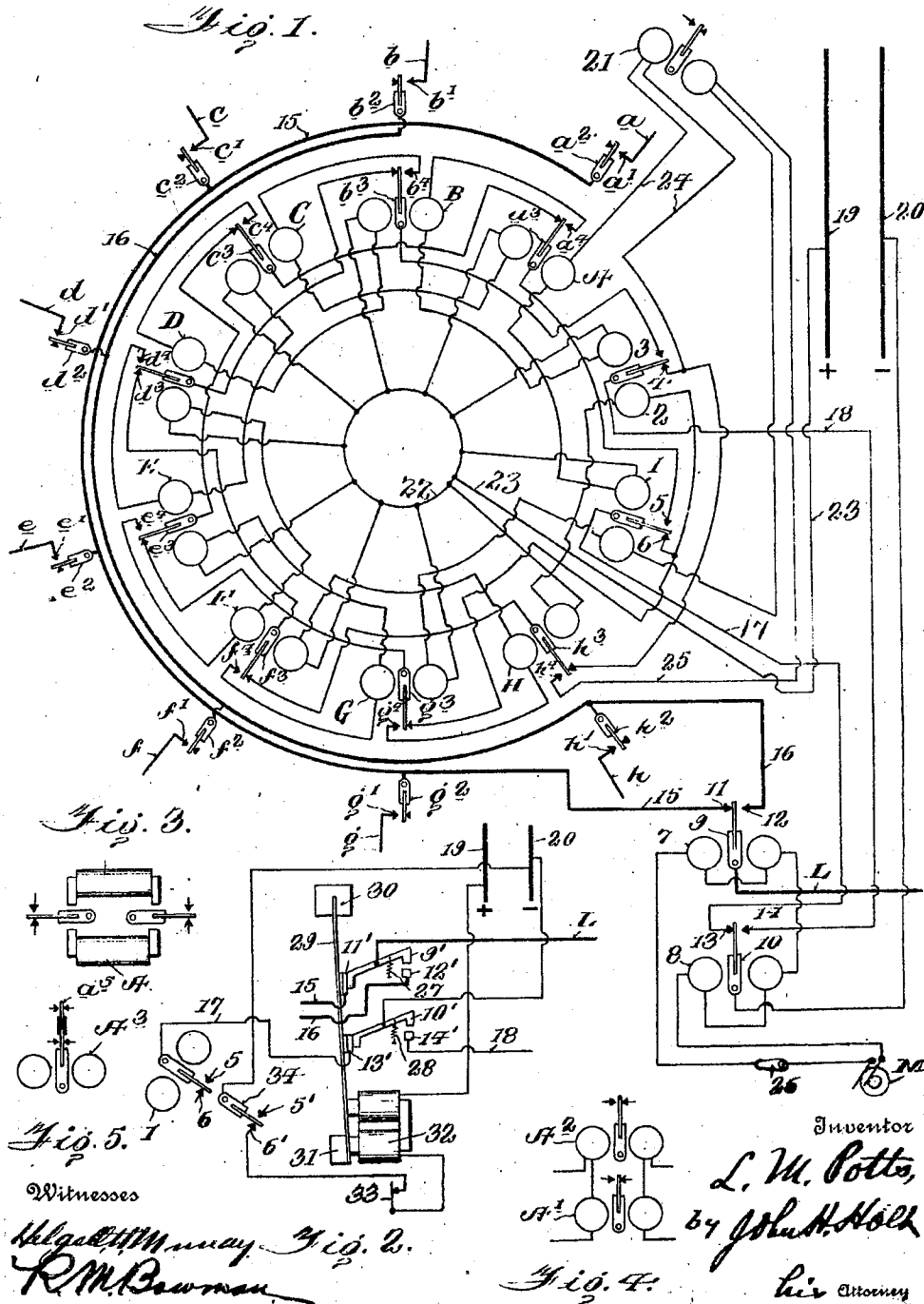


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ELECTRICAL STEP-BY-STEP TRANSLATING DEVICE.
APPLICATION FILED JAN. 31, 1912. RENEWED JULY 30, 1915.

