21, and the lower winding of relay 11. Relay 11 releases because its lower winding is energized differentially with respect to its upper winding. The release of relay 11 opens the holding circuit through the upper windings of relays 11 and 21; but relay 21 is held operated after relay 11 releases by the energization of its lower winding until relay 35 releases as hereinafter described. The opening of the circuit through the upper winding of relay 32 does not immediately effect the operation of relay 32 since its upper winding is energized by current charging condenser 33. At the end of a predetermined interval of

time after relay 30 operates, relay 32 is operated by the current energizing its lower winding. The operation of relay 32 connects ground to resistor 31 thereby causing a reversal of current through its lower winding and the windings of relays 35 and 36. Relays 35 and 36 are thereby released but the release of relay 32 is delayed for a predetermined interval of time due to the energization of the upper winding of relay 32 by current discharging condenser 33. The release of relay 36 opens the operating circuit of relay 40 and the release of relay 35 disconnects ground from conductor 39 thereby causing the release of relay 21. When relay 32 releases, it opens the discharge path for condenser 33 and disconnects ground from resistor 31 thereby again reversing the current through its lower winding and the windings of relays 35 and 36. Relays 35 and 36 are thereupon immediately reoperated but the reoperation of relay 32 is delayed for a predetermined interval of time by current charging condenser 33. The reoperation of relay 36 closes the circuit for operating relay 40. The reoperation of relay 35 closes a circuit from ground, through conductor 50, front contact of relay 35, conductor 39, a front contact of relay 30, conductor 29, lower back contact of relay 21, lower front contact of relay 22 and lower windings of relays 22 and 12. The current in this circuit holds relay 22 operated but causes the release of relay 12 since the windings of relay 12 are differentially energized. Relay 22 is held operated after relay 12 releases until ground is disconnected from conductor 39 by the next release of relay 35. The operation of relay 32, at the end of the aforementioned predetermined interval of time measured by the charging of condenser 35, again causes a reversal of current through its lower winding and the windings of relays 35 and 36. Relays 35 and 36 are again immediately released but the release of relay 32 is delayed for the desired predetermined interval of time by current discharging condenser 33. The release of relay 36 opens the circuit for operating relay 40 and the release of relay 35 disconnects ground from conductor 39 so as to cause the release of relay 22. When relay 32 releases, the current through its lower winding and the windings of relays 35 and 36 is again reversed to effect the reoperation of relays 35 and 36. Relay 36 again closes the circuit for operating relay 40 and relay 35 reconnects ground to conductor 39 without affecting any further counting relays because all the counting relays which were operated have been released. Before relay 32 can again be operated, relay 30 releases since its operating and holding circuits were opened by the release of relay 22. The release of relay 30 reconnects ground to conductor 34 so as to energize the upper winding of relay 32 in the non-operation direction and thereby prevent the reoperation of relay 32 so that no further impulses can be transmitted by relay 36 to relay 40.

Assume that the next digit dialed is the digit 0 to generate a train of ten dial impulses. Relay 9 is operated as hereinbefore described when the dial is moved off-normal, thereby connecting ground to conductor 16. Relay 10 is alternately released and reoperated each time the impulse contacts 6 are actuated. Relays 11 and 21 are operated responsive to the first impulse of the train and relays 12 and 22 are operated responsive to the second impulse of the train in the manner hereinbefore described. Relays 13 and 23 are operated in like manner responsive to the third impulse, relays 14 and 24 responsive to the

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fourth impulse and relays 15 and 25 responsive to the fifth impulse. When relay 23 operates it closes a circuit for operating relay 30 and relay 30 is held operated as long as any of the counting relays 21 to 25 are operated. The operation of relay 30 starts the operation of the timed impulse generating relay 32 as hereinbefore described whereby relay 36 is controlled to transmit impulses to relay 40 and relay 35 is controlled to effect the release of a set of counting relays each time an impulse is transmitted to relay 40. Thus when the fifth impulse of the train is registered by the operation of relays 15 and 25, relays 11 and 21 will have been released by the sending of the first impulse to relay 40 and are ready for reoperation responsive to the sixth impulse of the train of ten impulses created by the dialing of the digit 0. In like manner, relays 12 and 22 have been released by the sending of the second impulse to relay 40 and are reoperated responsive to the seventh dial impulse; relays 13 and 23 are released in like manner by the sending of the third impulse to relay 40 and are reoperated responsive to the eighth dial impulse; relays 14 and 24 are released by the sending of the fourth impulse to relay 40 and are reoperated responsive to the ninth dial impulse; and relays 15 and 25 are released by the sending of the fifth impulse to relay 40 and are reoperated responsive to the tenth dial impulse. Thereafter relays 11 and 21, 12 and 22, 13 and 23, 14 and 24 and 15 and 25 are again released in succession by the sending of the sixth, seventh, eighth, ninth and tenth impulses to relay 40. When relay 25 releases at the end of the tenth impulse, relay 30 releases thereby closing the circuit for energizing the upper winding of relay 32 to end the transmission of impulses to relay 40.

