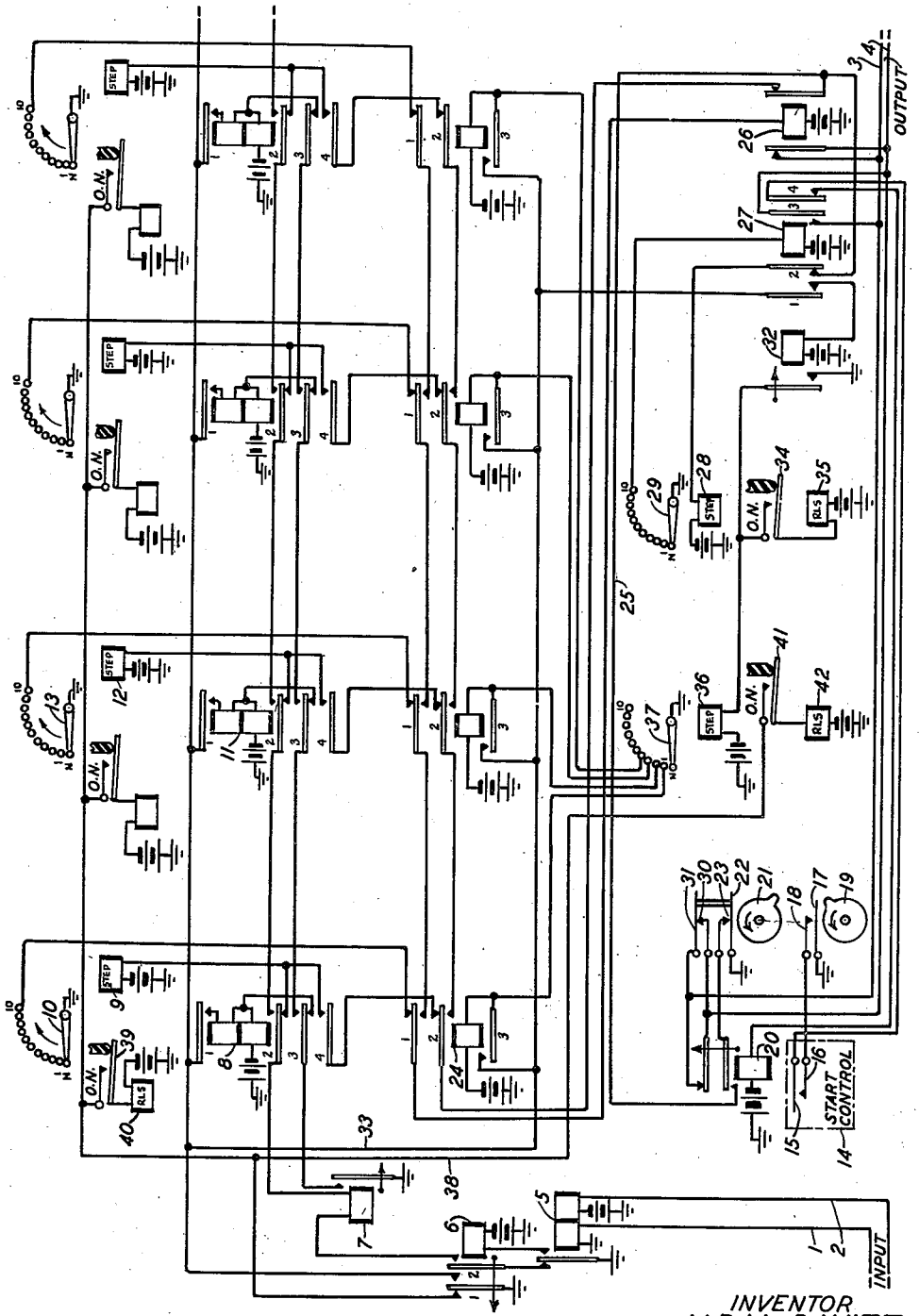
March 17, 1942. M. B. McDAVITT 2,276,665

PULSE REGENERATOR

Filed Oct. 25, 1940



INVENTOR
M.B.McDAVITT.
BY
ATTORNEY

Patented Mar. 17, 1942 2,276,665

UNITED STATES PATENT OFFICE

2,276,665

PULSE REGENERATOR

Marcellus B. McDavitt, Hartsdale, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application October 25, 1940, Serial No. 362,807

3 Claims. (Cl. 177—380)

This invention relates to signaling systems and particularly to impulse repeaters of the type known as register senders or impulse regenerators.

