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2,920,249

IMPULSE COUNTING DEVICE

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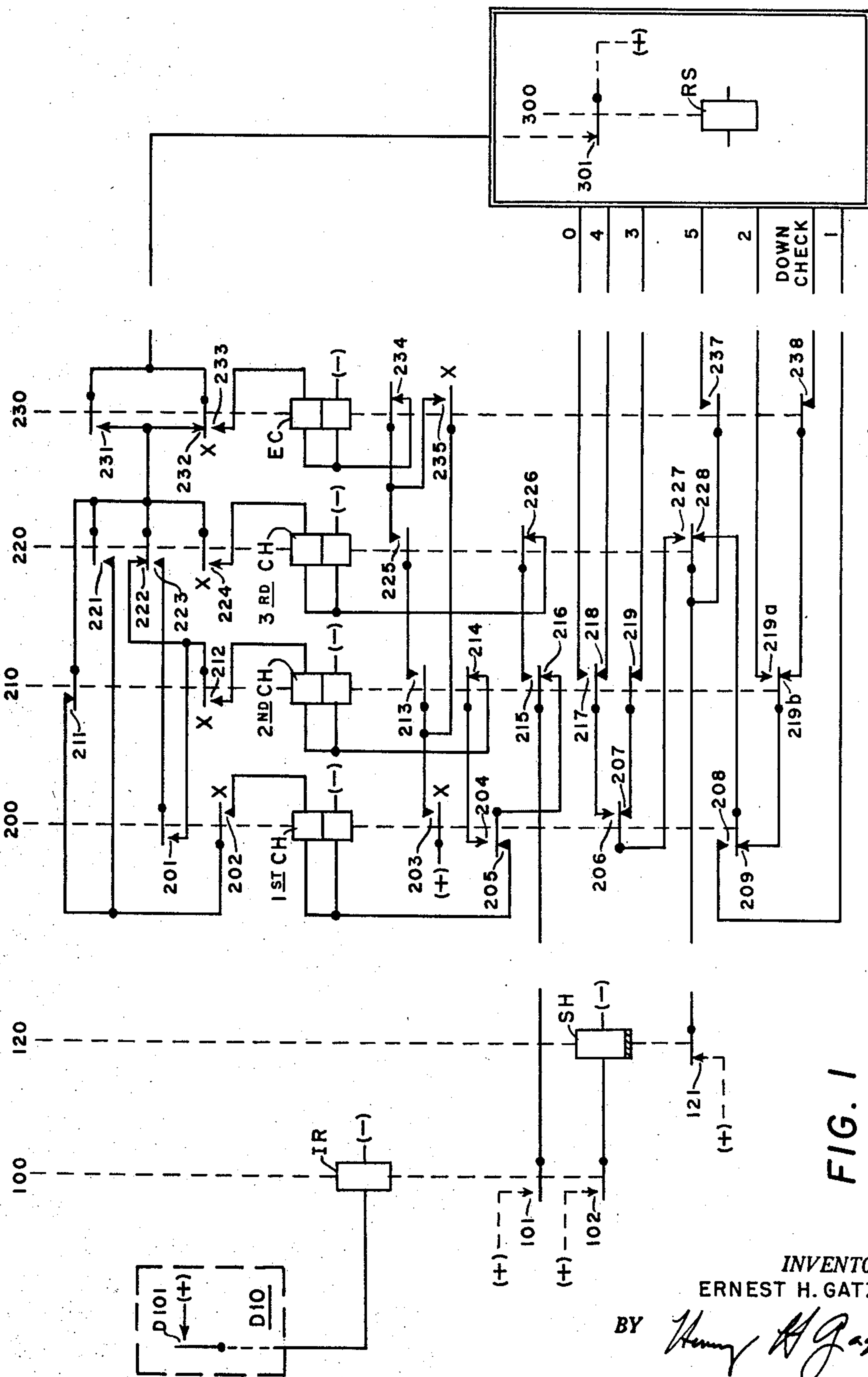


