

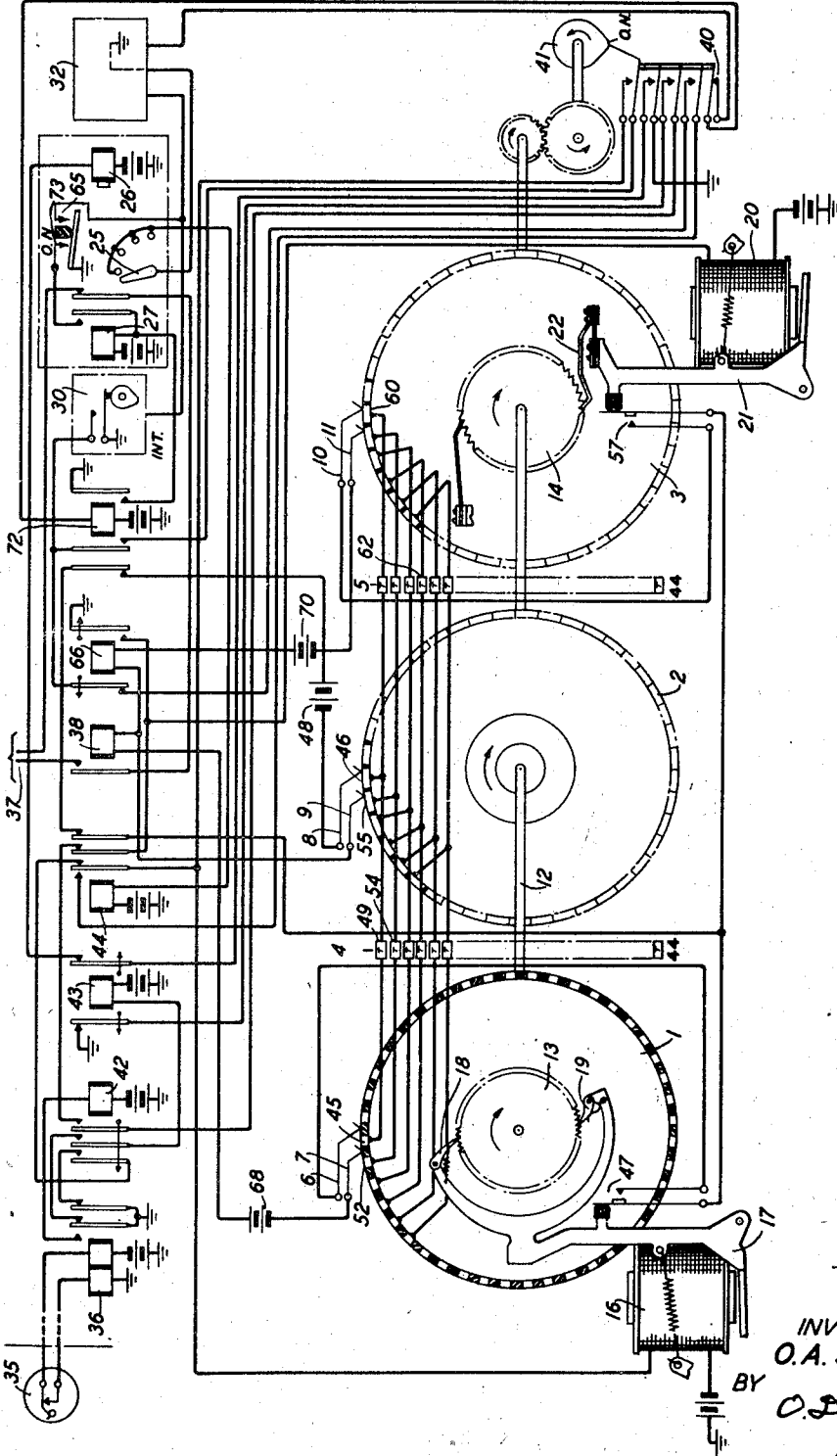
June 29, 1948.

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2,444,067

REPEATING SYSTEM

Filed Dec. 28, 1944



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## UNITED STATES PATENT OFFICE

2,444,067

## REPEATING SYSTEM

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Application December 28, 1944, Serial No. 570,074

9 Claims. (Cl. 177-380)

1

This invention relates to signal repeating systems and particularly to systems for repeating electrical impulses.

An object is to simplify such repeating systems and to improve the functional reliability of operation of such systems.