It is apparent that the rate and percentage break at which impulses are transmitted to relay 40 depend on the capacity of condenser 33 and conductance of resistor 31, and it is necessary to provide enough sets of counting relays so that each dial impulse will be registered to enable its transmission. The number of impulses which must be registered before the transmission of outgoing impulses can be started depends upon the relative rate at which impulses are being received and transmitted. For given rates of incoming and outgoing impulses, a certain number of counting relays will be provided; and the particular set, whose operation effects the operation of relay 30 depends on these two impulse rates in order that a set of counting relays will be operated responsive to each impulse of the maximum train which the dial is arranged to transmit.

What is claimed is:

1. In an impulse receiving and repeating device adapted to receive and repeat trains of current impulses each train consisting of any desired number of impulses, means comprising a plurality of sets of counting relays successively operable responsive to incoming impulses, means for transmitting corresponding outgoing impulses at a desired rate independent of the rate at which incoming impulses are received, means comprising a contact of a particular one of said sets of counting relays for initiating the operation of said impulse transmitting means when a predetermined plurality of impulses have been received, and means effective to release an operated set of counting relays for each outgoing impulse transmitted.

2. In an impulse receiving and repeating de-

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vice adapted to receive and repeat trains of current impulses each train consisting of any desired number of impulses, means comprising a plurality of sets of counting relays successively operable responsive to incoming impulses, one set by each impulse, means for transmitting corresponding outgoing impulses at a desired rate independent of the rate at which incoming impulses are received, means rendered effective by the operation of one of said sets of counting relays for initiating the operation of said outgoing impulse transmitting means when a predetermined plurality of impulses have been received, and means effective to release an operated set of counting relays for each outgoing impulse transmitted.

3. In combination, an impulse relay responsive to incoming current impulses, a plurality of counting devices successively operable under the control of said impulse relay, one device by each incoming impulse of a train, normally disabled impulse transmitting means comprising a timing relay for effecting the transmission of outgoing current impulses, means comprising one of said counting devices for initiating the operation of said transmitting means when a predetermined plurality of impulses have been received by said impulse relay, and means for successively releasing the operated counting devices in the order of their operation, one device for each outgoing impulse transmitted.

4. In combination, an impulse relay responsive to incoming current impulses, a plurality of sets of counting relays successively operable under the control of said impulse relay, one set by each incoming impulse of a train, normally disabled impulse transmitting means comprising a timing relay for effecting the transmission of outgoing current impulses at a rate independent of the rate at which corresponding incoming impulses are received, means comprising one of said sets of counting relays for initiating the operation of said transmitting means when a predetermined number of impulses have been received by said impulse relay, and means for successively releasing the operated sets of counting relays in the order of their operation, one set for each outgoing impulse transmitted.

5. In combination, an impulse relay responsive to incoming current impulses, a plurality of sets of counting relays successively operable under the control of said impulse relay, one set by each incoming impulse of a train, normally disabled impulse transmitting means comprising a timing relay for effecting the transmission of outgoing current impulses, means comprising one of said sets of counting relays for initiating the operation of said transmitting means when a predetermined number of impulses have been received by said impulse relay, and means for terminating the transmission of outgoing impulses as soon as an outgoing impulse has been transmitted for each impulse of a train received by said impulse relay, said last-mentioned means comprising means for successively releasing the operated sets of counting relays in the order of their operation, one set for each outgoing impulse transmitted.

6. In combination, an impulse sender adapted to transmit current impulses at a certain rate, an impulse relay responsive to each impulse transmitted by said sender, a plurality of sets of counting relays arranged for successive operation under the control of said impulse relay, one set by each incoming impulse of a train, means comprising a timing relay for transmitting outgoing impulses

at a rate independent of the rate at which impulses are transmitted by said impulse sender; a control relay having a contact normally disabling said impulse transmitting means, means comprising a particular one of said sets of counting relays effective when a predetermined number of impulses in a train have been received by said impulse relay for operating said control relay to initiate the operation of said impulse transmitting means, means comprising a contact of said sender for operating said control relay in case a train of less than said predetermined number of impulses is transmitted by said sender to initiate the operation of said impulse transmitting means, and means controlled by said timing relay for successively releasing the operated sets of counting relays in the order of their operation, one set for each outgoing impulse, the release of all of the operated sets of counting relays being effective to release said control relay and thereby disable the impulse transmitter as soon as an outgoing impulse has been transmitted for each impulse in a train created by the operation of said impulse sender.