FIG. 1

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AGENT

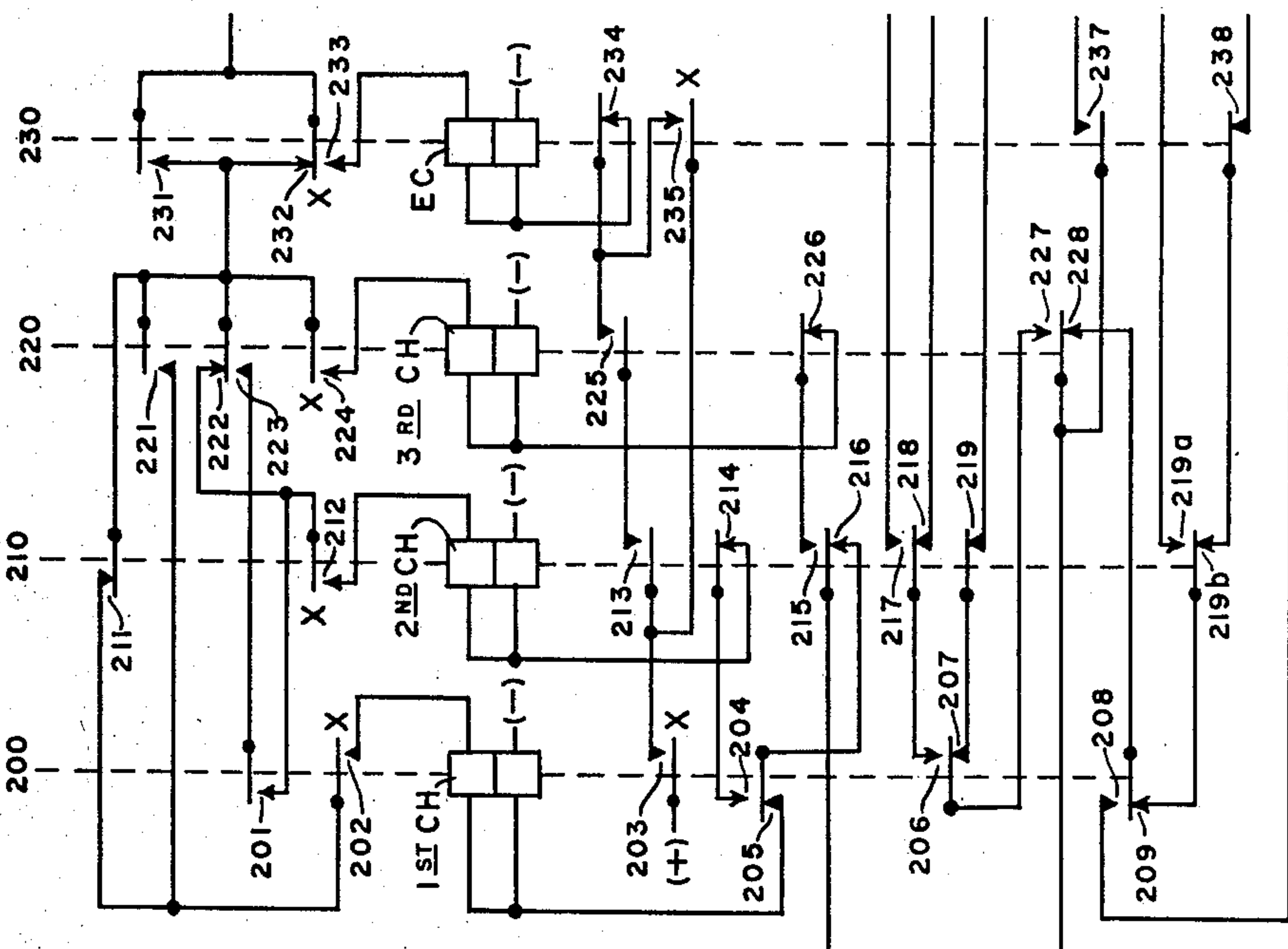


FIG. 2

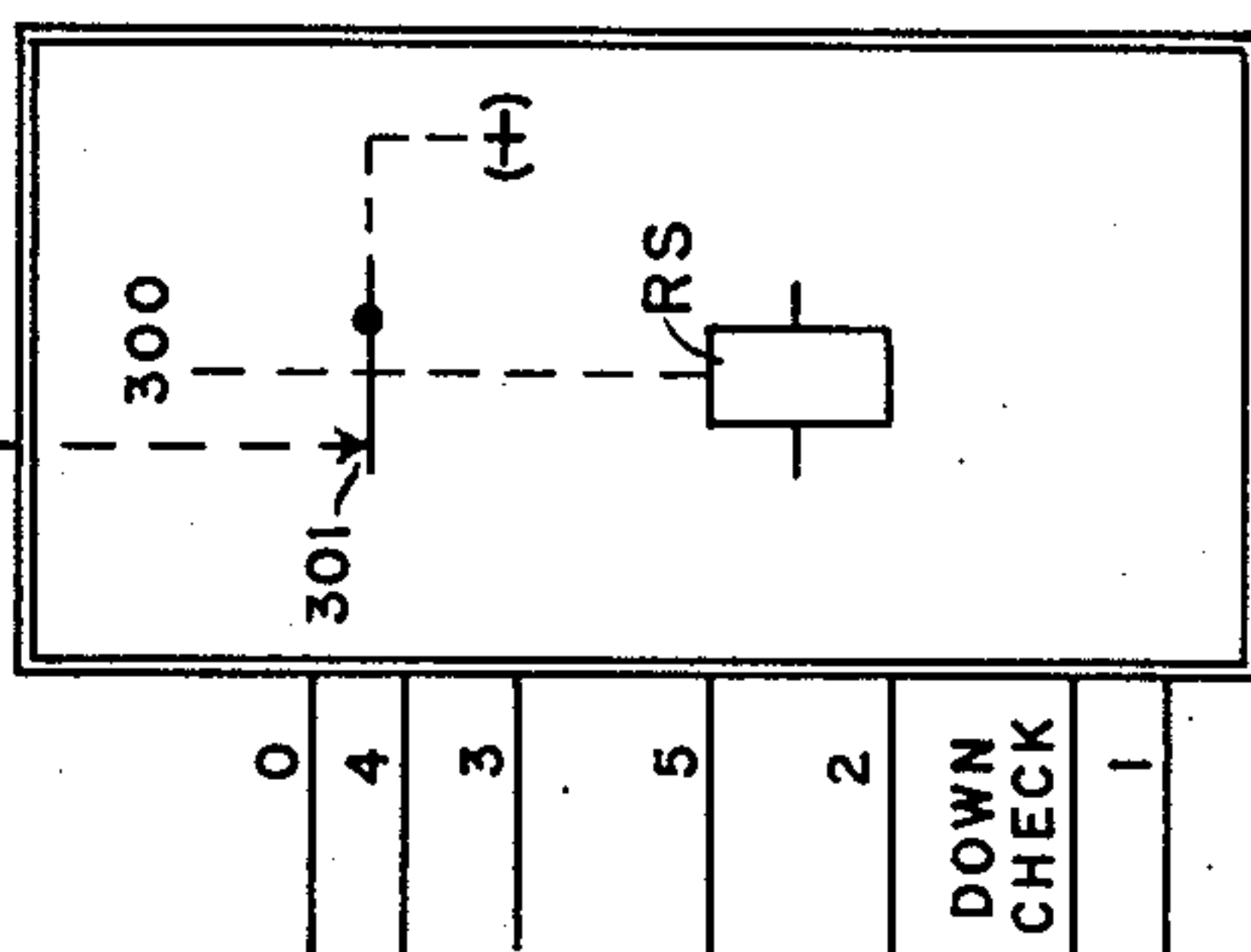


FIG. 3

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IMPULSE COUNTING DEVICE

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5 Claims. (Cl. 317-140)

My invention relates to a device for counting electrical impulses, and more particularly to an impulse counting device suitable for translating a train of impulses based on a first counting system into electrical signals based on a different counting system.