1,197,542.

Patented Sept. 5, 1916.



UNITED STATES PATENT OFFICE

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Specification of Letters Patent.

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Application filed January 31, 1912, Serial No. 674,606. Renewed July 30, 1915. Serial No. 42,529.

To all whom it may concern:

Be it known that I, LOUIS M. POTTS, a citizen of the United States, residing at Baltimore city, in the State of Maryland, have invented certain new and useful Improvements in Electrical Step-by-Step Translating Devices, of which the following is a specification.

The object of this invention is to produce a simple and efficient device for performing in step-by-step order, a series of acts electrically, such for example, as the operation of a series of switches for electrical signaling in any of its applications, or for effecting a series of mechanical movements in step-by-step order or for any other purpose to which this invention may be applied.

In order to more fully describe my said invention, reference will be had to the accompanying drawings wherein—

Figure 1 is a diagram illustrating one specific embodiment of my said invention; Fig. 2, a diagram illustrating a modification thereof, and Figs. 3, 4 and 5, detail views of various forms of relays herein referred to.

In the accompanying drawings *a, b, c, d, e, f, g* and *h* represent any eight conductors, which it is desired to connect consecutively to any common conductor *L*. These conductors *a* to *h* are connected to the forward contacts *a'* to *h'* of eight polarized relays *A* to *H*. These relays, I have shown each provided with two tongues *a''*—*a'''* to *h''*—*h'''*, though as will later more readily appear, these two sets of tongues may be operated by separate magnets. Also, the tongues *a''* to *h''* may be considered as insulated extensions of the tongues *a'* to *h'*. Cooperating with these relays *A* to *H*, are two polarized relays 1 and 2 which, for the present, may be considered as having each but one tongue and each a single pair of tongue contacts 3—4 and 5—6 respectively. Relays 1, 2 and 3 to *H* are not necessarily polarized.

Polarized relays 7 and 8 represent each any desired means for bringing a conductor into electrical engagement alternately with two other conductors. In the present case, the tongues 9 and 10 of these relays represent the conductors to be brought alternately into engagement, each with two other conductors as the contacts 11—12 and 13—14. Any desired means may be employed for op-

erating relays 7 and 8. In the diagram Fig. 1, I have shown for this purpose coils of the relays connected to any suitable source of alternating current, indicated conventionally by the generator *M*.

The tongues *a''*, *c''*, *e''* and *g''* of the relays *A*, *C*, *E*, and *G*, are all connected to a common conductor 15; while the tongues *b''*, *d''*, *f''* and *h''* of the relays *B*, *D*, *F* and *H* are all connected to a common conductor 16 and these conductors are connected respectively to the two tongue contacts 11 and 12 of relay 7. The tongues of relays 1 and 2 are connected by conductors 17 and 18 respectively to the two tongue contacts of relay 8.

The tongue of relay 7 is connected to the conductor *L*, and the tongue of relay 8 is connected to one negative in the case shown, of two direct current supply mains 19 and 20, leading from any suitable source of direct current. The relay 21 represents one which may be used in a special case, which we may disregard for the present.

The other circuits and connections of the relays 1, 2 and *A* to *H*, will be clear from the following description of the operation of the device in which these circuits will be traced. Let it be assumed that at a given moment the tongues of relays 7 and 8 are against their contacts 11 and 13. These relays being in series will operate in unison.

Considering first the relay 8, its tongue in this position completes the following circuit: negative main 20, relay tongue 10, contact 13, conductor 17, tongue of relay 1 and its back contact 6, back coil of relay 2, back coil of relay *H*, conductors 22 and 23 to the positive main 19. This circuit is traced backward, since it is easier to follow in that direction. The completion of this circuit energizes the back magnet coils of relays 2 and *H*, causing them to hold their tongues against their back contacts as shown. At this moment, all the other relay tongues will also occupy the positions shown, the tongues of relays *A* to *H* all being against corresponding contacts with respect to each other, but against opposite contacts with respect to relays 1 and 2. Now let us assume that the tongue of relay 8 has passed over to contact 14. This completes a circuit which may be traced as follows: main 20, relay tongue 10, contact 14, conductor 18, tongue of relay 2 and its back contact 4, conductor 24, for-

