

Dec. 24, 1940.

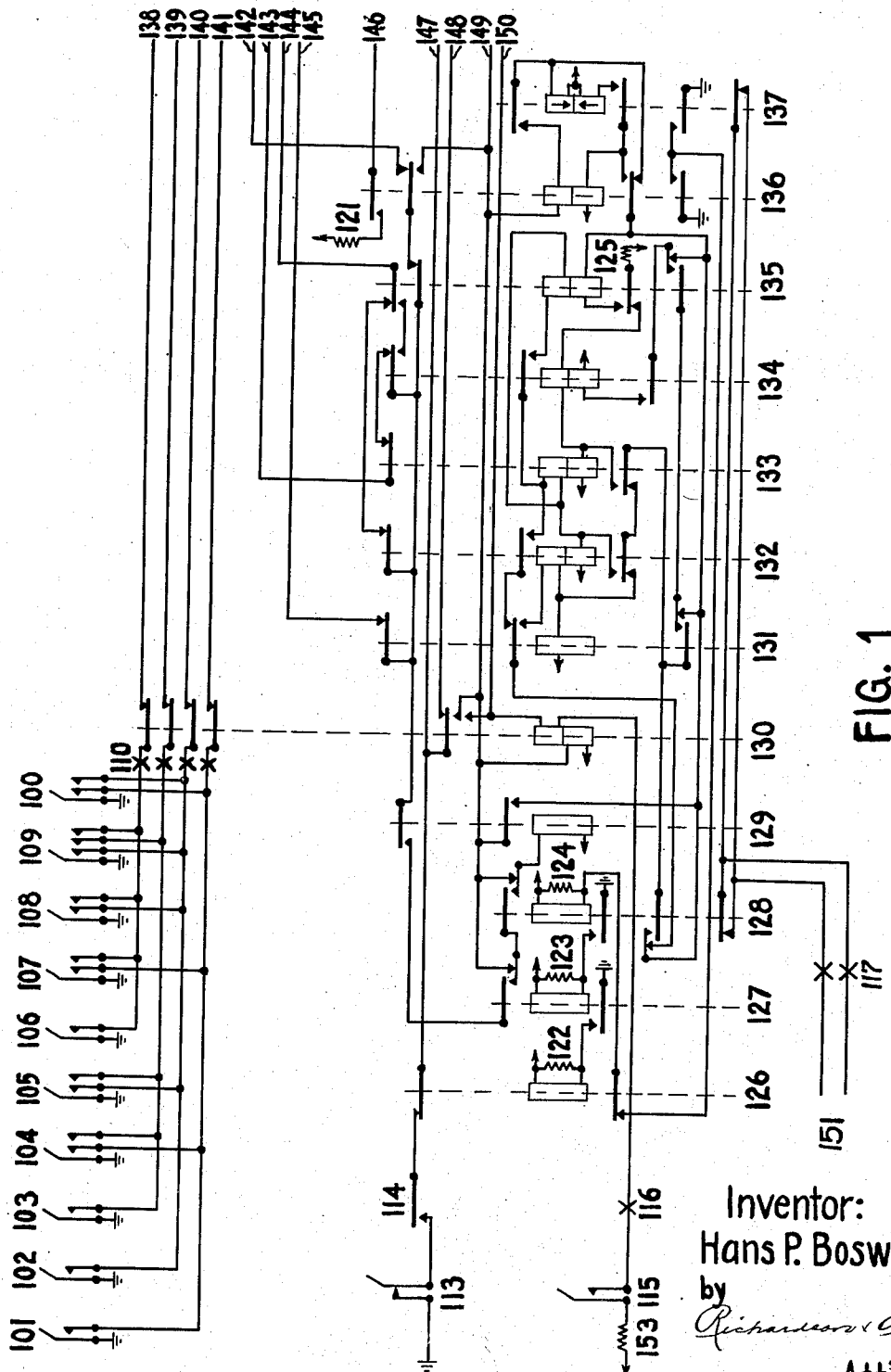
H. P. BOSWAU

2,225,680

IMPULSE SENDER

Filed Jan. 29, 1937

4 Sheets-Sheet 1



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IMPULSE SENDER

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4 Sheets-Sheet 2

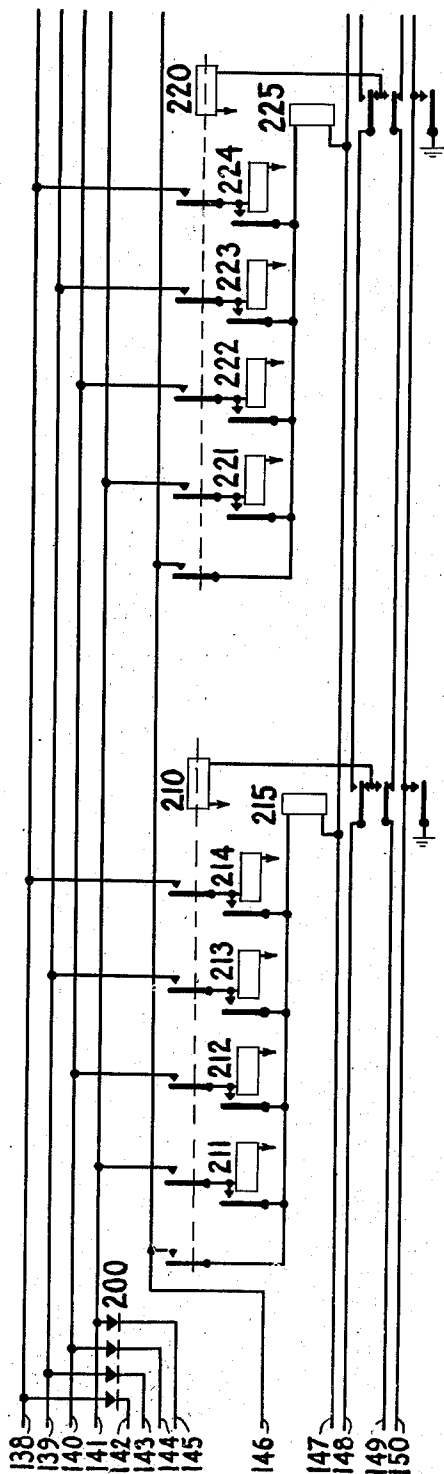


FIG. 2

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IMPULSE SENDER

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4 Sheets-Sheet 3

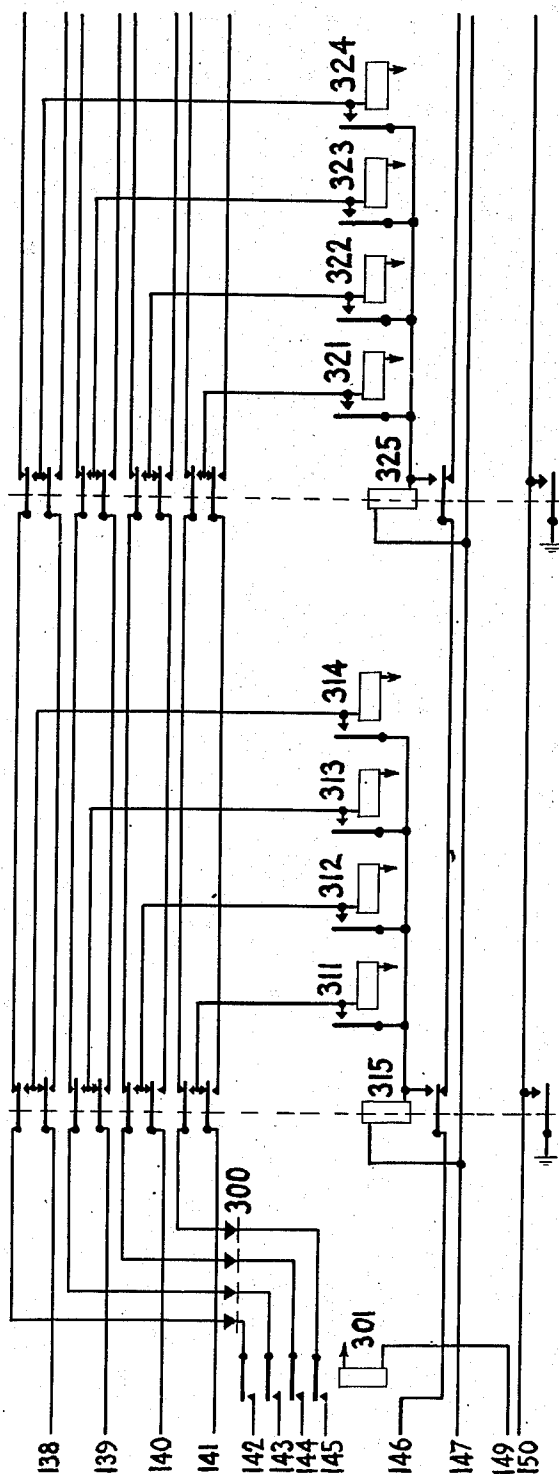


FIG. 3

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199

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IMPULSE SENDER

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4 Sheets-Sheet 4

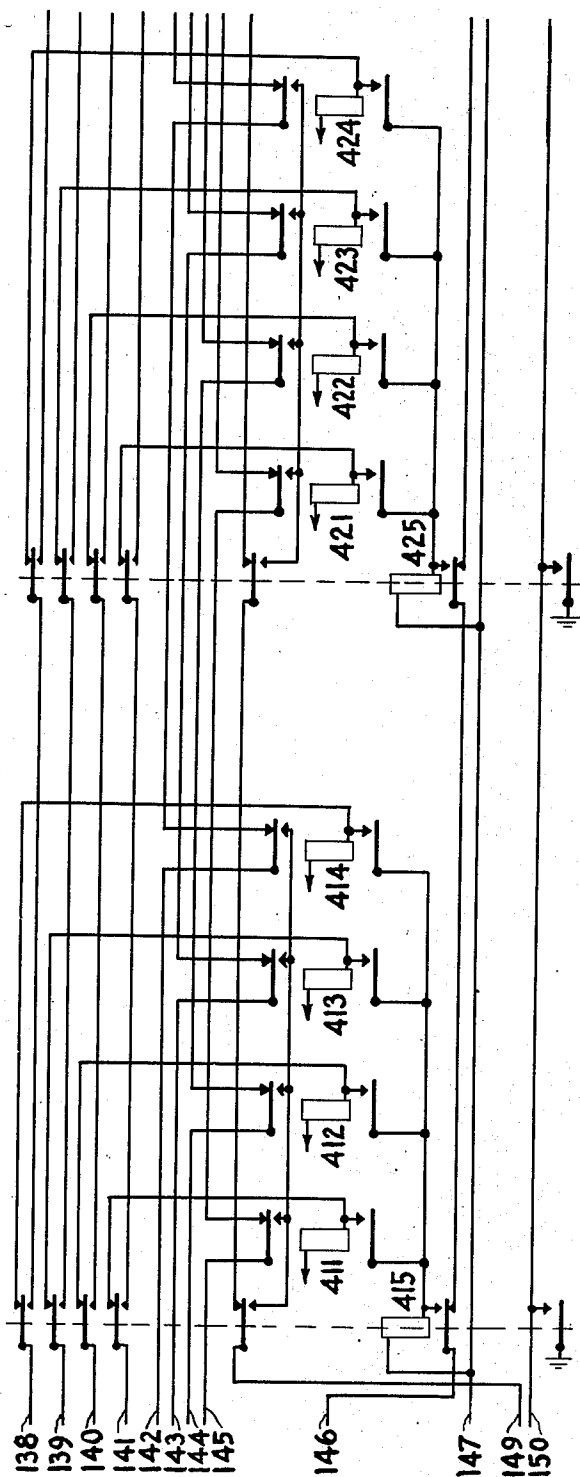


FIG. 4

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UNITED STATES PATENT OFFICE

2,225,680

IMPULSE SENDER

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Application January 29, 1937, Serial No. 122,899

12 Claims. (Cl. 177-380)

The invention relates to impulse senders of the type used by an operator in a semi-automatic telephone system for controlling the operation of automatic switches.

5 In known impulse senders of this type, which are usually based on the decimal system of numbers, the desired number is set up on groups of relays, known as "register relays", by the successive operation of so-called numerical keys in a key set. In order to reduce the number of register relays, it is customary to depart from the decimal system by using the register relays singly and in combination. Usually four register relays are provided for registering each digit of the desired number. In known impulse senders, the digit identified by the operated register relay or relays is translated back into the decimal system by suitable contact arrangements on the register relays, for the purpose of sending the corresponding number of impulses. This arrangement requires a comparatively large number of contacts on the register relays. One object of the invention, therefore is to reduce the number of contacts on the register relays by effecting the transmission of the proper number of impulses without first re-translating the digits stored in the register relays into the decimal system.