Heretofore various systems have been employed in which incoming impulses have been marked, stored or registered for later transmission as outgoing impulses. In some instances storing relays have been used and in other step-by-step mechanisms have been employed. In the latter case the arrangement may be such that the switch is stepped by the incoming impulses and a magnetic element is magnetized when the reception of such impulses ceases to mark the number of such incoming impulses, whereupon outgoing impulses are transmitted and the switch stepped until the marking magnetized element is encountered when the transmission of outgoing impulses is terminated.

The present invention relates, generally, to pulse repeating mechanisms of this latter type and a feature thereof is a step-by-step switch controlled by incoming impulses and associated with the switch are thermally responsive elements and means whereby on the reception of each incoming impulse and each step a particular thermal element is heated. When all impulses have been received the switch is controlled to continue stepping and means are provided for transmitting an outgoing impulse for each succeeding step as effected by the heated condition of said elements as encountered during said continued stepping of the switch. Thus the same number of outgoing impulses are transmitted as the number of incoming impulses received.

Another feature is an arrangement whereby succeeding series of incoming impulses may be thus repeated and means whereby an interval of time is recorded between succeeding series of impulses by the heating of another thermally responsive element. That is the heated condition of such other heated elements as encountered between the transmission of the outgoing series of impulses produces corresponding intervals of time between said outgoing series of impulses.

This invention has been illustrated in a more or less diagrammatic form showing a step-by-step switch and other required apparatus and circuit arrangements.

Referring now to this drawing, there is shown a series of three separate drums or commutator wheels 1, 2 and 3 having commutator segments on their outside surfaces, each segment on drum

2

1 being connected with a corresponding segment on drum 2 through an individual terminal element having a negative temperature coefficient of resistance and another connection is provided between each segment on drum 2 and the corresponding segment of drum 3 through an identical element. The two groups of elements are respectively referred to by numerals 4 and 5. Brushes 6 and 7 are provided for contacting with the segments on drum 1, brushes 8 and 9 are provided for drum 2 and brushes 10 and 11 are provided for drum 3 for contacting with corresponding segments on these drums. These three drums are connected together on a common shaft 12, on which is mounted on one end a ratchet wheel 13 and at the other end a ratchet wheel 14. A stepping magnet 16 is provided with an armature 17 having pawls 18 and 19 engaging the teeth on ratchet wheel 13 so that when the stepping magnet 16 is operated, pawl 18 will rotate the ratchet wheel 13 and the drums one step and on the deenergization of the stepping magnet 16, pawl 19 will rotate the ratchet wheel 13 and the drums another step. Another stepping magnet 20 is provided with an armature 21 having a pawl 22 engaging the ratchet wheel 14 so that on the energization of stepping magnet 20 the pawl 22 will engage the teeth on ratchet wheel 14 to rotate drums 1, 2 and 3. The rotation of the drums by these two magnets are in the same direction but the arrangements of the pawls are such that two steps taken by the ratchet wheel 13 by the operation and release of the stepping magnet 16 will advance or rotate the drums the same angular distance as one step taken by the ratchet wheel 14 as rotated by stepping magnet 20. To control the operation of the drums by these magnets, other circuit arrangements and relays have been disclosed in these drawings and also a minor step-by-step switch has been provided which may take four steps. This switch is disclosed in diagrammatic form at 25 and may be operated by stepping magnet 26 and released by a release magnet 27 to its normal position. An interrupting device shown at 30 provides a circuit as will hereinafter be described to control the stepping of the drums under such circumstances such as when the impulses are repeated and the speed of this interrupting device may determine the speed at which the outgoing impulses are transmitted. A timing device has been illustrated by a box 32 for applying certain required time pulses and this mechanism may be of any well-known type for furnishing circuit connections required at certain time intervals. The relays and circuits

3

shown in this drawing may be controlled by any incoming pulse device such as that disclosed at 35 for the operation of a pulsing relay 36 and the outgoing impulses may be transmitted over leads 37 by the operation of a relay 38. Off-normal contact pile-up 40 is controlled by a cam arrangement 41 controlled by the shaft 12 to place the contacts in their off-normal condition at the beginning of one turn of the shaft and return them to normal condition at the end of a second turn of the shaft 12, that is, the shaft will rotate twice for each operation of the off-normal contacts 40.