ward coil of relay 1, to conductors 22 and 23, and thence to terminal 19. Current in this circuit energizes the forward coils of relays A and 1, sending their tongues against their forward contacts a^1 and 5 respectively. Next, assume that the tongue of relay 8 has passed back to contact 13. This completes the following circuit: supply main 20, relay tongue 10, contact 13, tongue of relay 1, which is now over against its forward contact 5, tongue of relay A, which is now against its forward contact a^1 , forward coil of relay B, forward coil of relay 2, which sends its tongue to its forward contact 3, conductors 22 and 23, supply main 19. The tongue of relay 8 has now made two oscillations. The first oscillation sent the tongues a^2 and a^3 of relay A against their forward contacts a^1 and a^4 and the second oscillation sent the tongues b^2 and b^3 of relay B against their forward contacts b^1 and b^4 . On the third oscillation of the tongue of relay 8, on which it passes over to contact 14, the tongues c^2 and c^3 of relay C will be sent over to their forward contacts c^1 and c^4 , the tongues of relay A then returning to their back contacts. This is brought about by the completion of the following circuit: main 20, to relay tongue 10, contact 14, tongue of relay 2 and its forward contact 3, which said tongue now engages, thence to the tongue b^4 of relay B and its forward contact b^1 , forward coil of relay C, back coil of relay A, thence through conductors 22 and 23 to the supply main 19. This, as above stated, operates relay C to send its tongues forward, and the relay A to send its tongues backward.

On the fourth oscillation of the tongue of relay 8, it passes again to contact 13 when the forward coil of relay D will be energized, sending its tongue forward. At the same time, the back coil of relay B, which is in series with the forward coil of relay D, will be energized, restoring the tongues of the former relay to their back stops.

In a similar way, on the fifth oscillation of relay tongue 10, the tongues of relay E will be sent forward and tongues of the relay C restored to their back stops, and so on through the series. In this manner the tongues of the relays A to H are sent successively forward, stay forward until the second relay ahead acts and then return.

On the eighth vibration of relay tongue 10, it will be in engagement with the contact 13. The relay 1 however, has not yet received restoring current through its back coil. The tongue of relay 1 is therefore still against contact 5, where it has been since the first oscillation of the tongue of relay 10. A circuit from the supply mains 19—20 may then be traced as follows: main 20, relay tongue 10, contact 13, tongue of relay 1, its forward contact 5, relay tongues a^2 , a^3 ,

and a^4 , and their back stops, since these tongues are all now restored, thence through tongue g^2 of relay G, which is now against its forward contact g^1 , thence through the forward coil of relay H and back coil of relay F, restoring the tongues of the latter.

The tongues of all the relays A to H have now been sent successively forward, but only the tongues of relays A to F inclusive have been restored.

On the ninth oscillation of the relay tongue 10, the tongues of the relay G are restored by the completion of the following circuit: main 20, relay tongue 10, contact 14, tongue of relay 2 which is still against its forward contact 3, since its back coil has since the commencement of the present cycle received no current thence through said contact 3 to the tongue b^4 of relay B its back contact, tongue d^2 of relay D and its back contact, tongue f^2 of relay F and its back contact, tongue h^2 of relay H and its forward contact h^1 , thence through loop 25 to the back coil of relay 1, back coil of relay G, through conductors 22, 23 to main 19. This restores the tongues of relays G and 1 to their back contacts.

The cycle is completed in the present case with the tenth oscillation of the tongue of relay 10, which brings it against its contact 13, when the circuit therethrough is as follows: main 20, relay tongue 10, contact 13, tongue of relay 1 and its back contact 6, back coil of relay 2, back coil of relay H, which restores the tongues of these latter two relays to their back contacts, conductors 22 and 23 to main 19. All the relay tongues are now restored to the positions with which we started, and if the tongue of relay 8 is kept vibrating, this cycle of operations may be repeated over and over as long as the vibrating of the relay tongue continues; but instantly that the vibration of this relay tongue ceases, the switching of the relays will cease.