An object of the present invention is to provide a simple and inexpensive arrangement whereby trains of impulses, such as those used for setting switches in a telephone system, may be registered and retransmitted at full strength and proper timing regardless of the distorted nature of incoming impulses.

A feature of the invention is the use of an individual step-by-step device per train of impulses which performs a simple and single circuit closing operation at the end of a predetermined number of impulses. While the trains of impulses may be based on the decimal system, it is not necessary that the simple stepper perform its operation on its tenth step but it may so operate on any subsequent step thereafter that is found most convenient when adapting certain commercial types of apparatus to this use.

In accordance with another feature of this invention an additional but common stepper is provided to successively take the record off the individual digital steppers and thereafter control the transmission of out pulses.

Another feature is the use of a novel complementary counting system. For example, if a digital designation contains N places and the stepper must travel M places before performing its circuit closing operation, then it will be advanced N steps during the registration of the digit leaving M—N steps to be taken. Thereafter the stepper is associated with the common stepper and both take M—N steps leaving the common stepper to take M—(M—N) steps or N steps. Thereafter, as the common stepper takes these N steps, a regenerated impulse is transmitted on each step. In other words, the common stepper is set in accordance with the complement of the digital designation and the impulses transmitted therefrom are in accordance with the complement of the setting of such common stepper which, assuming the individual steppers and the common stepper to invariably perform their circuit closing operations on the same number of steps, will be exactly the same as the digital designation.

The drawing consists of a single sheet of circuit diagram.

This impulse repeater has been illustrated as a device which may be inserted in a two-wire line. The conductors 1 and 2 represent the input and the conductors 3 and 4 represent the output. When the line is seized over conductors 1 and 2, battery and ground are supplied to the substation or other circuit arrangement thereon through the windings of relay 5. Relay 5 operates and in turn causes the operation of relay 6.

When the first train of impulses is sent over the input consisting of conductors 1 and 2, these impulses take the form of interruptions of the circuit so that relay 5 moves its armature to its back contact once for each impulse. Thereupon a circuit is established from ground, armature and back contact of relay 5, armature 2 and front contact of relay 6, winding of relay 7, armature 2 and back contact of relay 8, winding of stepping magnet 9 to battery and ground. The stepping magnet 9 thus responds one step for each pulse transmitted and moves the switch arm 10 a corresponding number of steps. Through the energization of relay 7, a circuit is established from ground, armature and front contact of relay 7, armature 3 and back contact of relay 8, lower winding of relay 8 to battery and ground. It should be noted that the armature 1 of relay 8 responds to the energization of the lower winding alone of this relay while armatures 2, 3 and 4 do not so respond. Armature 1, therefore, is attracted and completes a circuit from ground, armature 1 and front contact of relay 6, armature 1 and front contact of relay 8 to one terminal of the upper winding of relay 8 which is now short-circuited by the ground leading to the junction between the two windings of this relay. As long as the pulses are being transmitted to the stepping magnet 9, this condition will hold, but a short time after this train of pulses has ceased as measured by the slow releasing characteristic of relay 7, the ground to the junction of the two windings of relay 8 will be removed through the release of relay 7 and relay 8 will now be energized through both its windings in series whereupon the armatures 2, 3 and 4 will be operated. The pulsing circuit is now transferred to the next registering switch and after a proper interdigit pause the subscriber will again send another series of impulses which will cause the relay 5 to operate. Upon each backstroke of the armature of relay 5, a circuit will now be established from ground, armature and back contact of relay 5, armature 2 and front contact of relay 6, winding of relay 7, armature 2 and front contact of relay 8, armature 2 and back contact of relay 11, winding of stepping magnet 12 to battery and ground. The second digit is, therefore, registered by the move-

ment of the switch arm 13 a number of steps corresponding to the number of impulses in the digit now being registered. Upon the first step, armature 1 of relay 11 will be operated and after the interdigit pause when relay 7 releases the armatures 2, 3 and 4 of relay 11 will be attracted.