In such systems, it is the practice to provide a plurality of sets of impulse responsive means which are operable in a cycle of unique combinations in response to certain successive operations of an impulse source such as a set of contacts connected to the input of the counting device. End-of-cycle means common to the sets of impulse responsive means are operative at the conclusion of a cycle of operations of the impulse responsive means. Output or counting means controlled by the sets of impulse responsive means and the end of cycle means are effective at the end of the transmission of a train of impulses for translating the incoming signal into other electrical impulses.

In the past, it has been the practice to provide more than one relay for each set of impulse responsive means as well as the end-of-cycle means. One relay of each set may be arranged to operate in response to starting of an individual operation of the pulse source; similarly, other relays of the same set may be arranged to operate during or in response to the end of the individual operation of the pulse sources to mark the end of the impulse and to set up for the next successive combination of operations of the sets of relays. Means jointly controlled by the sets of relays are effective in response to the registration of a particular operated combination of the relay sets for indicating the corresponding number of operations of the impulse repeating means up to the number of unique combinations in which the relay sets are operable. In response to the last unique combination of operations of the relay sets, one of the relays of the end-of-cycle responsive means is operated to release the impulse responsive sets to their normal conditions; other relays of the end of cycle means may be operated after the restoration of the impulse responsive sets to normal condition for making the sets of impulse responsive in another cycle of operations to register further successive operations of the impulsing means. In such systems it has been necessary to provide at least first and second relays in each such set of impulse responsive means and the end-of-cycle means in order to insure the fact that only one set is operated in response to each incoming impulse and in order to insure the full release of the impulse responsive sets prior to the completion of operation of the end-of-cycle responsive means.

Accordingly, it is an object of my invention to provide a new and improved counting device.

Another object of my invention is to provide a counting device in which only one relay is employed in the end-of-cycle means.

I accomplish these and other objects by providing in the preferred embodiment of my invention a counting chain comprising at least one two-step relay which is operative through its second step for indicating certain

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ones of a series of successive operations of an impulse repeating means comprising a set of normally open contacts. The latter contacts are arranged to close and reopen in response to each of a train of repeated impulses.

Closing of the contacts is effective to complete a circuit for energizing a first winding of the relay to operate the relay through its first step. Certain contacts on the relay are operated in response to the operation of the relay through its first step for completing a circuit for energizing a second winding of the relay in series with the first to operate the relay through its second step. Closing impulsing contacts to energize the first winding only is also effective for shorting out the second winding in order to prevent the series energizing circuit from being effective during the time that the operation of the impulsing means is incomplete. Thus the registration of the certain operation of the impulse repeating means is prevented until after the contacts of the impulse repeating means have been reopened.

The operation of the relay through its second step also is effective for transferring the impulsing contact circuit from its connection to the first winding of the relay to the first winding of the next succeeding relay in the chain; and for selectively releasing certain others of the chain of relays which have been previously operated through their first and second steps. Thus the relays of the counting chain are operated in a cycle of unique combinations, each combination representing a particular one of successive operations of the impulse repeating means.

At the conclusion of a cycle of operations of the counting chain relays, the single end-of-cycle relay is operated through a first step in response to the operation of the impulse responsive relays in the last of the unique combinations of a cycle for releasing the impulse responsive relays to their normal condition and for preparing a circuit for energizing the first and second windings of the end-of-cycle relay in series. The end-of-cycle relay energized through its first and second windings in series operates through its second step for registering the end of a cycle of operations and for restoring operated ones of the counting chain relays to normal. In order to prevent the end of cycle registration from taking place prior to the complete release of the impulse responsive means, means comprising a circuit energized by the operation of the last released of the counting chain relays an alternate circuit is effective for shorting out the second winding of the end-of-cycle relay, so that the last released of the impulse responsive relays prevents the end-of-cycle relay from being operated through its second step.