The stepping along of a series of relay tongues in the manner or by the means just described is believed to be generically new and of wide application. I have shown it as herein applied to connecting in step-by-step or successive order, a series of conductors a to h to a line L. This is effected in the present case in the following way: The tongues of relays 7 and 8 engage simultaneously corresponding tongue contacts and vibrate in unison. The tongue contacts of relay 7 are, as before described, connected respectively to alternate tongues a^2 to h^2 of the relays A to H.

Assume that the tongues of the various relays are in the positions shown in Fig. 1. The first vibration of the relay tongues 9 and 10, results in the sending of the tongues of relay A to their forward contacts, as described, and the sending of relay tongue 9

to contact 12. Relay contact 12, however, is not connected to tongue a^2 , so that on this movement of the relay tongue 9, the conductor a will not be connected to the conductor L.

At the next vibration of the tongues 9 and 10 which carries them to contacts 11 and 13, tongue a^2 of relay A is still against its forward contact, and conductor a is then connected to conductor L through contact a^1 , tongue a^2 of relay A, conductor 15, relay contact 11, and tongue 9. On this vibration of the relay tongues 9 and 10, the relay B is operated to send its tongues to their forward contacts, but the conductor b cannot at this time be connected to the conductor L for the reason that the tongue of relay 7 is against its contact 11 which is not connected to the tongue b^2 of relay B. But when the tongue of relay 7 goes back to the contact 12 on the next step, the conductor b will then be connected to the conductor L through contact 12. In a similar manner, as the tongues a^2 to h^2 are stepped along into engagement successively with their contacts a^1 to h^1 the conductors a to h are connected successively to the conductor L, through alternate relay contacts 11 and 12, the times of these connections lagging one step behind the oscillations of the relay tongue 7 as described. In other words, the relay tongues a^2 to h^2 each goes over to its forward contact, on, say, one movement of the tongue of relay 7, stays in that position during the next movement of the tongue of said relay, then moves to its back stop on the next movement of the tongue of said relay 7. The purpose of thus keeping the contacts at a^1 to h^1 closed longer than the contacts 11 and 12, is to allow a margin of safety, so that the contacts a^1 to h^1 will certainly be closed longer than any given vibration of the tongue 9, whereby the contact of said tongue always closes and opens the circuit. The tongue 9, or its relay, therefore, is the element which actually times the interval for which any conductor a to h is connected to conductor L.

The relays 1, 2, A to H may be for any purpose wherein they may be utilized for performing a series of successive acts, whether these be for electrical signaling for the purpose of effecting mechanical movements.

One specific use of my invention which may be mentioned as illustrating a practical application thereof is its adaptability to selective electrical signaling or telegraph systems, such for example, as that shown in U. S. Patent No. 713,497 to Henry A. Rowland, or that shown in British Patent No. 15,167 of 1909, granted to me, in either of which cases the present device replaces the rotary sunflower distributor which is employed in the case of my British patent, for connecting the eight branch circuits from

the key board or automatic transmitter to a common conductor to line, or in the Rowland U. S. patent mentioned for connecting a corresponding number of branch circuits of a key board to a common operating circuit of a main line relay. Or it may be employed to supplant the mechanical step-by-step switch of my U. S. application for improvements in selective electrical signaling, filed Nov. 18, 1911, Ser. No. 661,185, in which case the conductors a to h represent circuits similarly identified in that application. The present device, however, possesses many advantages over either the continuous sunflower distributor or a mechanical step-by-step switch device. Comparing it with the sunflower distributor of the Rowland system, for example, to produce the same effect, the Rowland device requires a synchronizing commutator, a motor, gearing, distributing commutator and brush arm. In the case of a device similar to the Rowland, the motor runs continuously and does not stop when the synchronizing current stops, but with this device, when the impulses cease the device stops at that point so that to accomplish the same results with a continuous synchronizing device it would be necessary to add a clutch to the brush arm as means of starting and stopping it with the impulses; that is, the arrangement would be similar to the line unit apparatus shown in my said British patent Figs. 87, 88 and 89.