Thus the full series of trains of impulses will be registered, each on a separate switch in this manner.

In the lower part of the drawing, there is a broken rectangle marked "start control" and numbered 14. This includes a pair of contacts 15 and 16 which when closed start the automatic transmission of impulses on the output conductors 3 and 4. The start control is indicated in this manner since it may be under various conditions operated in different manners. For instance, the start control may be operated by the movement of any one of the relays 8, 11, etc., so that the transmission of pulses on the output path may begin soon after they have been registered over the inward path or at some delayed interval thereafter depending on which of the relays 8, 11, etc., is used for this operation. On the other hand, these contacts 15 and 16 may be on a relay controlled over the output conductors from a distant point or they may be controlled over the input conductors from a distant point. Again the contacts 15 and 16 may be controlled by some timing mechanism set in operation by the operation of relay 6 or they may be operated through a chain circuit controlled by relays 8, 11, etc. so that they will not be operated until all these transfer relays have been operated.

When the contacts 15 and 16 are closed, a circuit will be established from ground, contacts 17 and 18, controlled by interrupter 19, through contacts 16 and 15, back contact of relay 27, winding of relay 20 to battery and ground. Relay 20 is slow to release and will hold its armatures in their operated position for an appropriate period after the circuit for the relay is opened. When the interrupter 19 reaches the point where the circuit through contacts 17 and 18 is closed, relay 20 responds. Interrupter 21 is on the same shaft as interrupter 19 and, therefore, while relay 20 is operated the contacts controlled by the interrupter 21 will be operated. Thereupon a circuit may be traced from ground, contact 22, contact 23, inner armature and front contact of relay 20, conductor 25, right-hand armature and back contact of relay 26, armature 2 and back contact of relay 24, armature 4 and front contact of relay 8, winding of stepping magnet 9 to battery and ground. In parallel with the winding of stepping magnet 9, a circuit may be traced from conductor 25, through the back contact and armature 2 of relay 27, winding of stepping magnet 28 to battery and ground. Thus stepping magnets 9 and 28 will be periodically energized and wipers 10 and 29 will be stepped in unison.

When wiper 10 comes to its last contact, a circuit will be established from ground, wiper 10, back contact and armature 1 of relay 24, to the winding of relay 26 so that the circuit of stepping magnet 9 is now opened. At the same time, a short circuit across the conductors 3 and 4 held by the left-hand armature and back contact of relay 26 is removed so that now during the energization of relay 20, the circuit through the output conductors 3 and 4 will be opened each time the interrupter contacts 30 and 31 are operated. Since these contacts are under machine control, the timing of the out pulses thus produced may be strictly controlled. The number of pulses sent out will now be the difference between the number of steps taken by wipers 10 and 29 in unison and the total number of steps which may be taken by the wiper 29 until it reaches its last contact. When this contact is reached, a circuit is established from ground, wiper 29, its last contact, winding of relay 27 to battery and ground. Relay 27 through its armature 3 and front contact short-circuits the output conductors 3 and 4 so that further operation of the contacts 30 and 31 will be ineffective. Relay 27 also releases relay 20 after slow release, thus assuming pick-up on each train of pulses.

It should be noted that the switches having wipers 10, 13, 29, etc., may have any number of steps between the first and the last contacts but that these numbers of steps must be the same in all switches. Thus, if the subscriber registers the digit 4 through the movement of wiper 10, it will be moved four steps. When the wipers 10 and 29 are moved together they will be moved simultaneously a number of steps equal to the difference between the total number of steps which may be taken by wiper 10 and four steps. If the total number of steps to be taken by these switches is ten, then the number of steps which wipers 10 and 29 will take together will be 10—4 or 6. Wiper 29 now having taken six steps, it will have 10—6 or 4 steps to take during which the out pulsing takes place. Consequently, the number of out pulses is equal to the number of in pulses.