30 In known impulse senders, the register relays usually have one set of contacts for holding the relays operated after the numerical keys are released, and a second set of contacts for controlling the sending of impulses. Another object of the invention, therefore, is a further reduction in the number of contacts on the register relays by using the same contact both for holding a relay operated and for controlling the sending of impulses, thereby reducing the number of contacts required on each register relay to one normally open contact.

40 Known impulse senders of the relay type are usually provided with one set of relays for shifting the control circuits from the key set from one group of register relays to the next after each digit has been registered, and a second set of relays for shifting the sender control circuits from one group of register relays to the next during the sending of impulses. Accordingly, another object of the invention is to combine the functions of these two separate sets of relays, so that the same relays effect the shifting from one register to the next, both during the registration of a number and during the transmission of impulses. In some embodiments of

the present invention, a single relay per digit is sufficient for this purpose.

The relay counting chains employed in known impulse senders of the relay type usually require seven or eight relays for counting up to ten impulses. The problem of counting ten impulses requires the discrimination of twenty distinct conditions, viz., ten so-called "marking" conditions for the ten impulses, nine so-called "spacing" conditions for the pauses between the impulses, and one condition with all relays de-energized when the counting chain is at rest. With ordinary relays, such as used in automatic telephone systems, which have a non-operated and an operated position, but no intermediate partially operated position, the total number of combinations obtainable with a given number of relays is equal to 2^n where n is the number of relays. Accordingly, it is possible to obtain the twenty distinct conditions necessary for counting ten impulses with not more than five relays in the counting chain, five relays giving 2^5 or 32 combinations. Four relays provide 24 or 16 combinations, which is not enough.