7. In combination, an impulse relay responsive to incoming current impulses, a plurality of sets of counting relays successively operable under the control of said impulse relay, one set by each incoming impulse of a train, the maximum number of impulses in an incoming train being greater than the number of sets of counting relays, normally disabled impulse transmitting means comprising a timing relay for effecting the transmission of outgoing current impulses, means comprising one of said sets of counting relays for initiating the operation of said transmitting means when a predetermined number of impulses have been received by said impulse relay, and means for successively releasing the operated sets of counting relays in the order of their operation, one set for each outgoing impulse transmitted, whereby the number of outgoing impulses corresponds to the number of incoming impulses.

8. In combination, an impulse sender adapted to transmit current impulses at a certain rate, an impulse relay responsive to each impulse transmitted by said sender, a plurality of sets of counting relays arranged for successive operation under the control of said impulse relay, one set by each incoming impulse of a train, the maximum number of impulses which said sender is adapted to send in one train being greater than the number of sets of counting relays, means comprising a timing relay for transmitting outgoing impulses at a rate independent of the rate at which impulses are transmitted by said impulse sender, a control relay having a contact normally disabling said impulse transmitting means, means comprising a particular one of said sets of counting relays effective when a predetermined number of impulses in a train have been received by said impulse relay for operating said control relay to initiate the operation of said impulse transmitting means, means comprising a contact of said sender for operating said control relay in case a train of less than said predetermined number of impulses is transmitted by said sender to initiate the operation of said impulse transmitting means, and means controlled by said timing relay for successively releasing the operated sets of counting relays in the order of their operation, one set for each outgoing impulse, the release of all of the operated sets of counting relays being effective to release said control relay and thereby disable the impulse transmitter as soon

as an outgoing impulse has been transmitted for each impulse in a train created by the operation of said impulse sender.

9. In an impulse receiving and repeating device adapted to receive and repeat trains of current impulses, each train consisting of any desired number of impulses, means comprising a plurality of counting devices successively operable responsive to incoming impulses, means for transmitting corresponding outgoing impulses at a desired rate independent of the rate at which impulses are received, means effective in case the number of impulses in a train is equal to or greater than a predetermined plurality for initiating the operation of said impulse transmitting means when said predetermined plurality of impulses have been received by said counting devices, and means effective to release an operated counting device for each outgoing impulse transmitted.

10. In an impulse receiving and repeating device adapted to receive and repeat trains of current impulses, each train consisting of any desired number of impulses, means comprising a plurality of sets of counting relays successively operable responsive to incoming impulses, the maximum number of impulses in a received train being greater than the number of sets of counting relays, means for transmitting outgoing impulses at a desired rate independent of the rate at which impulses are received, means for initiating the operation of said impulse transmitting means when a plurality of predetermined numbers of impulses have been received by said counting relays, and means effective to release an operated set of counting relays for each outgoing impulse transmitted.

11. In an impulse receiving and repeating device adapted to receive and repeat trains of current impulses, each train consisting of any desired number of impulses, means comprising a plurality of sets of counting relays successively operable responsive to incoming impulses, one set by each impulse, the maximum number of impulses in a received train being greater than the number of sets of counting relays, means for transmitting outgoing impulses at a desired rate independent of the rate at which impulses are received, means comprising a contact of a particular one of said sets of counting relays for initiating the operation of said impulse transmitting means, and means effective to release an operated set of counting relays for each outgoing impulse transmitted.

12. An impulse repeating arrangement comprising impulse receiving means responsive to a train of current impulses, means for transmitting a train of current impulses corresponding to the received train, and means for initiating said transmission when a predetermined plurality of impulses have been received or for initiating said transmission after the last impulse of a train of impulses of less than said predetermined number has been received.

13. An impulse repeating arrangement comprising impulse receiving means for operation responsive to a train of incoming current impulses, means for transmitting a corresponding train of outgoing current impulses at a desired rate independent of the rate at which said incoming impulses are received, and means for initiating the transmission of the outgoing impulses when a predetermined plurality of incoming impulses have been received or for initiating the transmission of the outgoing impulses after

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the last impulse of a train of impulses of less than said predetermined number has been received.

14. An impulse repeating arrangement comprising a plurality of counting relays responsive successively to a train of current impulses, means comprising said counting relays for transmitting a train of current impulses corresponding to the received train, and means for initiating said transmission when a predetermined plurality of impulses have been received or for initiating said transmission after the last impulse of a train of impulses of less than said predetermined number has been received.

15. In an impulse receiving and repeating device adapted to receive and repeat trains of current impulses each train consisting of any desired number of impulses, means comprising a plurality of counting devices successively operable responsive to incoming impulses, means for transmitting corresponding outgoing impulses at a desired rate independent of the rate at which impulses are received, means for initiating the operation of said impulse transmitting means

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when a predetermined plurality of impulses have been received by said counting devices or for initiating the operation of said impulse transmitting means after the last impulse of a train consisting of less than said predetermined plurality of impulses has been received by said counting devices, and means effective to release an operated counting device for each outgoing impulse transmitted.

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