With this preliminary description of the various elements of the applicant's invention as disclosed in this drawing, a description will now be made of the reception and repeating of impulses. The arrangement has been designed so that in this case four succeeding series of incoming impulses may be repeated with a desired time interval between the series. If it is then considered that the drums are in the normal position shown in the drawing and the pulsing mechanism 35 begins to operate to transmit a first series of impulses, the moment this device is connected to the pulsing relay 36, a circuit is completed for the operation of relay 36. Relay 36, in operating, closes an obvious circuit for the operation of relay 42. This relay is slow-to-release and remains operated during the succeeding impulses of this series or as long as the relay 36 remained operated thereafter. If then the pulsing mechanism 35 opens the circuit for pulsing relay 36, this relay releases and a circuit is thereby closed for the operation of relay 43 from battery, through the winding of this relay, contacts of relays 42 and 36 to ground. A circuit is also closed for the stepping magnet 16 from battery, through the winding of this magnet, contacts of relays 44, 42 and 36 to ground. Stepping magnet 16 in operating rotates the drums in what may be called one-half step. This causes the brush 6 on drum 1 which normally is centrally located between two segments to engage the next segment 45 while brush 8 remains on the segment 46 on drum 2 to which it was originally connected. It should be noted now that on the operation of armature 17, contacts 47 are closed. This closes a circuit from a battery 48, contacts of relays 72 and 44, contacts 47, brush 6, the first segment 45 on drum 1, the first thermal element 49 of the group 4, brush 8, back to battery 48. This circuit causes the current through element 49 to heat this element and consequently reduce its resistance, the purpose of which will become evident as the description proceeds. When relay 36 again operates after the first impulse, the circuit for the stepping magnet 16 is opened and the armature 17 through its pawl 19 advances the drum another half step, placing the brush 6 between element 45 and element 52 on drum 1 and the brush 8 on element 55 of drum 2. On the next release of relay 36 in response to the second impulse, these operations as described are repeated and the drums are stepped another two half steps, one half step on the operation of the stepping magnet 16 and the other on its release, and during these movements the next element 54 receives a similar current impulse from battery 48 to heat it to the same degree as element 49 was heated. Similarly the succeeding elements in group 4 are heated during succeeding impulses as transmitted by the pulsing device 35 and the drum advances accordingly until the last impulse in this digit is received. Then as the relay 36 remains operated for an interval before the second digit begins the

4

slow-to-release relay 43 has time to release and now closes a circuit for the operation of stepping magnet 20 of the minor switch 25 from battery through the winding of this stepping magnet, contacts of relay 43, to ground through the off-normal contacts 40 causing the brush of this switch to take one step to connect with the first terminal. The purpose of the operation of this minor switch will be described hereinafter. A circuit is also completed for the operation of the stepping magnet 20 from battery through the winding of this magnet, contacts of relays 44 and 42, off-normal contacts 40 to ground at contacts of relay 43. This causes the stepping magnet 20 through its armature 21 and pawl 22 to advance the ratchet wheel 14, shaft 12 and the drums 1, 2 and 3 one step. Each such step is equal to two steps taken by the stepping magnet 16. When the armature 21 is attracted by stepping magnet 20, it closes a circuit through contact 57. This circuit is now completed from battery 48, brush 8 and the associated segment on drum 2 on which brush is resting through a corresponding element in group 5 and the corresponding segment on drum 3, brush 10, contacts 57, contacts of relays 44 and 72 back to battery 48. Thus while this step is taken by the magnet 20 this element in group 5 will be heated to reduce its resistance in the same manner as the elements 49, 54 and others in group 4 were heated. Of course, in this case the particular element heated in group 5 will be the one which is next in line in this group 5 after the elements such as 49 and 54 and others in group 4 have been heated by the succeeding impulses of the first digit. This, for example, may be the element 62 if only three impulses were received during the sending of the first digit or any succeeding element depending on the number of impulses received.

The equipment is now in condition for reception of the second digit or series of impulses by the operation of the pulsing device 35. The operation of the mechanism is exactly the same for succeeding series of impulses produced by the device 35 and the equipment is arranged for the transmission of storing and repeating of four such series of impulses. Each series may consist of from one to ten impulses. In this manner the four series of impulses will be recorded on the elements in group 4 by drums 1 and 2 and the intervals between the series to be recorded on the element in group 5 between drums 2 and 3 and if the maximum of ten impulses are contained in each digit the drum would have rotated a complete revolution. In any case whether the drums have rotated a complete revolution or not as depending on the number of impulses in the four digits, the drums will now, if not rotated a complete revolution, at the end of this fourth digit, be rotated to complete the first revolution and also be controlled to rotate a second revolution during which the repeating of the impulses will take place as will be described hereinafter.