25 It is another object of the invention, based on the foregoing, to reduce the number of relays required for counting ten impulses to the theoretical minimum, viz., five, without unduly increasing the number of contacts required on each of these five counting relays.

30 In summing up, the general object of the invention is to provide an impulse sender accomplishing all the functions required of such senders with a materially smaller number of relays and relay contacts than is customary in known impulse senders.

35 The invention is illustrated in the accompanying drawings, in which Fig. 1 shows one embodiment of the impulse sender control and counting circuits and Fig. 2, 3, and 4 show several embodiments of the associated register relays.

40 The operator's position with which the impulse sender is associated may be provided with ten numerical keys 100 to 109, Fig. 1, for selecting the ten digits of the decimal system, one correction key 113 for releasing all previously selected digits in the case of an error, and one start key 115. The impulse sender is engaged for the purpose of sending a number of external circuit means, not shown in detail, but indicated diagrammatically by the contact 114. Where an operator's position has access to more than one impulse sender, or where one impulse sender is accessible to more than one operator's position, selective means are interposed between the posi- 55

tion equipment and the impulse sender at the points indicated by the reference numbers 110, 116, and 117, in addition to the contact 114. These selective means form no part of the impulse sender and are therefore not shown.

In the following description, terms such as "winding 210," "break contact 215" or "make contact 211" shall be understood to mean "winding of relay 210," "break contact of relay 215," or "make contact of relay 211," respectively.