The present invention, however, presents a number of very striking advantages generally over a commutator and motor device, among which might be mentioned the following: First. It synchronizes instantly. Second. There are no running parts when the device is not in actual use. Third. There are no commutators to require frequent cleaning. The relay contacts require no substantial attention if they are properly protected. Fourth. Increased durability. The relays last indefinitely while the motor and commutator will wear out and require repairs. Fifth. Increased simplicity of construction. Sixth. If it is desired to have a different number of contacts in the series, additional ones, or to vary the length of any of the contacts this can all be done by identically the same mechanical parts and requires only a change of wiring, so that the same mechanical parts can be used for a great variety of apparatuses doing different things, and even the same device, by a series of changeable connections, can be made to vary the length and number of contacts which it closes, as hereinafter more particularly described.

The present device also possesses advantages of a mechanical step-by-step switching device, among others, in that it may be operated accurately at a higher speed, ques-

tion of friction of the parts is negligible, and it requires much less current to operate it.

The relay 21 is shown to illustrate the point mentioned at the end of the sixth advantage of this apparatus, mentioned above. This relay has its forward coil connected in series with the forward coil of the A relay and its back coil in series with the forward contact of the H relay. Therefore, on the first operation of the A relay, the tongue of relay 21 will be sent to its forward contact and will remain there until the relay H, the last in the series acts, when it will be drawn to its back contact. Therefore, the relay 21 may be made to close a circuit at any given time after the relays A to H start and to open said circuit at any given time subsequent thereto during the operation of said relays, depending simply upon which of the relays A to H are connected to the forward and back coils of relay 21, as described. Such an arrangement has practical application in the operation of the key board locking device in either of the patents or applications herein mentioned, the relay 21 corresponding to what is called the clapper relay in my said British patent.

The relays 7 and 8 may be operated either locally or from a distance by any desired means and for any desired intervals of time. In Fig. 1, I have merely indicated an alternating current generator M, as one way of effecting their operation and have indicated a switch 26 as any desired means for starting and stopping which switch may be considered as either local to or located at a distance from the device. The relays 7 and 8 may be replaced by, among other devices, a tuning fork or vibrator reed, as shown in Fig. 2 and later herein more particularly described.

As hereinbefore stated, the relays 7 and 8 represent but one of many ways of operating this device. In Fig. 2 I have shown these relays replaced by two switches, operated by a single tuning fork blade or reed. These switches comprise pivoted switch levers 9' and 10', and contacts 11'—12' and 13'—14', corresponding identically in function to the tongues and contacts of the relays 7 and 8. The switch levers 9' and 10' are operated against the tension of springs 27 and 28 by the tuning fork blade 29, mounted fast at one end in a rigid support 30 and carrying at its bottom end a weight 31. The lower end of this reed is adapted to vibrate in front of the poles of an electromagnet 32, adapted to be energized by current in a circuit leading from a positive main 19, coils of magnet 32, a normally closed switch 33, contact 6' and tongue 34 of relay 1, to negative main 20. In this case the relay 1 is provided with a second pair of contacts 5' and 6' as in the case of the relays

A to H. Besides showing a different arrangement from relays 7 and 8, Fig. 2 shows an arrangement whereby the relays A to H may be made to go through one cycle and automatically stop until some act is done which will start them again.

In Fig. 2, it is assumed that unconnected ends of wires 15, 16 and 18 lead to the same parts to which they are connected in Fig. 1. If it is desired to start the device with the arrangement shown in Fig. 2, the switch 33 is opened. This breaks the energizing circuit of reed magnet 32, which now lets go the reed which starts to vibrate. The first outward vibration of the reed from the magnet will allow switch lever 9' to engage contact 12'. This starts the relay 1, just as in the case of the first engagement of relay tongue 10 with contact 14. The operation of relay 1 breaks the energizing circuit of the reed magnet at contact 6', which circuit remains broken at that contact until the final relay of the series A to H acts, whereby the tongues of relay 1 are brought to their back stops and the circuit of magnet 32 closed. This energizes magnet 32, which then attracts the reed 29 and stops its vibration, holding it in the position shown, until the switch 33 is again operated.