It should now be observed that at the end of each digit when relay 43 releases as described, the minor switch 25 will take a step. Thus at the end of the fourth digit when relay 43 releases for the fourth time switch 25 will have taken four steps and caused its brushes to engage the fourth terminal. The timing device 32, which was started when the first step of the switch 25 was taken by the closing of a starting circuit to ground through off-normal contacts 65, will now function to exercise control over the arrangements after an interval of time has elapsed of sufficient

length to permit these four series of digits to be received. This interval of time will always be of the same duration regardless of whether the four series of digits all contain the greatest number of impulses that is ten impulses each or whether they contain lesser number of impulses. Therefore when this interval of time has elapsed, a ground at the device 32 will be supplied to cause the operation of relay 44 from battery through the winding of this relay, the brush and fourth terminal of switch 25 to this ground. Relay 44 now, in operating, closes a circuit for the operation of stepping magnet 16 from battery through the winding of this magnet, contacts of relay 44, off-normal contacts 40, contacts of relay 66, to contacts of the interrupter 30 to ground. The interrupter 30 may be considered as having started functioning under control of a ground applied by off-normal contact 65 and it will operate at a speed suitable for the stepping of the stepping magnet 16 and for the transmission of repeated impulses over conductors 37. The stepping magnet 16 steps the drums to complete the first revolution. It should be observed that on the next to the last step a circuit is closed for relay 38 as at this time the brush 7 of drum 1 will be located on the segment 45 and brush 9 of drum 2 will be located on segment 46. The circuit for relay 38 will extend from battery 68, brush 7, segment 45, element 49, segment 46, brush 9, winding of relay 38, back to battery 68. Relay 38 will operate due to the decrease in the resistance of the element 49 which was effective by the heating of this element during the first impulse of the first digit received. Relay 38 in operating, closes the circuit over conductors 37 to transmit a first impulse of the first digit. The stepping magnet 16 continues to step the drums and for each succeeding two steps by this magnet a succeeding operation of relay 38 takes place to transmit a succeeding impulse for the first digit, that is, as long as the brushes 7 and 9 encounter heated elements in group 4. At the end of this first series of impulses and at the next step a connection is established between brushes 9 and 11 over the next element in the group 5 and as this has been heated it causes the operation of relay 66 from battery 70 through the winding of this relay brush 9, a corresponding segment of drum 2, a corresponding element of group 5, a corresponding segment on drum 3, brush 11 back to battery 70. The operation of relay 66 opens the operating circuit for stepping magnet 16 and closes the circuit for the operation of stepping magnet 20 from battery through the winding of this magnet contacts of relay 66 to ground. As the element in group 4 passed by the brushes 7 and 9 during the stepping of the stepping magnet 20, is not heated relay 38 will not be operated at this time during this stepping of the stepping magnet 20 and consequently no impulse is transmitted over conductors 37. This step of the drums by magnet 20 will be equivalent to an interval between the first and second digits and the stepping magnet 16 will, of course, not receive any impulse to step during the operation of relay 66 as the circuit from interrupter 30 is broken at the left-hand armature and back contact of this relay 66. However, as soon as this step is taken by the stepping magnet 20, relay 66 will release and the circuit for stepping magnet 16 will be again established to continue the stepping of the drums and the transmission of impulses comprising the second digit will commence. The operations for transmitting the succeeding series of impulses

are the same with the relay 66 operating between each series. At the end of the transmission of the fourth series of impulses, the circuit for the stepping magnet 16 will again be closed on the last release of relay 66 and this stepping magnet 16 will therefore at this time continue to step the drums to normal. During this stepping no impulses are repeated as relay 38 will not operate due to the fact that no remaining elements in group 4 have had their resistances reduced. When the drums 1, 2 and 3 have been returned to normal position, the off-normal contacts 40 are returned to normal condition and this opens the circuit for the stepping magnet 16 and the mechanism comes to rest. At this time or shortly after the arrangement in the timing circuit 32 may be such that relay 44 releases and relay 72 operates. Relay 72 in operating closes an obvious circuit for the operation of the release magnet 27 for the switch 25 which now returns to normal and on its return the off-normal contacts 73 will open a locking circuit for the release magnet 27 and relay 72 will release after an interval through the timing device 32.

It should now be observed that the switch 25 serves another purpose. In case the pulsing mechanism 35 does not operate to send all four digits but merely one, two or three digits the timing mechanism at 32 will eventually operate and cause the operation of relay 72 which operates the release magnet 27 to release the switch 25 as described and also as the drums 1, 2 and 3 have not completed two revolutions, the off-normal contacts 40 will be in their actuated off-normal condition and thus close the circuit from the interrupter 30 through contacts of this relay 72, off-normal contacts 40, the winding of the stepping magnet 16 to battery and therefore causes this stepping magnet to return the drums to normal position. No impulses can be transmitted during this return of the drums even though recorded thereon as the circuit for relay 38 is broken by the operation of relay 72. Relay 72 will release after an interval through timing circuit 32.