Upon engagement of the impulse sender by the closure of contact 114, relay 210 operates from battery over winding 210, break contact 215, conductor 148, break contacts 130 and 126, contact 114 and correction key 113 to ground. The operation of relay 210 connects the four register relays 211, 212, 213, and 214, over the four conductors 141, 140, 139, and 138, and through break contacts 130 to the numerical keys, preparatory to the registration of the first digit of the desired number. The operation of any one of these keys energizes one or more of the register relays 211 to 214 the relay combination associated with each key being shown in the following table:

Key 101 energizes relay 211	and registers digit 1
Key 102 energizes relay 212	and registers digit 2
Key 103 energizes relay 213	and registers digit 3
Key 104 energizes relays 211 and 213	and registers digit 4
Key 105 energizes relays 212 and 213	and registers digit 5
Key 106 energizes relay 214	and registers digit 6
Key 107 energizes relays 211 and 214	and registers digit 7
Key 108 energizes relays 212 and 214	and registers digit 8
Key 109 energizes relays 212, 213, 214	and registers digit 9
Key 100 energizes relays 211 and 212	and registers digit 0

Only the relay or relays which correspond to the operated key are energized, notwithstanding the fact that conductors 142, 143, 144, and 145 are all multiplied together at contacts of relays 131 to 136 inclusive. This result is accomplished by the insertion of rectifiers 200, which prevent current flow in conductors 142, 143, 144, and 145 in a direction toward the register relays.

When a relay such as 211 is energized by the operation of the associated key, locking circuits are prepared for the operated relay over its own make contacts, winding 215, conductor 147, break contact 126, contact 114, and key 113 to ground. While the numerical key is operated, relay 215 is short-circuited and cannot operate, but when the key is released, the short-circuit is removed, and as a result relay 215 operates in series with the operated register relay 211. The operation of relay 215 opens the circuit of relay 210 and in its stead operates relay 220, which connects the numerical keys to the register relays 221 to 224, associated with the second digit.

The next operation of one of the numerical keys energizes one or more of the relays 221 to 224. When the operated key is released, the energized register relay (or relays) is locked in series with relay 225, which operates, releasing relay 220 and operating a relay similar to relay 220 in the register for the next digit, not shown. It will be evident that as many digits as desired may be registered in the described manner, a group of register relays similar to those shown for the first and second digits being provided for each additional digit.

It will be noted that the locking circuit for relays 211 to 215, 221 to 225 and for the corresponding relays of additional digits is carried through key 113, so that any number or part thereof, which may have been registered, can be wiped out by operating correction key 113.

After registering the desired number, which may or may not have the full number of digits for

which registers are provided, the operator manipulates the start key 115, thereby closing a circuit for relay 130 from battery over resistance 153, key 115, upper winding 130, conductor 150 to ground through make contacts 215, 225 and so forth. It will be noted that the circuit for relay 130 is completed only if at least one digit has been registered, so that the operation of the start key 115 will have no effect on the impulse sender, unless it is preceded by the registration of a number.

Relay 130 closes a locking circuit for itself from battery over lower winding 130, upper and lower make contacts 130, conductor 150 to ground through make contacts 215, 225 and so forth. Relay 130 also provides a new locking circuit for the register relays 211 to 215, 221 to 225, etc., from conductor 147 over upper and lower make contacts 130, conductor 150 and make contacts 215, 225, etc., so that contact 114 may now be opened or correction key 113 operated, without affecting the further operation of the sender.

The operation of relay 130 opens the connections from the numerical keys to the register relays, so that subsequent operations of these keys will not change the number already registered. Where selective means are provided to switch the position equipment to another idle impulse sender as soon as the start key is operated, the four break contacts of relay 130 in conductors 138, 139, 140 and 141 may be omitted, in view of the fact that the selective means will disconnect the keys from conductors 138 to 141 at the point indicated by the reference number 110.

As a further result of the operation of relay 130, ground is removed from conductor 148 and the circuit of relay 220 or of the corresponding relay for the last digit of the registered number is opened and in its stead a circuit is closed for relay 210 of the first digit from battery over winding 210, make contact 215, conductor 149, upper and lower make contacts 130, and conductor 150 to ground through make contacts 215, 225, and so forth. Relay 210 connects register relays 211 to 214 of the first digit to conductors 142 to 145 for the purpose of controlling the number of impulses transmitted for the first digit, as described in detail below.

The operation of relay 130 also closes a circuit for relay 129 from battery over winding 129, break contact 128, upper and lower make contacts 130, conductor 150 to ground through make contacts 215, 225, and so forth. Relay 129 operates, in turn energizing relay 137 from battery over upper winding 137, break contact 136, make contact 129, upper and lower make contacts 130, conductor 150 to ground through make contacts 215, 225, and so forth.

Relay 137 prepares a locking circuit for itself in series with the upper winding of relay 136. The latter winding, however, is short-circuited over make contact 129, so that relay 136 cannot operate as long as relay 129 is energized. The operation of relay 137 also energizes relay 128 from ground over make contact 137, break contact 126, and winding 128 to battery. Relay 128 operates relay 127, which in turn energizes relay 126, over obvious circuits. Relay 126 opens the circuit of relay 128, causing the successive release of relays 128, 127, and 126, whereupon the cycle of operations is repeated. Thus relays 128, 127, and 126 constitute a relay interrupter, resistances 122, 123 and 124 or other suitable means being provided to delay the release of the interrupter relays for

the purpose of obtaining the required sending speed with the desired ratio of make and break intervals.