This may be stated generally in this way: If the digit comprises X pulses then the initial movement of wiper 10 will be X steps. If wiper 10 and all similar switches are capable of taking N steps before their effective contact is closed then wipers 10 and 29 together will take N—X steps. Thereafter wiper 29 in transmitting out pulses will take N—(N—X) or X steps.

Upon the operation of relay 27, a slow operating relay 32 will be energized from ground, armature 1 and front contact of relay 6, conductor 33, armature 1 and front contact of relay 27, winding of relay 32 to battery and ground. Relay 32 after an appropriate interval will close a circuit from ground, front contact and armature of relay 32 through the off-normal contacts 34 to release magnet 35 which will restore the wiper 29 to its normal position. At the same time stepping magnet 36 will be operated and wiper 37 will move to its first position where relay 24 will be operated. Thus the wiper 29 is restored to normal and now associated with wiper 13 so that the digit registered on wiper 13 will now be transmitted through the simultaneous stepping of wipers 13 and 29 and then the stepping of wiper 29 to its last point where the action described will again take place.

At the conclusion of the operation of this device, relay 5 will be released through any well-known means and after an appropriate interval relay 6 will restore to normal. Thereupon a connection will be established from ground, armature 1 and back contact of relay 6, conductor 38 which leads through the off-normal switches of each of the digit registering devices such as the off-normal contacts 39 to the release magnet 40 whereby the wiper 10 is restored to normal. This conductor 38 also connects a ground through the off-normal contacts 41 to the release magnet 42

whereby the wiper 37 is restored to normal so that the whole circuit reverts to its idle condition.

What is claimed is:

1. Means for regenerating trains of impulses, comprising a plurality of steppers each arranged to complete a cycle of operations on a predetermined number of steps, each said stepper being responsive to the impulses of a different train of impulses, a common stepper arranged to complete a cycle of operations on the same predetermined number of steps as said individual steppers, means for associating said common stepper with each of said individual steppers in turn, means thereupon operative under control of the associated individual stepper to step in unison said common stepper and the individual stepper with which said common stepper is at that time associated a number of steps equal to the difference between said predetermined number and the number of impulses in the train to which said individual stepper has responded, leaving said common stepper a number of remaining steps to take equal to the number of impulses in the train to which said individual stepper has responded, and means under control of said common stepper for transmitting an outgoing impulse for each of said remaining steps taken by said common stepper.

2. Means for regenerating trains of impulses, comprising an input circuit operating in response to a plurality of incoming trains of impulses to successively advance a corresponding plurality of individual steppers each a number of steps corresponding to the number of impulses in the train which said individual stepper has been allotted to register, a common stepper, said common stepper and each of said individual steppers being arranged to complete a cycle of operations on a given total number of steps not less in number than the greatest number of impulses in any train of impulses, means for successively placing said common stepper under control of each of said individual steppers, means for advancing said common stepper under control of its then associated individual stepper a number of steps equal to the difference between the said given total number and the number of steps which said then associated individual stepper has been advanced by a train of impulses, and means under control of said common stepper for transmitting outgoing impulses equal in number to the difference between said given total number and the number of steps advanced by said common stepper under control of said associated individual stepper.

3. Means for regenerating trains of impulses, comprising a plurality of individual steppers, a common complementary stepper, an input circuit for setting said individual steppers, each said individual stepper registering the number of impulses in a separate train of impulses, an output circuit, a start control circuit for bringing said complementary stepper into operation, said complementary stepper registering the complement of the registration of said individual steppers under control of said individual steppers and controlling the transmission into said output circuit of the complement of the registration effected thereon, an advance circuit for successively associating said complementary stepper with each of said individual steppers and a machine controlled impulse circuit associated with said output circuit and under control of said complementary stepper.

MARCELLUS B. McDAVITT.