What is claimed is:

1. An electrical impulse repeating mechanism comprising thermally responsive non-linear resistances, means responsive to incoming impulses, passing directly through said resistances, for heating said resistances in succession and means, comprising a circuit passing directly through said resistances, for effecting by the heated condition of said resistances corresponding succeeding outgoing impulses.

2. An electrical impulse repeating mechanism comprising thermally responsive non-linear resistances, means responsive to variable groups of succeeding incoming impulses, passing directly through said resistances, for heating corresponding succeeding variable groups of said resistances and means, comprising an output control circuit extending directly through said resistances, for effecting by the heated condition of said resistances corresponding variable groups of outgoing impulses.

3. An electrical impulse repeating mechanism comprising thermally responsive non-linear resistance elements, means responsive to variable groups of succeeding incoming impulses received at intervals, and passing directly through said elements, for heating corresponding succeeding variable groups of said elements, means, comprising an output control circuit extending directly through said elements, for effecting by

7

the heated condition of said elements corresponding variable groups of outgoing impulses and means for effecting a time interval between the succeeding groups of outgoing impulses of sufficient duration to provide an identifying pause between said succeeding groups of outgoing impulses.

4. An electrical impulse repeating mechanism comprising thermally responsive elements, means responsive to a definite number of groups of succeeding incoming impulses for heating corresponding succeeding groups of said elements, means for effecting by the heated condition of said elements corresponding groups of outgoing impulses and means operative if all of said groups of incoming impulses are not received within a definite time interval for preventing the recreation of any outgoing impulses.

5. An electrical impulse repeating mechanism comprising a step-by-step switch, thermally responsive elements, means responsive to incoming impulses for stepping said switch and for causing said elements to be heated by said impulses during said stepping, and means for continuing the stepping of said switch after the heating of said elements is completed and for causing said elements due to said heating to repeat said impulses during said continued stepping of said switch.

6. An electrical impulse repeating mechanism comprising a step-by-step switch, thermally responsive elements, means responsive to succeeding variable groups of incoming impulses incoming at intervals for causing said elements to be heated by said groups of incoming impulses during said stepping, means for continuing the stepping of said switch after all of said incoming groups of impulses are received and for causing said elements due to said heating to repeat said incoming impulses as outgoing impulses during said continued stepping of said switch, and means for effecting a time interval between said groups of outgoing impulses of sufficient duration to provide an identifying pause between said groups of outgoing impulses.

7. An electrical impulse repeating mechanism comprising a step-by-step switch, elements each having a negative temperature coefficient of resistance associated with said switch, means responsive to incoming impulses for stepping said switch one step for each impulse received and for heating one of said elements to reduce its resistance for each step of said switch and means for continuing the stepping of said switch after said elements have their resistances reduced and for utilizing the reduced resistance of each of said elements to produce a corresponding outgoing impulse for each said continued step by said switch.

8

8. An electrical impulse repeating mechanism comprising a step-by-step switch, elements having a negative temperature coefficient of resistance associated with said switch, means responsive to impulses incoming in groups at intervals for stepping said switch one step for each impulse received and for stepping said switch one step between each group of impulses, circuit means operative during the stepping of said switch for raising the temperature of one element for each step taken by the switch to reduce the resistance of said element, means for continuing the stepping of said switch after the reception of said impulses ceases, and means operative during the continued stepping of said switch for utilizing the reduced resistance of said elements heated during the reception of impulses for transmitting corresponding outgoing impulses and for utilizing the reduced resistance of the elements heated during the interval of reception of said incoming impulses for creating a corresponding interval between the groups of outgoing impulses.

9. An electrical impulse repeating mechanism comprising a plurality of step-by-step switches, thermally responsive elements, means responsive to impulses incoming in groups at intervals for stepping said switches one step for each incoming impulse and one step for each interval between the reception of said groups of incoming impulses and for heating one of said elements on each step of said switches and means for continuing the stepping of said switches after the reception of incoming impulses have ceased and for effecting an outgoing impulse as a result of the heating of a corresponding element by corresponding incoming impulses and for effecting an interval between each group of outgoing impulses as a result of the heating of a corresponding element between said groups of incoming impulses.

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