The intermittent operation and release of relay 128 controls the counting chain consisting of the five relays 131 to 135. The first operation of relay 128 energizes relay 131 from battery over winding 131, break contacts 132 and 133, make contacts 128 and 129, upper and lower make contact 130, conductor 150 to ground through make contacts 215, 225, and so forth. The first release of relay 128 closes a holding circuit for relay 131 in series with the upper winding of relay 132, which operates, from battery over windings 131 and 132, make contact 131, break contact 128 to ground over the previously described circuit. The second operation of relay 128 closes a holding circuit for relay 132 from battery over lower winding 132, make contact 132, break contact 133, make contact 128 and so forth to ground. At the same time, the holding circuit for windings 131 and 132 in series is opened at break contact 128, so that relay 131 releases. The second release of relay 128 energizes relay 133 in series with relay 132 from battery over lower winding 132, upper winding 133, make contact 132, break contacts 131 and 128, and so forth to ground. The third operation of relay 128 opens this circuit, causing the release of relay 132, while relay 133 is locked from battery over lower winding 133, make contacts 133 and 128, and so forth to ground. At the same time relay 134 is energized in parallel with lower winding 133 over upper winding 134, break contact 135 and resistance 125 to battery. Upon the third release of relay 128, the locking circuit of relay 133 is opened, thereby releasing relay 133, while relay 134 locks from battery over lower winding 134, make contact 134, break contact 135, make contact 129, upper and lower make contacts 130, conductor 150 to ground through make contacts 215, 225, and so forth.

The fourth, fifth and sixth operation and release of relay 128 control relays 131, 132 and 133 as described for the first three steps. In addition, the fifth release of relay 128 energizes relay 135 over make contact 134 in parallel with upper winding 133. Relay 135 locks up from battery over resistance 125, make contact 135, lower winding 135, make contact 129, and so forth to ground. Moreover, relay 135 transfers the above described locking circuit of relay 134, from break contact 135 to make contact 135 and break contact 131.

The seventh operation of relay 128 energizes relay 131 as described for the first impulse. With relay 131, operated, relay 134 locks over its own make contact and make contacts 135, 131, 128, and so forth to ground. Upon the seventh release of relay 128, relay 132 operates in series with relay 131 as described above. With relays 131, 132 and 135 energized and relay 128 released, ground is disconnected from the locking circuit of relay 134, causing it to release.

During the eighth and ninth impulses, relays 131, 132 and 133 function as described for the second and third impulses. Relay 134 cannot be energized again, as its operating circuit is opened by break contact 135. The tenth operation of relay 128 energizes relay 131 as described for the first impulse.

It will be noted that relays 131, 132 and 133 constitute a three-step counting chain, which repeats its operation several times, whereas relays 134 and 135 serve to discriminate between these

successive repetitions. For a clearer understanding of the operation of the counting chain, the various relays which are operated during each of the ten impulses are listed in the table below.

Impulse	Relays operated during impulses	Relays operated between impulses
1st.....	131 - - - -	131 132 - - -
2nd.....	- 132 - - -	- 132 133 - -
3rd.....	- - 133 134 -	- - - 134 -
4th.....	131 - - 134 -	131 132 - 134 -
5th.....	- 132 - 134 -	- 132 133 134 135
6th.....	- - 133 134 135	- - - 134 135
7th.....	131 - - 134 135	131 132 - - 135
8th.....	- 132 - - 135	- 132 133 - 135
9th.....	- - 133 - 135	- - - - 135
10th.....	131 - - - 135	- - - - 135

Attention is invited to the fact that, although only five relays are used for counting ten impulses, not one of these relays has more than six contact springs in the counting circuit proper, one relay having only five springs, one relay four springs, and one relay three springs. The total number of contact springs in the counting circuit proper is only twenty-four, which is believed to be less than in any ten-step counting chain heretofore known.

While the counting chain is going through these steps with relay 137 energized, the external impulse circuit controlled by the sender and including conductors 151 is interrupted once for every operation of relay 128, thus transmitting impulses over these conductors. Instead of breaking a normally closed circuit, as shown, the external impulse circuit may be closed for every operation of relay 128, or it may be arranged in any other suitable manner, depending upon the purpose to be served.

For descriptive purposes, it has been assumed in the foregoing description that relay 129 remains energized while ten impulses are being transmitted. However, each time an impulse is transmitted, the original energizing circuit of relay 129 is replaced by a test circuit controlled by a group of register relays, and relay 129 may or may not remain energized for the full number of ten impulses, depending on the digit registered. For this purpose, the circuit of relay 129 is transferred over make contacts 128, 127, and 129 through contacts of the counting relays 131 to 135 to conductors 142, 143, 144 and 145, which are connected over make contacts of relays 210, 220, etc., to the register relays on which the digit being transmitted at the time is registered.

This transfer does not take place until relay 128 has operated relay 127, in order to insure that the counting relays controlled by relay 128 have assumed their new positions before the test is made. For a similar reason, the test circuit is transferred back to the original operating circuit of relay 129 as soon as relay 128 releases, so that the changes in the counting chain caused by the release of relay 128 will have no effect upon the test circuit.

The test is accomplished by providing a holding circuit for test relay 129 over contacts of the counting and register relays during each test period until the desired number of impulses has been transmitted, whereupon relay 129 no longer

finds a holding circuit during the test period and therefore releases.