Further objects and advantages of my invention will become apparent as the following description proceeds, and features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

For a better understanding of my invention, reference may be had to the accompanying drawings in which:

Fig. 1 shows a skeletonized representation of an impulse source;

Fig. 2 shows an impulse counting device; and

Fig. 3 shows a skeletonized representation of a storage unit.

The apparatus referred to in the following paragraphs is made to function from power supplied from a source such as a battery; the most positive terminal or plate of the battery is connected to ground and is referred to hereafter as "ground" and in the drawings as "(+)"; the most negative, ungrounded terminal or plate of the battery is referred to as "battery" and in the drawings as "(-)."

In an impulsing counting device of the type contemplated, a plurality of two-step, counting chain relays such as 200, 210 and 220 are arranged to operate in a cycle

of various, unique combinations in response to certain ones of a successive train of impulses which are caused by the operation of the impulse repeating means comprising make contact 101 of relay 100. In the preferred embodiment of my invention, the impulse counting device is arranged to count a train of impulses comprising any number up to and including a maximum of ten.

Referring to Fig. 1, a train of impulses is created by the operation of any of a number of well known means such as dial D10, which causes contacts D101 to be repeatedly closed and reopened, thereby causing impulse repeating relay 100 to be correspondingly operated and released. Impulse repeating means comprising contacts 101 are thereby successively closed and opened in response to each impulse in a train of impulses created by the operation of dial D10.

As the following description proceeds, it will be seen that the two-step chain relays 200, 210 and 220 are operated in cycles of five unique combinations. By making it possible to run through the cycle of operated combinations twice, a train of ten impulses may be counted. For the sake of convenience, the following table shows the input number of impulses in comparison to the numbers of the relays that are placed in operated condition as a result of applying the impulses to the input circuit of the chain of relays.

Number of Impulses	Counting Chain Relays Operated
1 or 6.....	200.
2 or 7.....	210.
3 or 8.....	220.
4 or 9.....	200 and 220.
5 or 10.....	200, 210 and 220.

The method of operation for the chain relays is next explained.

Assume for the purposes of demonstration that the number of impulses in a train of impulses repeated by relay 100 is "7." Thus, contacts 101 are closed and reopened seven consecutive times. In response to the first closure of contacts 101, a circuit is completed for energizing the lower winding of the first chain relay 200 as follows: from ground through make contacts 101, break contacts 216 on unoperated relay 210, break contacts 205 on unoperated relay 200, the lower winding of relay 200 to battery.

The energization of the lower winding of relay 200 is effective for operating relay 200 through its first step, that is, sufficiently to operate the preliminary make contacts 202 and 203, and not sufficiently to operate the remaining contacts of the relay. The operation of make contacts 202 is effective for closing a circuit for energizing the upper and lower windings of relay 200 in series over the following circuit: from ground through break contacts 301, 232 and 211 on unoperated relays 300, 230 and 210, respectively, make contacts 202 on operated relay 200, and the upper and lower windings of relay 200 to battery. In order to prevent the series energizing circuit of relay 200 from being effective until the pulse caused by the closing of contacts 101 is completed, the circuit for energizing the lower winding only supplies ground to the left hand terminal of the upper winding of relay 200, thereby shorting out the upper winding and preventing the operation of relay 200 through its second step.

At the conclusion of the first impulse, relay 100 releases, opening contacts 101 and removing the short around the upper winding of relay 200. The series energizing circuit is thereupon effective to operate relay 200 through its second step. The operation of relay 200 through its second step is effective for disconnecting the impulsing contacts 101 from the lower winding of relay 200 at break contacts 205.