Obviously in order for the circuit of magnet 32 to be completed by the closure of contact 6', switch 33 must have first been closed. This may be done in many ways. The switch 33 may represent any switch or key which will close directly after operation. For example, the movable contact of this switch may be a spring blade which will return to the stationary contact as soon as released, in which case this switch may correspond to contacts 151 and 152 of my said British patent, which are operated each time a key is operated to send a signal.

If it is not desired to stop the device at the end of a cycle, the switch 33 may be held open, when the device will continue to operate as long as the reed vibrates. It will be observed that the vibration of the reed is absolutely free. The magnet 32 merely acts to release the reed to start it into vibration and to stop it.

Fig. 3 represents any of the double tongued relays herein referred to; Fig. 4 shows how instead of making these relays with two tongues, they may be replaced by two single tongued relays A¹ and A² in series, and Fig. 5, shows the arrangement hereinbefore referred to, wherein a relay having one tongue with insulated section a⁵ may replace either of the arrangements shown in Figs. 3 or 4.

While I have herein shown eight relays A to H, it should not be understood that my invention is by any means limited to this or any other special number of relays, and it should also be understood that my invention

is susceptible to modifications other than those herein specifically pointed out, without departing from the spirit thereof.

In the claims I refer to certain of the relays as "even numbered relays" and to others as "odd numbered relays." By the even numbered relays is meant the second, fourth, sixth and eighth relays of the series A to H, while the odd numbered relays are the first, third, fifth and seventh of these relays commencing with the A relay.

What I claim is:

1. A series of relays, a single switch adapted to control all of said relays, and means coöperating with said switch to operate the tongues of said relays in successive step-by-step order and to restore said relays in the same order, the restoration of the tongues of said relays occurring on the forward operation of the second subsequent relay in the series.

2. A series of electrically operated switches which operate in two directions in successive order, a series of circuits controlled by said switches, a conductor for connection with said circuits, and an independent timing element comprising a body having a natural period of motion adapted to control the time of connection of said circuits to said conductor.

3. A series of relays, in combination with means to operate the tongues of said relays in two directions in successive step-by-step order, a series of conductors, a common conductor for connection to any of said conductors, the said relays acting to partially complete said connection, and a timing device adapted to complete the connection of said circuits to said common conductor.

4. A series of relays, in combination with means to operate the tongues of said relays in two directions in successive step-by-step order, a series of conductors, a common conductor for connection to any of said conductors, the said relays acting to partially complete said connection, and a timing device comprising a switch and a freely vibrating reed operating said switch to complete the connection of said circuits to said common conductor.

5. An oscillating contact and two contacts, with which said oscillating contact is adapted to engage alternately, in combination with a series of relays, two sets of circuits, one including one of the above mentioned two contacts, the tongue contacts of each of the even numbered relays and a coil of each of the odd numbered relays, and the other circuit including the other of the above mentioned two contacts, and the contacts of odd numbered relays and the coils of the even numbered relays.

6. A series of polarized relays having two coils, in combination with a series of circuits, each circuit including the front coil of one relay and the back coil of the second preceding relay, and means to close and open each of said circuits in succession.

7. A series of relays, in combination with means to cause said relays to close their front contacts in step-by-step order and to cause the second preceding relays to open their front contacts in step-by-step order isochronally with the step-by-step action of the first mentioned contacts.

8. A series of relays, in combination with means including operating circuits in which said relays are connected, to cause the contacts to close in succession, and to simultaneously open the front contact of the second preceding relay, means acting subsequently to the first mentioned means to complete the circuit through the contacts of each relay, the said second mentioned means acting to successively open the circuit including the contacts of each relay, previous to the action of the first mentioned means.

9. A series of relays, a series of circuits in which the coils of said relays are connected, the contacts of said relays controlling the partial closing of said circuits successively, and means acting subsequently to complete said circuits.

In testimony whereof I affix my signature in presence of two witnesses.

LOUIS M. POTTS.

Witnesses:

H. I. ROBINSON,
HARRY N. RODENMAYER.