Assuming that the digit registered is the digit 1, register relay 211 will be operated while register relays 212, 213 and 214 are de-energized. When relay 127 operates during the first impulse, after relays 128 and 131 have been energized, the circuit of relay 129 is extended over make contacts 128, 127 and 129 and break contacts of relays 132, 133, 134, 135 and 136 to conductors 144, 143, and 142, which are open at the make contacts of relays 212, 213, and 214, while conductor 145, which is grounded through make contact 211, winding 215, etc., is disconnected from relay 129 by break contact 131. As a result, relay 129 releases during the first impulse, stopping the sending of further impulses, as described hereinafter.

If the digit 2 has been registered, register relay 212 will be operated, while register relays 211, 213 and 214 are de-energized. In this case, relay 129 finds a holding circuit during the test period of the first impulse which extends from battery over winding 129, make contacts 128, 127, 129, break contacts 132 and 135, conductor 144, rectifier 200, make contacts 210 and 212, winding 215, conductor 147, make contacts 130, conductor 150, make contact 215 to ground. During the second test period, this circuit is opened by relay 132, so that relay 129 releases after two impulses have been sent.

For the digit 3 register relay 213 will be operated while the other three register relays are de-energized. During the first and second test periods, relay 129 finds a holding circuit from battery over winding 129, make contacts 128, 127 and 129, break contacts 134 and 133, conductor 143, rectifier 200, make contacts 210 and 213, winding 215, and so forth to ground. In the third test period, this circuit is opened by break contacts 133 and 134, causing relay 129 to release.

The register relay combination for the digit 4 is relays 211 and 213 operated, providing the last described holding circuit over break contacts 133 and 134 during the first and second test periods. In addition, another holding circuit is completed during the second test period over break contact 131 and make contacts 210 and 211, this holding circuit also being effective during the third test period. When the fourth test period is reached, both holding circuits are opened by relays 131 and 134, thereby releasing relay 129.

When the register is set for the digit 5, relays 212 and 213 operated, relay 129 holds during the first test period over break contacts 132 and 135 and make contacts 210 and 212, and also over break contacts 134 and 133 and make contacts 210 and 213. The first mentioned circuit is also effective during the second test period, while the last mentioned circuit holds relay 129 during the third and fourth test periods. In the fifth test period, relays 132 and 134 are both operated, thus breaking both holding circuits for relay 129.

If the digit 6 has been registered, register relay 214 alone is operated, providing a holding circuit for relay 129 over break contacts 135 and 136 and make contacts 210 and 214 during the first five test periods. This holding circuit is broken during the sixth test owing to relay 135 being operated at this time.

If the digit 7 has been registered, register relays 211 and 214 are operated. In this case, the holding circuit for the first five test periods

is the same as for six impulses. Moreover, another holding circuit over break contact 131 and make contacts 210 and 211 is effective during test periods 2, 3, 5, and 6. Both circuits are open during test period 7, which is characterized by having relays 131, 134 and 135 operated.

For the digit 8, register relays 212 and 214 are energized, providing a holding circuit over break contacts 135 and 136 and make contacts 210 and 214 for the first five test periods, a second holding circuit over break contacts 132 and 135 and make contacts 210 and 212 during test periods 1, 3 and 4, and a third holding circuit effective during test periods 6 and 7 over make contacts 134, 135, 210, and 212. In test period 8, relays 132 and 135 are operated, while relay 134 is de-energized, so that all three holding circuits are open.

When the register is set for the digit 9 by having relays 212, 213 and 214 operated, the holding circuit for test periods 1 to 5 is traced over break contacts 135 and 136 and made contacts 210 and 214. Another holding circuit over break contacts 134 and 133 and make contacts 210 and 213 is closed in test periods 1, 2 and 8, while break contacts 132 and 135 and make contacts 210 and 212 complete an additional holding circuit for test periods 1, 3 and 4. During test periods 6 and 7, relay 129 holds over make contacts 134, 135, 210 and 212. When test period 9 is reached, relay 135 opens the holding circuits completed over make contacts 212 and 214, while relay 133 breaks the circuit extending over make contact 213.

For the digit 0, corresponding to ten impulses, relays 211 and 212 are operated, closing a holding circuit for test periods 2, 3, 5, 6, 8 and 9 over break contact 131 and make contacts 210 and 211, another holding circuit for test periods 1, 3 and 4 over break contacts 132 and 135 and make contacts 210 and 212, and a third holding circuit for test periods 6 and 7 over make contacts 134, 135, 210 and 212. All these holding circuits are open in the tenth test period, thus causing relay 129 to release.

It will be seen that each of the ten different register relay settings causes the release of relay 129 after the sender has transmitted the number of impulses which corresponds to the digit registered. The release of relay 129 opens the operating and holding circuits of all five counting relays 131 to 135, thereby restoring the counting chain to normal. A make contact 129 is included in the test circuit of relay 129 to prevent its immediate re-operation during the last test period due to the re-closure of the test circuits by the release of the counting relays.

When relay 129 releases, the short-circuit across the upper winding of relay 136 is opened, allowing this relay to operate in series with the upper winding of relay 137. The operation of relay 136 shunts any of the register relays 211 to 214 which may be operated, over resistance 121, conductor 146, make contact 210 and over the make contacts of the operated register relays. Resistance 121, being a protective device customarily provided where relay contact springs are connected to battery, is of sufficiently low value to reduce the current flowing in windings 211 to 214 so much that these relays release.