The closing of contacts 101 a second time is effective in response to the operation of relay 200 through its second step for closing a circuit for energizing the lower winding of second chain relay 210 as follows: from ground through make contacts 101, break contacts 216 on unoperated relay 210, make contacts 204 on operated relay 200, break contacts 214 on unoperated relay 210, and the lower winding of relay 210 to battery. The energization of the lower winding is effective to operate the relay 210 through its first step, thereby closing contacts 212 but not operating the remaining contacts on relay 210.

In response to the operation of relay 210 through its first step, a circuit for energizing the upper and lower windings of relay 210 in series is completed from ground through break contacts 301, 232, and 222 on relays 300, 230 and 220, respectively, make contact 212 on relay 210, and the upper and lower windings of relay 210 in series to battery. In a manner similar to the one described in the case of relay 200, the presence of ground supplied through the impulsing contacts 101 is effective for preventing the series energizing circuit for the windings of relay 210 from operating relay 210 through its second step so long as contacts 101 are closed.

In a manner similar to the one described in the case of relay 200, the opening of impulsing contacts 101 is effective for removing the short around the upper winding of relay 210 so that the series energizing circuit for the windings of relay 210 described in the preceding paragraph is effective for operating relay 210 through its second step. The subsequent operation of relay 210 through its second step is effective for releasing relay 200 by opening the locking circuit for relay 200 at break contacts 211; the operation of relay 210 through its second step is also effective for disconnecting the impulsing contacts 101 from the lower winding of relay 210 at break contacts 216.

The third successive closing of contacts 101 is effective in response to the operation of relay 210 through its second step for closing the following circuit for energizing the lower winding of relay 220: from ground through contacts 101, make contacts 215, on now operated relay 210, break contacts 226 on unoperated relay 220, and the lower winding of relay 220 to battery. The energization of the lower winding of relay 220 is effective for operating relay 220 through its first step so that preliminary make contacts 224 are closed thereby completing a circuit for energizing the upper and lower windings of relay 220 in series over the following circuit: from ground through break contacts 301 and 232 on relays 300 and 230, respectively, make contacts 224, and the upper and lower windings of relay 220 to battery.

In the manner similar to the ones previously described in the cases of relays 200 and 210, the extension of ground from the operating circuit for the lower winding of relay 220 to the left-hand terminal of the upper winding of relay 220 is effective for shorting out that upper winding until such time as make contacts 101 are opened to mark the end of the impulse. Upon the removal of the ground from the lefthand terminal of the upper winding of relay 220, relay 220 operates through its second step. The operation of relay 220 through its second step is effective for releasing relay 210 by opening the previously traced series circuit for the windings of relay 210 at break contacts 222.

The closing of impulsing contacts 101 a fourth consecutive times is effective in response to the release of relay 210 for completing a circuit to energize the lower winding of relay 200 over the previously traced circuit. Relay 200 operates through its first step in the previously described manner to close a circuit for energizing the upper and lower windings of relay 200 in series from ground through break contacts 301 and 232 an unoper-

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ated relays 300 and 230 respectively, the now operated contacts 221 on relay 220, make contacts 202 on relay 200, and the upper and lower windings of relay 200 to battery. Relay 200 thereafter operates through its second step in the previously described manner after contacts 101 open at the end of the impulse. The operation of relay 200 through its second step is effective for opening the above described connection between the impulsing contacts 101 and the lower winding of relay 200 at break contacts 205. Relays 200 and 221 are thereafter held operated through their second steps so long as the above traced holding circuits including contacts 223 on relay 220 are held closed.

The closing of contacts 101 a fifth consecutive time responsive to the operation of relay 200 through its second step is effective in the previously described manner for completing the energizing circuit for the lower winding of relay 210 at make contacts 201. Relay 210 thereupon operates through its first step in the previously described manner and closes an energizing circuit for the upper and lower windings of relay 210 in series as follows: from ground through break contacts 301 and 232 on unoperated relays 300 and 230 respectively, make contacts 223, 201 and 212 on now operated relays 220, 200 and 210, respectively, and the upper and lower windings of relay 210 to battery. Relay 210 thereafter operates through its second step after contacts 101 open at the end of the impulse in the previously described manner. Relay 210 is held operated through its second step so long as the above traced circuit including break contacts 232 is kept closed.