While relay 136 is operated, relay 215 remains energized from battery over resistance 121, make contact 136, conductor 146, make contact 210, winding 215, and so forth to ground.

When relay 128 releases at the end of the last

test period, during which relay 129 is released, a circuit is again closed for relay 129 over break contact 128 and make contacts 130 and 215. Relay 129 operates, preparing the operating and holding circuits for the counting relays and energizing the lower windings of relay 136 and 137 from ground over make contacts 215, 130, 129, 136 and 137. The two windings of relay 137 are so connected as to oppose each other, with the result that relay 137 releases, while relay 136 remains energized over its lower winding.

In order to provide the necessary time interval between successive series of impulses, the sender now takes six steps; that is, the relay interrupter, including relay 128, continues to operate, but without breaking the external impulse circuit, relay 137 being de-energized at this time. The holding circuit for relay 129 during the first five test periods is traced over break contact 135 and make contact 136. In the sixth test period, relay 135 is operated, so that relay 129 releases. As a result, the counting relays and relay 136 are de-energized, the latter relay opening the previously described circuit for relay 215. The release of relay 215 de-energizes relay 210 and closes a circuit for relay 220, which connects the register relays for the second digit to conductors 142 to 145 in preparation for the transmission of impulses in accordance with the second digit.

When relay 128 releases at the end of the last described test period, relay 129 operates again as explained above, and the impulse sender from now on functions exactly the same as for the first digit, except that relay 220 being operated instead of relay 210, the sender is under control of register relays 221 to 224 of the second digit. After the second digit has been transmitted, relays 221 to 224 are released as described above for the first digit, whereupon the sender takes six steps to provide the time interval between digits. At the end of this interval relay 225 releases, shifting the control to the register relays for the next digit, and this action continues until the sender has transmitted all digits that have been registered. When the last one of the relays 215, 225, and similar relays for the succeeding digits is released, ground is removed from conductor 150, thereby restoring the impulse sender to normal. The circuit through contact 114, over which the sender may be engaged, is held open by a break contact of relay 126, which is the last relay to release, in order to insure the complete release of the sender, even though contact 114 is still closed at the time.

The register circuit shown in Fig. 2 has been worked out with the aim to reduce the number of register contacts to a minimum, but not to use the smallest possible number of relays. In this circuit, the register for one digit requires only twenty-six contact springs, of which the two springs constituting the lowest make contact of relays 215, 225, etc., could be eliminated by substituting for them a common make contact on a relay with its winding placed in series with conductor 147. It is believed that no further reduction in the number of contacts is possible when using ordinary telephone relays.

As far as the minimum number of relays necessary for a register is concerned, the answer will be found by determining the required number of relay combinations. Ten distinct relay combinations are necessary for registering the desired numeral. When the registration of the digit is completed, the key circuits must be shifted to the

next register, while preserving the identification of the registered numeral, so that ten additional relay combinations are needed. The shift from registering to sending is accomplished by the common part of the sender, thus requiring no additional relay combinations. After the digit has been transmitted, the sender test circuit must be transferred to the next digit. At this time it is no longer necessary to preserve the registered numeral, so that one additional relay combination will be sufficient. Adding one relay combination for the normal condition with all relays released, it will be seen that twenty-two different combinations are necessary, which can be obtained with five relays.

The register circuit shown in Fig. 2 uses six relays per digit. In order to reduce the number of relays to the theoretical minimum, relays 210, 220, etc., can be eliminated, as shown in Fig. 3, by the use of additional contacts on relays 315, 325, etc. In Fig. 2 the winding of relay 210 is controlled over the two make and break contacts shown immediately below winding 215. The upper one of these contacts controls relay 210 during the registering period, whereas the lower one is used during the transmission period. In Fig. 3 two make and break contacts of relay 315 in a similar circuit are substituted for each of the four right-hand make contacts of relay 210. The lefthand make contact of relay 210 is replaced by a single make and break contact of relay 315, as this contact is used only during the transmission of impulses, but not while a number is being registered. Relay 301 is added in order to close the circuits from conductors 142 to 145 to the contacts on relays 315, 325, etc., which come into play when the sender is transmitting impulses. Relay 301 operates over a make contact of relay 130 after the start key 115 is operated.

The register circuit shown in Fig. 3 uses the smallest possible number of relays and requires only a single make contact on four of the register relays, but the fifth register relay must be provided with a comparatively large number of contact springs. In the circuit arrangement shown in Fig. 4 the number of contact springs on the fifth register relay is reduced by transferring some of the functions performed by it during the transmission period to additional contacts on the other four register relays. In this case the sender control circuit is switched during the transmission period from one digit to the next by a single make and break contact of relay 415, making it impossible to connect conductors 142 to 145 in multiple to the register relays of all digits, as in Fig. 2. Instead, it is necessary to open conductors 142 to 145 between successive digit registers by break contacts of relays 411 to 414, 421 to 424, etc., in order to avoid undesired circuit paths. Assuming, for example, that numerals 1 and 4 were registered for the first and second digit, respectively, and that no break contacts were provided on relays 411 to 414, etc., a circuit would be closed from conductor 145, which is grounded during the transmission of the first digit, over make contacts 421 and 423 to conductor 143, which should be open for numeral 1, thus causing the impulse sender to transmit four impulses instead of one for the first digit. Providing break contacts on relays such as 411 makes it possible to substitute a single make and break contact of relay 415 for four make and break contacts of relay 315. In this embodiment, the holding circuit or test circuit for relay 129 does not include the locking contacts of the register relays, but is com-

pleted through separate contacts on these relays, so that the rectifiers, such as 200 or 300, may be omitted.

Comparing the features of the three register circuits shown in Figs. 2, 3 and 4, it may be said that Fig. 2 uses the smallest number of contacts and the largest number of relays, whereas Fig. 3 has a minimum of relays, but a maximum of contacts. Fig. 4 shows a circuit with a minimum of relays and a number of contacts intermediate between Figs. 2 and 3.

While my improved sender has been described herein as being used by an operator in a semi-automatic telephone system, it will be understood that it is adapted for use in other types of systems, such as stock quotation systems, remote control systems, fire alarm systems, etc., either in the form shown or with modifications appropriate to the associated equipment. I do not, therefore, desire to be limited to the exact disclosure herein, but desire to include and have protected by Letters Patent all forms and modifications of my invention which come within the scope of the appended claims.

I claim:

1. In a register sender, digit registering relays, each having a pair of locking contacts, circuit means for locking any energized relay through its locking contacts, a counting device, and a test circuit including said locking contacts for stopping said device.

2. In a register sender, digit registering relays, each having a single pair of contacts, means for setting said relays to register digits, a sender controlled by said relays, locking circuits for said relays including said contacts, and circuits also including said contacts for stopping said sender.

3. In a register sender, a set of keys, a group of register relays, a group of conductors over which said relays are set from said keys to register digits, a sender, a group of branch conductors extending to said sender which together with the conductors of said first group enable the sender to be controlled by said relays, said branch conductors being connected together at the sender at the time said register relays are being set, and rectifiers inserted in said branch conductors to effectively isolate the conductors of said first group during the setting of said relays.

4. In a register sender, a group of register relays, a group of individual control conductors over which said relays are set, a sender, a group of branch conductors over which said relays control said sender, said branch conductors being connected together at the sender at the time said register relays are being set, and a rectifier in each branch conductor to prevent a setting potential applied to one of said control conductors from causing a current flow over two branch conductors in series and bring about a false setting of said register relays.

5. In a register sender, a group of register relays, a sender, individual conductors leading from said relays, respectively, to a common test circuit at said sender, a rectifier inserted in each of said conductors to enable a portion thereof adjacent the associated relay to be used for setting the relay to register a digit, said rectifiers being effective to prevent potentials applied to said conductors individually from being effective on all the conductors due to their connection at the said common test circuit, and means for applying potentials to the said portion of said conductors to set said relays as set forth.

6. In a register sender, a register, a counting

device, an interrupter device for transmitting impulses and for controlling said counting device, a test relay, a test circuit including said counting device and said register, an energizing circuit for said test relay, and means included in said interrupter device for substituting said test circuit for said energizing circuit each time an impulse is transmitted.

7. In a register sender, a register, a counting device, a test circuit including said register and counting device, a relay for transmitting impulses, means for operating the counting device to change the test circuit each time an impulse is transmitted, a test relay, and means for temporarily connecting said test relay to said test circuit each time after the circuit has been changed.

8. In a register sender, a register, a counting device, a test circuit including said register and counting device, a sender for transmitting impulses, said sender including means for operating said counting device each time an impulse is transmitted to open the test circuit when the number of impulses transmitted corresponds to the setting of said register, means including a test relay for stopping the sending of impulses by de-energizing, and means whereby the continued energization of said test relay is made dependent upon the continuity of said test circuit for an interval during the transmission of each impulse.

9. In a register sender, a plurality of relay registers, a group of setting conductors, means including transfer relays for associating said conductors with said registers successively, means responsive to setting of said registers over said conductors for energizing said transfer relays successively, a sender, sender control conductors associated with the first of said registers after the same have been set, means controlled by said sender for restoring said registers successively and also for restoring said transfer relays successively, contacts on the register relays for transferring said sender control conductors from one register to the next as the registers are restored, and contacts on the transfer relays whereby the sender is able to control the restoration of said registers and transfer relays as set forth.

10. In a register sender, a relay register, means for setting said register by energizing one or more relays thereof, a locking circuit for the energized relays including a relay common to the relays of the register, a sender, a group of sender control conductors comprising a conductor individual to each register relay, and circuit means for placing a potential on the control conductor corresponding to any operated register relay, said last means including a contact on the operated relay and a contact on the said common relay.

11. In a register sender, a relay register, means for setting said register by energizing one or more relays thereof, a sender, a group of sender control conductors comprising a conductor individual to each register relay, means including a front contact on each register relay for placing a control potential on the associated control conductor, a back contact on each register relay through which the associated control conductor is extended to the corresponding relay in a second register, the register relays in the second register also having front contacts for placing control potentials on said conductors, and means for preventing an energized relay in the second register from placing a control potential on the associated conductor while the corresponding relay in the first register is energized.

12. In a register sender, a plurality of relay

registers, means for setting each register in accordance with a digit by energizing one or more relays thereof, a common locking circuit for the relays of each register including a transfer relay, a sender, means whereby the sender is controlled by said registers to transmit the registered digits, a conductor on which a potential is momentarily placed under control of the sender after each digit is transmitted, said conductor being so connected

at the first register that the potential placed thereon after the first digit is transmitted is effective to shunt down all operated register relays and hold the transfer relay, the transfer relay being released when the potential is removed, and contacts on each transfer relay except the last for extending said conductor to the next register. 5

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