At the conclusion of the fifth successive operation of the impulse repeating means, relays 200, 210 and 220 have been operated through a complete cycle of operated combinations and are now held operated through their second steps. In response to this last of the series of operated combinations, a circuit for energizing the lower winding of end of cycle relay 230 is completed as follows: from ground through preliminary make contacts 203 on relay 200 and make contacts 213 and 225 on now operated relays 210 and 220, respectively, break contacts 234 on relay 230, and the lower winding of relay 230 to battery. The energization of the lower winding of relay 230 is effective for causing relay 230 to be operated through its first step thereby closing preliminary make contacts 233 and 235 and opening preliminary break contacts 232 without operating the remaining contacts of the relay.

The operation of relay 230 through its first step is effective for opening the previously described holding circuit for relays 200, 210 and 220 at break contacts 232, thereby restoring the counting means comprising the chain relays to its normal condition. The operation of relay 230 through its first step also completes a circuit for energizing the upper and lower windings of relay 230 in series from ground through break contacts 301 on unoperated relay 300, make contacts 233 on now operated relay 230, and the upper and lower windings of relay 230 to battery.

Chain relays 200, 210 and 220 are released to their normal positions at substantially the same time. However, the preliminary make contacts 203 of relay 200 which close in response to the operation of that relay through its first step remain closed longer than the contacts 221 and 223 of third chain relay 220 because the latter contacts are closed in response to the operation of relay 220 through its second step. Therefore, the opening of contacts 203 signals the release of all the chain relays. A circuit for preventing the operation of the end of cycle relay is maintained until contacts 203 have opened. The latter circuit shorts out the upper winding of the latter relay over the following path: from ground, through make contacts 203 and 235 on relays 200 and 230, respectively, break contacts 234 on relay 230 to the upper lefthand terminal of relay 200. Upon the open-

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ing of contacts 203, the circuit for energizing the windings of relay 230 in series is rendered effective so that relay 230 operates through its second step. The operation of relay 230 through its second step is effective for opening the circuit at break contacts 234 for shorting out the upper winding of relay 230, so that relay 230 continues to be held operated through its second step in the face of a subsequent operation of the chain relays in the combination representing the last of a cycle of counting operations.

The operation of relay 230 through its second step marks the end of a cycle of operated combinations of relays 200, 210 and 220. The latter relays, released in the previously described manner, are now free to be re-operated in the same predetermined series of unique combinations in response to further successive operations of the impulsing means comprising contacts 101. In the example chosen, it is seen that the first of the remaining two impulses of the seven is effective for operating relay 200 and that the second is effective for operating relay 210 which, in turn, causes the release of relay 200. Thus, at the conclusion of seven operations of the impulsing means, chain relay 210 and end of cycle relay 230 are in operated condition.

Returning to the impulsing means, during the time that relay 100 is being intermittently energized, a circuit is completed for operating shunt relay 120 by completing an intermittent energizing circuit for the winding of relay 120 at make contacts 102. Relay 120, being a slow-release type, is held in its operated condition throughout the transmission of the previously described train of impulses by relay 100. Upon the stopping of transmission of the impulses, the operating circuit for relay 120 is opened at contacts 102 for an interval of time sufficient to allow relay 120 to release. Marking means comprising contacts operative in response to the release of relay 120, contacts rendered effective in response to the operation of the impulse-responsive chain relays, and the operation of the end-of-cycle means comprising relay 230 are effective for selectively placing marking potentials on the output leads connecting the counting device of Fig. 2 to the storage unit shown in Fig. 3. Thus in the case of the digit 7 which has been chosen for demonstration here, the release of relay 120 and the operation of relays 210 and 230 complete a circuit for placing ground on the "2" lead that is traced as follows: from ground through break contacts 121, 228 and 209 on relays 120, 220, and 200, respectively, and make contacts 219a on now operated relay 210 to the "2" lead; similarly ground is placed on the "5" lead over the following circuit: from ground through break contacts 121 on now released relay 120, make contact 237 on now operated relay 231 to the "5" lead.

Means within the storage unit which are not shown because they are not a part of the present invention are operative in response to the above described selective energization of the marking leads; these means are effective for storing the information transmitted from the counting device and for thereafter energizing the winding of reset relay 300. Relay 300 thereupon operates to open the previously described holding circuits for the chain relays 200, 210 and 220 as well as the end-of-cycle relay 230 at break contacts 301 so that any operated one or ones of the latter relays is thereupon released. The release of the operated ones of the chain relays and the end-of-cycle relays is sufficient to restore the counting device to its normal condition and thereby render it effective for counting the next chain of impulses transmitted from the repeating means comprising relay 100 and contacts 101.

While I have shown and described the specific embodiment of my invention, other modifications will readily occur to those skilled in the art. I do not, therefore, desire my invention to be limited to the specific arrangements shown and described, and I intend in the appended

claims to cover all modifications within the spirit and scope of my invention.

What is claimed is:

1. In an impulse counting device, impulsing means operative in response to each of a train of impulses, means comprising a two-step relay effective in its second operated step for counting the number of operations of said impulsing means, sequential means driven by said impulsing means having a normal condition and operative through a cycle of operations in response to successive operations of said impulsing means, said sequential means being coupled to said relay and effective for operating said relay through its first step at the end of a cycle of operations, locking means normally effective for maintaining said sequential means in any of its operated conditions, said relay operated through its first step being effective for making said locking means inoperative in order to restore said sequential means to normal condition, a circuit completed in response to the operation of said relay through its first step for thereafter causing said relay to operate through its second step, and shorting means operative in response to the operation of said sequential means to an operated condition for rendering said circuit ineffective, whereby said means including said relay is ineffective to register the number of operations of said impulse responsive means following the operation of said relay through its first step until said sequential means has been restored to normal condition.

2. The system set forth in claim 1 and having in addition means operative in response to the operation of said relay through its second step for thereafter rendering said shorting means inoperative.

3. In an impulse counting device, impulsing means operative in response to each of a train of impulses, a two-step relay, sequentially operated means responsive to each operation of said impulsing means in combination with said relay for counting the number of operations of said impulsing means, said sequentially operated means having a normal condition and being operative through a cycle of operations in response to certain successive operations of said impulsing means, said relay having first and second windings and being operative through a first step in response to the energization of said first wind-

ing and operative through a second step in response to the energization of said first and second windings in series, locking means for holding said cyclically operating means in any one of its operated conditions, a first circuit for energizing said first winding, a second circuit for energizing said first and second windings in series, said sequentially operated means in the last of the cycle of its operated conditions also being operative for energizing said first circuit, means responsive to the operation of said relay through its first step for rendering said locking means in order to restore said sequentially operated means to normal condition, other means operative in response to the operation of said relay through its first step for completing said second circuit, and said sequentially operative means in an operated condition being effective for shorting out said second winding, whereby said counting means is ineffective to register the number of operations of said impulse responsive means following the operation of said relay through its first step until said sequentially operated means has been restored to its normal condition.

4. The claim set forth in claim 3 having means operative in response to the operation of said relay through its second step for rendering said locking means effective whereby said sequentially operated means is rendered effective following the operation of said relay through its second step.

5. The system set forth in claim 3 having means operative in response to the operation of said relay through its second step for rendering said sequentially operated means ineffective to short out said second relay winding, whereby said relay remains operated through its second step when said sequentially operated means is driven through a second cycle of operations by said impulsing means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,920,249

January 5, 1960

Ernest H. Gatzert

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 69, for "times" read -- time --; column 8, line 11, after "means" insert -- ineffective --.

Signed and sealed this 2nd day of August 1960.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents