

May 8, 1945.

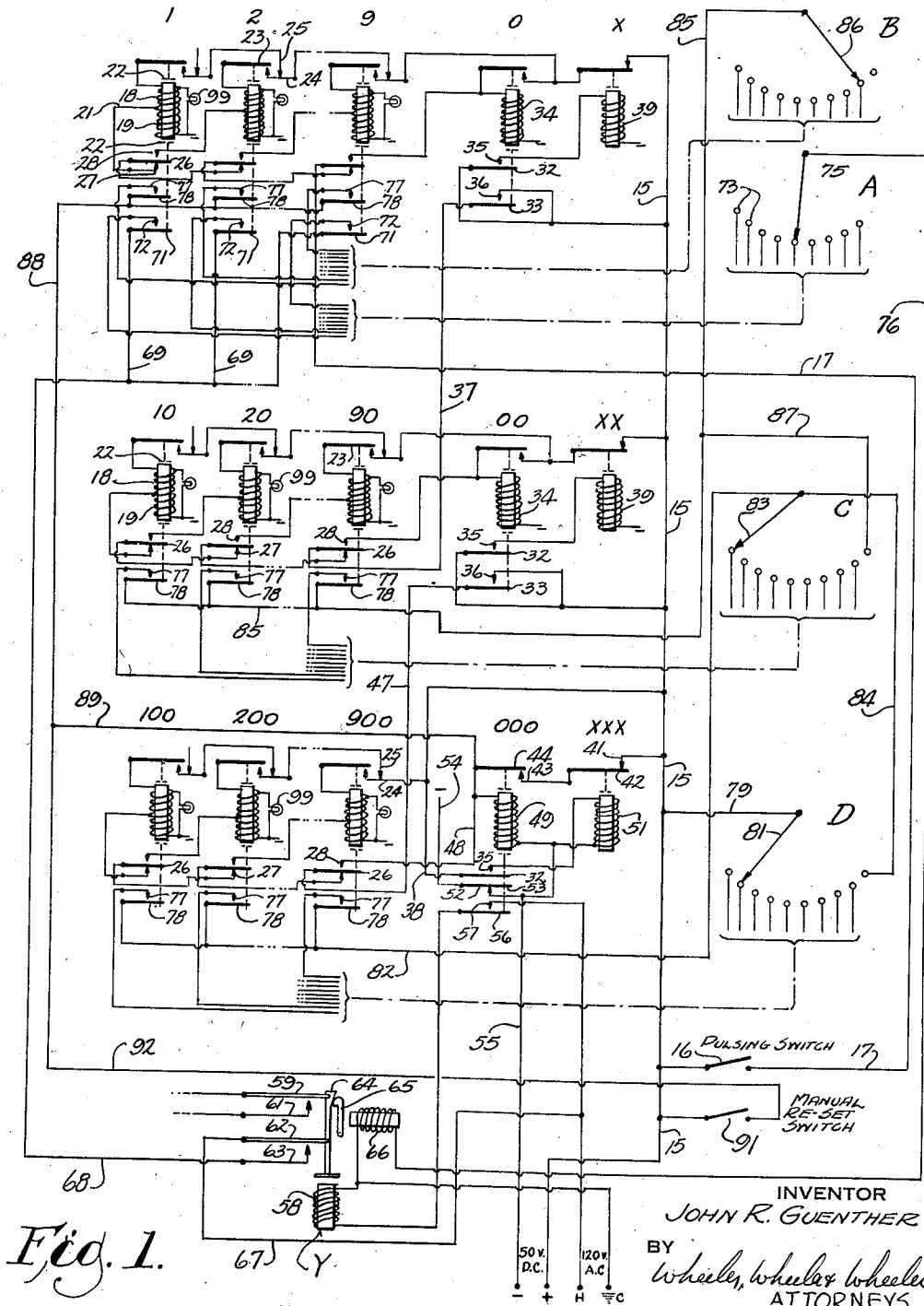
J. R. GUENTHER

2,375,413

COUNTER

Filed Feb. 17, 1943

2 Sheets-Sheet 1



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J. R. GUENTHER

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COUNTER

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2 Sheets-Sheet 2

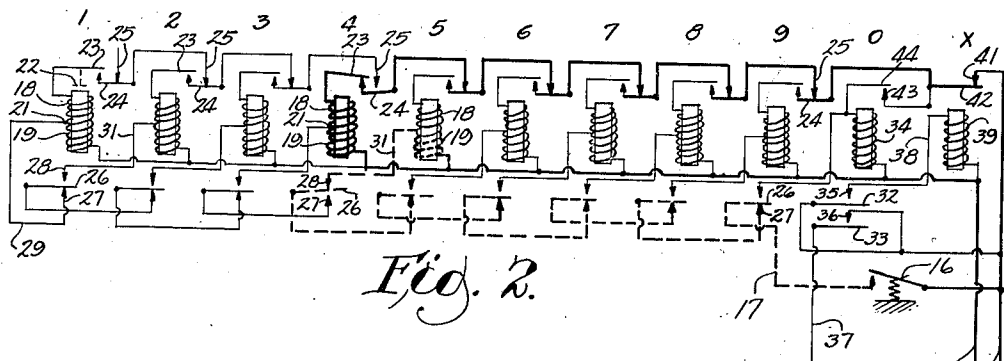


Fig. 2.

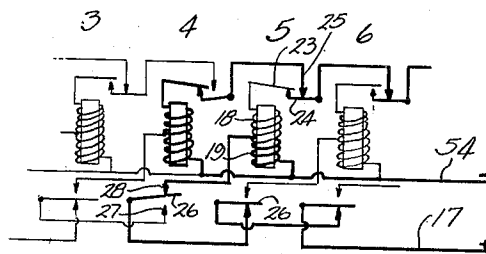


Fig. 3.

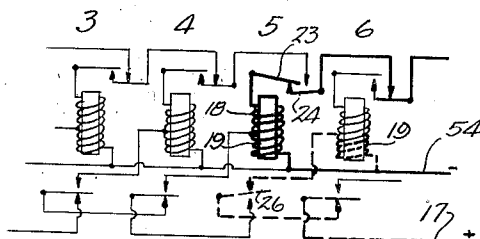


Fig. 4.

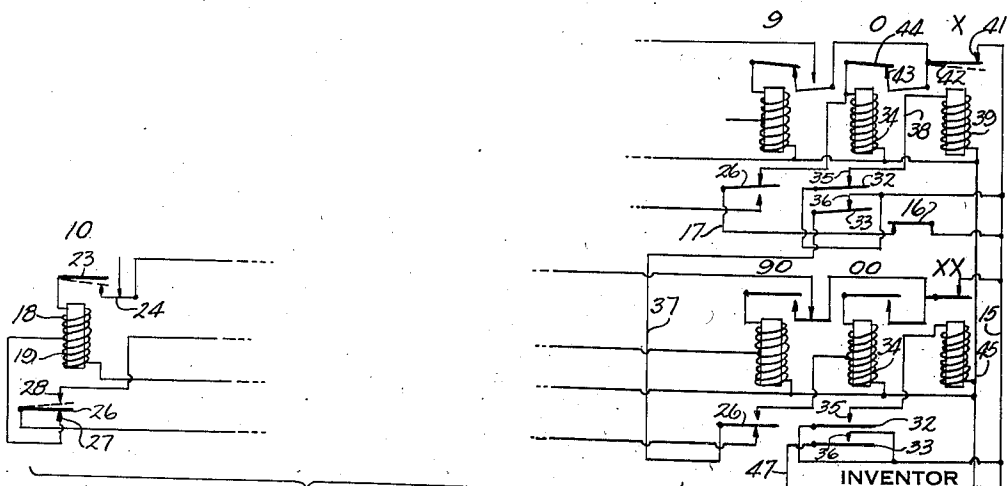


Fig. 5.

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2,375,413

COUNTER

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15 Claims. (Cl. 175—320)

This invention relates to improvements in counters.

It is a primary object of the invention to provide a type of counter which will function electrically to count any predetermined number of operations of any kind; which will automatically or manually be reset and which may automatically be made to perform a further operation or sequence of operations at the conclusion of a specified number of operations counted.

My improved counter employs counting relays, transfer relays, and clearing relays, so connected that as each counting relay is actuated it opens and closes circuits as required to transfer the next impulse to a succeeding relay in a given sequence. The specific objects of invention have to do with the connection and operation of the various relays for the purposes intended, and will be more apparent to those skilled in the art upon study of the following disclosure of the invention.

In the drawings:

Fig. 1 is a circuit diagram fragmentarily illustrating a counter capable of counting operations up to the total number of 999, or any intermediate number of operations, the relays being arranged in series corresponding to digits, tens and hundreds, and certain intermediate relays of each series being omitted.

Fig. 2 is a detail view diagramming the circuit of a single set of relays, the circuit connections through which current is actually passing at the moment being shown by the use of heavy lines.

Fig. 3 shows a fragment of the circuit of Fig. 2 to illustrate the changes in circuit consequent upon the operation shown in Fig. 2.

Fig. 4 shows a fragment of the circuit shown in Fig. 2 illustrating further changes consequent upon the changes illustrated in Fig. 3.

Fig. 5 fragmentarily illustrates another portion of the circuit shown in Fig. 1 in connection with the showing of a transfer from the relays which count digits to the relays which count tens.

Like parts are identified by the same reference characters throughout the several views.

For convenience in the actual operating conditions for which the particular device illustrated was designed, two separate current sources are used, as indicated at the bottom of Sheet 1, Fig. 1. One may be regarded as a power source and this may be alternating current such as is used in ordinary lighting systems. The conductor marked C may be grounded, while the conductor marked H is the live conductor.

The other source of current which may be used to operate the several relays is preferably a source of D. C., the current being respectively designated with positive and negative symbols. In practice 50 volts has been found satisfactory.

The supply line for positive D. C. connects with the terminal marked with the plus symbol and extends upwardly through the diagram at 15. Deriving power from this source is a pulsing switch 16 which represents, for the purpose of this disclosure, all the sources of the impulses to be counted. It will, of course, be understood that regardless of the character of the operation to be counted, it is easily possible to connect the pulsing switch 16 in such a manner that it will be closed and opened once in the course of each of the operations to be counted.

From the pulse switch 16 a line 17 leads to the set of relays which extends transversely of the top of Sheet 1, Fig. 1, and is shown in more complete detail in Fig. 2. As illustrated, there is a series of nine counting relays marked with reference characters 1 to 9 respectively, a transfer relay marked 0, and a clearing relay marked X. It will, however, be understood that for special purposes a different number of relays may be employed. The number illustrated is of universal application for counting in the decimal system, as will hereinafter be explained. When I say that it is of universal application I mean that the mechanism can be so adjusted by the use of a selection switch that less than the total number of relays may be operated when desired.

There is nothing unusual about the relays used. They are standard telephone type relays. Relays numbers 1 to 9 inclusive are of a type known commercially as C-10,097. The relays numbered 10, 20, etc., and 90, and those numbered 100, 200, etc., and 900 are of a type known as B-10,097. Other commercial types may be substituted where the functioning is modified somewhat from that disclosed herein.

Referring first to the relays comprising the series 1 to 9, one of these will be described.

The winding is in two sections 18 and 19, having a mid point connection 21 serving as a tap. The armature 22 operates several contacts. Contact 23 is normally open. It is connected to the end of winding 18. When closed it engages spring contact 24 which is normally closed against stationary contact 25. In the No. 1 relay contact 25 is dead. In the No. 2 and each subsequent relay up to and including the No. 9 relay, contact 25 is connected in each case back to the spring contact 24 of the next preceding relay.

The armature 22 of each relay also operates a single pole double throw contact 25 which is normally closed upon the stationary contact 27 but, upon energization of the whole winding 18, 19, it is drawn upwardly into engagement with stationary contact 28, breaking the connection to contact 27. The single pole double throw contact 26 of each relay is connected to the stationary contact 27 of the next successive relay. In the No. 1 relay the contact 27 is connected by conductor 29 with the mid point 21 between the winding sections 18 and 19 of the No. 1 coil. Contact 28 is connected by conductor 31 to the mid point tap 21 between the winding sections 18 and 19 of the next successive relay, throughout the series.

The electromagnetic strength of the winding 19 of each relay is sufficient to draw the armature 22 downwardly to the extent required to engage armature contact 23 with spring contact 24, but is not sufficient to move the spring contact out of engagement with the stationary contact 25. However, as soon as the contact 23 is closed into engagement with spring contact 24, a separate holding circuit is established directly from the positive supply line 15 (as will hereinafter be described), which supplies positive current not merely to section 19 of the relay coil, but to sections 18 and 19 of the relay coil. Both coils being connected in series and both being now energized, there is a sufficient increase in electromagnetic force to immediately flex the spring contact 24 sufficiently to break its connection with stationary contact 25 and at the same time to engage the double throw contact 26 with stationary contact 28 instead of contact 27.

The circuit thus established through both sections of the relay coil constitutes a holding circuit which retains both sections of the coil of this relay energized and holds the several contact parts in the positions last described until further impulse comes from the pulsing switch 16.

The impulse from the pulsing switch 16 is delivered to the double throw contact 26 of the No. 9 relay. As most clearly appears in Fig. 2, it will pass backwardly through the series of relays, entering each relay at the double throw switch contact 26 and leaving it through the stationary contact 27 toward which contact 26 is normally biased to close. At the initiation of the sequence of operations the impulse from the pulsing switch will normally, after passing through the entire series from 9 to 1, reach the mid point 21 between winding sections 18 and 19 of the No. 1 relay. Here it will cause the holding circuit of the No. 1 relay to be closed as above described, and the resulting increase in energy in the relay will throw contact 26 from engagement with contact 27 to engagement with contact 28, where it will remain pending receipt of a further impulse into the system.

When a second impulse traversed the system due to another closing of the pulsing switch 16, the second impulse will likewise commence to travel backwardly through the system from relay 9 to relay 1, as above described. Upon reaching the moving contact 26 of the No. 1 relay, however, it will no longer be able to pass through the windings of the No. 1 relay but will be diverted, in the raised position of contact 26, to contact 28, and will pass through conductor 31 to the mid point 21 of the No. 2 relay. The No. 2 relay, energized only by winding section 19, will have only sufficient power, in the first instance, to operate its contact 23 under engagement with

contact 24. This will complete a holding circuit of increased power through both coil sections of the No. 2 relay. The first effect will be to flex the spring contact 24 away from stationary contact 25, thereby interrupting the holding circuit to the No. 1 relay. The No. 1 relay will now be reset to its initial inoperative position by the inherent bias of its contacts. Meantime No. 2 relay is maintained operative by the holding circuit above described to hold its contact 26 engaged with its contact 28. This interrupts all connection between the pulsing switch and the coils of the No. 2 relay, but it establishes a connection between the pulsing switch and coil section 19 of the No. 3 relay.

It will, of course, be understood that the lower ends of the several coil sections 19 are connected to negative. Such connection is indicated purely diagrammatically in Fig. 1 but the conductor affording such a connection is illustrated at 54 in Figs. 2, 3 and 4.

The relay marked 0 is somewhat different. Instead of a double throw switch contact at 26, it employs two single throw contacts 32 and 33 both of which are normally open. When the full length winding 34 is energized, contact 32 is engaged with the stationary contact 35 and contact 33 is engaged with the stationary contact 36. Contact 36 derives current through a direct connection with the positive supply line 15. Contact 33 is connected with a conductor 37 which leads to the second series of relays which, for the purposes of the present disclosure, constitutes a tens series corresponding in all respects to the digit series of relays as already described. From the standpoint of the second series of relays the contacts 33 and 36 are, in effect, a second pulsing switch operated by every tenth pulsation reaching the digit series of relays from the main pulsing switch 16.

Contact 32 is likewise directly connected with the positive supply line 15. Contact 35 is connected by conductor 38 with the full length winding 39 of the relay X. This relay is a resetting or circuit breaking relay. It includes the stationary contact 41 directly connected with the positive current supply line 15 and a movable contact 42 which is normally closed against contact 41 and which is connected to the stationary contact 43 of the 0 relay and also to the spring contact 24 of the No. 9 relay. The only function of the contact 43 of the 0 relay is to supply a holding circuit when engaged by the movable contact 44 of the 0 relay.

Fig. 2 shows in heavy lines the circuits established through the digit set of relays at a time when there had been four impulses already developed by the pulsing switch 16 and the system is in readiness to receive a fifth. Positive current is passing from line 15 through contact 41 of the clearing relay X to the spring contact 24 of relay 9, and thence through the spring contacts 24 of successive preceding relays down to No. 4. In the No. 4 relay the energization of both sections 18 and 19 of the winding has flexed the spring contact 24 out of engagement with the stationary contact 25 so that current supplied from the line 15 can reach the windings of relay No. 4 but can go no farther back through the series. Passing through such windings the holding circuit is completed by the return line 54 which leads back to the negative conductor 45. The holding circuit thus described is the only circuit closed at this moment.

The path travelled by the next impulse derived

from the pulsing switch 16 is indicated by heavy broken lines. Upon the closing of the pulsing switch 16 current is momentarily switched from the positive line 15 to conductor 17 to pass backwardly through the contacts 26 of the several relays until the No. 4 relay is reached. In this relay, due to the operation of the holding circuit, contact 26 is not engaged with contact 27 but with contact 28. Accordingly, the impulse travels through conductor 31 to the mid point between the coil sections 18 and 19 of the No. 5 relay. Fig. 3 shows this situation. The path travelled by the impulse is now shown in solid lines, for the potential circuit indicated by broken lines in Fig. 2 has become, with the closing of the pulsing switch 16, an actual circuit in which current is momentarily travelling. It will be noted that only coil section 19 is energized. Almost instantly, however, the attraction of the armature results in establishing the holding circuit by the slight deflection of contact 23 into engagement with spring contact 24. Although both of the coils 18 and 19 are now connected in circuit between the positive supply line 15 of the negative line 54, the amount of current flowing through coil 18 will be negligible as long as the pulsing switch 16 remains closed. Coil 19 provides a much shorter current path than as provided by coils 18 and 19 in series. Accordingly, until the pulsing switch opens, coil 18 will be ineffective.

As soon as the pulsing switch opens, the relatively short current path through coil 19 only, is broken. Thereupon the current is forced to flow through both of the coil sections 18 and 19 in series, and the resulting increase in energization of the core exerts sufficient attraction on the armature 5 to open the circuit to fixed contact 25. This immediately breaks the circuit previously established through relay 4 to coil section 19, and establishes a new circuit connection through contact 26 of relay 5 to coil section 19 of relay 6. The new potential impulse circuit is shown by broken lines in Fig. 4.

After nine such impulses have been generated by the pulsing switch 16 it will be apparent from the foregoing description that relay 9 will be energized by its own holding circuit and that a new potential circuit will have been established through the full length winding 34 of relay 0. From the connections shown, and from the foregoing description, it will be apparent that when the tenth impulse comes from the pulsing switch 16, the resulting energization of relay 0 will momentarily establish a holding circuit for such relay but will almost immediately break the holding circuits of relays 9 and 8 by energizing the clearing relay X at the same time that an impulse is created in the secondary impulse switch 33-36 to pass through conductor 37 to the second series of relays.

Since the clearing relay X has broken the last holding circuit in the entire digit series of relays, it must be apparent that all relays in the digit series have been restored to the initial position indicated in Fig. 1 so that the next impulse generated in switch 16 will start over again by energizing the No. 1 relay as above described. It must likewise be apparent that every time ten impulses are received through the digit series of relays the tenth impulse not only clears all relays of the digit series but communicates a single impulse through conductor 37 to the No. 10 relay of the tens series.

The relays of the tens series count tens impulses in exactly the same manner in which the

relays of the digit series count individual impulses. The second impulse received in the tens series through conductor 37 will energize the No. 20 relay and the third will energize the No. 30 relay, etc., until nine such impulses have been received and the No. 90 relay has been energized. Thereupon, exactly as in the digit series, the tenth impulse received through conductor 37 will energize the 00 relay, with the result that the entire tens series of relays will be cleared by the XX relay and the closing of contact 33 against contact 36 of the 00 relay will generate an impulse which will pass through conductor 47 to the hundreds series of relays.

The first impulse communicated through conductor 47 will necessarily be the one hundredth impulse developed by the pulsing switch 16. The next impulse from the switch contacts 36, 33, of the tens series of relays (being the two hundredth impulse generated by the main pulsing switch) will result in the energization of relay 200, etc., until 900 such impulses have been received and the ninth relay in the hundreds series has been operated. As many more series of relays may be used as may be desired. However, the foregoing description is illustrative of how transfer is made, and therefore no further series of relays are illustrated. Instead, I will now describe how the device functions when the end of the series is reached.

After 99 impulses from the main pulsing switch have passed through the first and second series of relays, following energization of the relay 900, the one thousandth impulse will be transferred to the circuits already described to the relay 900 and from contact 26 thereof to contact 28 which is connected by conductor 48 to the coil 49 of the reset relay 000. Like relay 0 and relay 00, the impulse reaching this relay establishes a holding circuit by engaging contact 44 with contact 43, the latter being connected through contacts 42 and 41 with the power from supply line 15. Another result of the energization of relay 000 is to communicate current from the positive supply line 15 through conductor 38 and contacts 32 and 35 to the winding 51 of the clearing relay XXX, thereby opening the holding circuit to the reset relay 000. In the meantime, however, the contact 52 has been drawn away from contact 53 with which it is normally engaged. Contact 53 is connected to the main negative supply line 55 and thereby interrupts the negative connection to the conductor 54 which, as indicated by the negative symbol in Fig. 1, is connected to all of the other negative terminals throughout the series of relays. This opens all circuits, breaking all holding circuits and resetting the entire system in readiness for a repetition of the sequence.

Relay 000 is also provided with power circuit connections. When this relay is energized the normally open contact 56 closes against contact 57 to complete an alternating current connection through the winding 58 of the relay Y, this being a relay controlling the application of power to any desired point. Contacts 59 and 61 are illustrated as being available for any desired control function. Contacts 62 and 63, likewise normally open, are likewise normally available but they are illustratively shown as connected to additional contacts for a subsequent operation as will hereinafter be described.

The armature 64, by means of which the moving contacts 59 and 62 are actuated, is latched closed by a detent 65 released by the winding of electromagnet 66. Through the mechanism now

to be described such release may be effected at any desired point in the next cycle of operation of the apparatus.

When contacts 62 and 63 are closed, A. C. current is communicated from the terminal H through conductor 67 to conductor 68 and thence to conductors 69 leading to the moving contacts 71 with which the relays 1 to 9 are shown to be provided and with which any of the other relays may be provided as desired. The stationary contacts 72 with which the several moving contacts 71 are adapted to co-operate, are connected through suitable conductors to the corresponding terminals 73 of a selector switch A having a manually adjustable moving contact 75 which may be set in engagement with any one of the several terminals 73.

During the next cycle following the operation of the power relay Y, as soon as the sequence of impulses is transferred through the apparatus to a point such as to energize the particular relay whose moving contact 71 is in circuit through the selector switch A with contact 75 of the latter switch, then the energy communicated through the contacts 71 and 72 of such relay and the appropriate contacts of the selector switch will be communicated through conductor 76 back to coil 66 to release the detent 65 and thereby to re-open the power relay Y which, up to this time, has been held closed by the latch detent 65.

As thus far described, the counter will invariably count a thousand impulses and then repeat. At the thousandth impulse it will operate the power relay. Obviously, by omitting some of the intervening relays, or adding additional relays or series of relays, the set number of impulses counted in a given cycle can be determined at will. In addition, however, it is possible to make a universal device which can be manually adjusted to count any number of impulses within its capacity and then to actuate the power relay and reset itself to repeat the cycle. The mechanism illustrated for performing this function will now be described.

Each of the several relays is provided with an additional set of contacts where it is desired that the device be set to operate the power relay at any predetermined point. The fixed and movable contacts are respectively designated by reference characters 77 and 78. Whenever any relay 1 to 9 or 10, 20, etc., to 90, or 100, 200, etc., to 900, throughout the entire series is energized, its respective contact 78 will engage its respective contact 77. Leading from the positive supply line 15 is a branch conductor 79 extending to the manually operable moving contactor 81 of the selector switch D which has ten stationary terminals with which the moving contactor 81 is selectively engageable. The first nine of these terminals are individually connected (the connections being represented by a single broken line) to the respective stationary contacts 77 of the several relays 100, 200, etc., of the hundreds series (or whatever series is last in the apparatus). The several movable contacts 78 of the relays in this series are all connected to the common conductor 82 which extends to the corresponding manually operable moving contact 83 of selector switch C. The tenth terminal of selector switch D is also connected directly by conductor 84 to the moving contact 83 of selector switch C.

The first nine of the ten stationary contacts of selector switch C are individually connected by separate leads (again indicated by a broken line) to the several stationary contacts 77 of the relays

in the second last series (in this case the tens series). The moving contacts 78 of the relays of this series are all connected by a common conductor 85 back to the moving contact 86 of selector switch B in the next preceding series (in this case the digit series of relays). The tenth terminal of selector switch C is connected directly to the moving contact 86 of selector switch B, such connection being made by conductor 87 which, as a matter of convenience, leads to conductor 85.

The moving contact 78 of the relays of the first series are all connected by means of conductor 88 with a conductor 89 leading to the winding 49 of the reset relay 000. A shunt circuit comprising a manually reset switch 91 and conductor 92 likewise leads from the positive supply line 15 to the conductor 89 and thence to the winding 49 of the reset switch 000.

In operation, it will be apparent that whatever number is set up in the moving contacts 81, 83 and 86 of the selecting switches B, C and D will be the number of impulses at which the counting device will be reset for another cycle and the power relay will be operated. Assume, for example, that the number selected is 219. The selector switch contact 81 will be set in contact with the second terminal. The contact 83 of selector switch C will be set in contact with the first terminal. The contact 86 of selector switch B will be set in contact with the ninth terminal.

Regardless of how often the No. 9 relay and the No. 10 relay may be operated, the circuit to the resetting relay 000 will remain open pending the operation of the relay in the hundreds series which has been selected (namely, the No. 200 relay). Upon the closing of the No. 200 relay a circuit will be partially completed through selector switch D to selector switch C but there the circuit will still remain open until the No. 10 relay is again operated. This will extend the circuit through the selector switch B but the circuit to the resetting switch will still remain open until the No. 9 relay is energized, this finally completing the entire circuit from the positive supply line through the several selector switches to the winding 49 of the resetting relay 000 and thence back to the negative main conductor 55. Thereupon the resetting relay 000 will function to open all circuits and reset the device for another cycle and the power relay will be energized as above described.

If the number chosen is less than 100, the moving contact 81 of selector switch D will be set to the tenth or zero terminal, whereupon conductor 84 will short out all of the pertinent contacts of the third series, leaving only the contacts of the first two series to function in accordance with the presetting of their respective selector switches. Similarly, if the number selected is less than 10, the moving contact 83 of selector switch C will be set to zero, thereby shorting out all of the pertinent contacts of the second series. The arrangement can obviously be extended as desired. Moreover, at any time, by simply closing the resetting switch 91, the operator can cause the power relay to function and the device to reset itself for the commencement of a new cycle.

It will be noted that the control effected through the selector switch A is one which may be used to effectuate any secondary function in any predetermined relation to the primary operation performed at the conclusion of the predetermined cycle. In this instance it happens that the secondary function is only the opening of the detent

latch which has held the contacts of the power relay Y closed. Obviously, however, the circuit described can be used to perform an additional or substitute function as desired.

As an example of the utility of the device herein disclosed, its use in the paper industry may be cited. A paper converting machine is cutting a paper web into sheets and delivering the sheets into a stack. It is desired to count accurately the number of sheets in the stack in units of one hundred and to insert in the stack a paper marking strip or tab which is simply interposed between successive sheets in the stack when the respective units are counted. If the marking strip is cut off immediately upon being positioned on top of the one hundredth sheet of the counted unit, it will fall from its position, or be blown away by the wind created by the deposit of the next successive sheet. The mechanism used for inserting this strip is of such a nature that it is electrically energized and does not cut off the strip until the circuit is opened. The contacts 59 and 61 may be used to control this device. They will be operated by the power relay at the impulse which shows completion of the predetermined unit of sheets in the stack, the pulsing switch being set to close each time a sheet is deposited in the stack. Since the latch detent 65 holds contact 59 closed to contact 61 for a certain period, the marking strip will not immediately be cut off and meantime additional sheets will be deposited in the stack. As soon as a sufficient number of sheets has been deposited in the stack to assure firm retention of the marking strip in a stack, then the closing of contacts 72 and 71 at a point determined by selector switch A will release the detent of the power relay, allowing contact 59 to open from contact 61, and the resulting interruption of current to the marking strip feeder will permit such feeder to operate to cut off the strip previously fed. It will be understood that no claim is made to the well known sheet cutting machine or marking strip feeding machine above described, these being referred to only by way of illustrating one use to which the counting device herein disclosed may be put. From this one illustration, and from the multitude of other possibilities which will suggest themselves to those skilled in the art, it will be apparent that any desired function or series of functions in any predetermined order or interval can be automatically controlled in accordance with predetermined settings of the apparatus herein disclosed and suggested.

It will be understood by those skilled in the art that one of the great advantages of a counter of the type described lies in its ability to count impulses or signals arriving at any conceivable speed. Devices equipped with this counter have been speeded up beyond the capacity of any mechanical apparatus to accomplish the work.

It will also be recognized by those skilled in the art that within the broad concept of a counter in which successive signals or impulses are transferred from one relay to another through a predetermined series, then to repeat the cycle, and using each cycle to clear an impulse for operating relays in another series, many changes in the circuit and the specific character of the relays may be made without deviating from the invention.

It will further be understood that where visual indication of the count is desired at any time, it is only necessary to incorporate any desired annunciator, here exemplified simply by pilot

lamps 99, in series or parallel with the circuits of the several relays (particularly in the holding circuits) to enable an operator to read the count accurately at any moment in terms of hundreds, tens, and digits (or higher numbers if additional series of relays are employed). Many other changes are possible within the scope of the appended claims.

I claim:

1. In a counter system for counting electrical impulses, the combination of a plurality of sets of relays, an impulse-receiving circuit having a temporary connection to the first relay of the first set, each relay of said set comprising electromagnetically operable means for transferring such connection to the next successive relay of the set, resetting means associated with each relay other than the first of each set for resetting the preceding relay upon energization of a subsequent relay, a transfer and resetting relay mechanism at the end of said first set comprising means for reconnecting said impulse-receiving circuit to the first relay of the first set and comprising means for generating a new impulse, said impulse generating means being connected to the first relay of a second set and the second set comprising relays each including electromagnetic means adapted upon the energization of successive relays to connect the second impulse generating means with successive relays of the second set.

2. An electric counting device comprising the combination with an impulse-receiving circuit, of a first set of relays with which said circuit is selectively coupled, each of several relays in said set comprising means for transferring the coupling of said circuit from itself to a successive relay in said set and means for clearing the next preceding relay, a terminal relay of said set comprising means for generating a secondary impulse and for transferring the circuit coupling back to the first relay of said set, thereby representing the conclusion of a cycle, together with a second similar set of relays and a circuit connected to receive said secondary impulse and with which the relays of the second set are successively connected, each relay of the second set comprising means for disconnecting itself and connecting a subsequent relay of said second set to receive said secondary impulse, whereby the particular relay energized in the second set will be a function of the number of cycles completed in the first set.

3. The device of claim 2 in which at least one of said sets of relays is provided with a manually operable selector switch and a circuit clearing device connected with said selector switch for terminating the cycle and reestablishing circuit connections for the commencement of a new cycle at a point determined by the setting of the selector switch.

4. In a counter of the character described, the combination with a set of nine relays and an impulse-receiving circuit for connection successively to the relays of said set, each relay comprising circuit breaking and circuit connecting means operatively organized to interrupt the impulse-receiving circuit connection to the energized relay and to establish an impulse-receiving circuit connection to the next successive relay of the set, a tenth relay comprising a resetting relay specific to said set and comprising electro-magnetic means connected to the impulse-receiving circuit upon the energization of the main relay and adapted when en-

energized by receipt of a tenth impulse to re-establish the connection of the impulse-receiving circuit to the first relay of the set and to transmit an impulse, a second set of relays like the first and adapted successively to receive impulses transmitted from the first set, together with clearing means operated upon a predetermined cycle of impulses for clearing both of said sets and re-establishing circuit connections for the initiation of a new cycle, circuit connections for energizing a plurality of separate operations at different predetermined points in each cycle, and means for selectively determining the point in the cycle at which at least one of said separate operations will be performed.

5. A counter system comprising the combination with an impulse-receiving circuit, of relays each comprising a two pole switch having stationary and movable contacts and a two stage switch having a normally open contact and a normally closed contact, an energizing coil and a holding coil, the moving contact of the double pole switch of the last relay of the series being connected to the impulse-receiving circuit, normally closed contacts of the double pole switches of the respective relays being connected in each instance with the moving contact of the double pole switch of the next preceding relay down to the first relay of the series, whereof the stationary contact of the double pole switch is connected to the energizing coil, circuit connections from the normally open contacts of the double pole switches of the respective relays being successively connected to the energizing coils of successive relays in the series down to the last relay in the series, whereof the normally open contact of the double pole switch has a repeat circuit connection, the normally closed contacts of the two stage switches of successive relays being connected from the last toward the first in a holding circuit connection and the normally open contact of each two stage switch being connected to the holding coil of the respective relay, together with a repeat relay having an energizing coil in circuit with said repeat circuit connection, and a holding circuit interrupter energized by said repeat relay and comprising means for interrupting all holding circuits throughout said series, whereby to de-energize all of said relays and thereby to re-establish a connection through the double pole switches of the respective relays for the transmission of a subsequent impulse from said impulse-receiving circuit to the first relay of the series, each successive impulse energizing the energizing coil of a relay of said series and thereby establishing a holding circuit through the holding coil of such relay and opening the holding circuit of the next preceding relay and throwing the double pole switch to place the energizing coil of the next succeeding relay in series connection with the impulse receiving circuit, whereby successive impulses are transferred to successive relays in each cycle, and, in further combination, a second like series of relays, a second impulse circuit adapted to receive impulses upon each energization of the resetting relay of the first circuit, such impulses being transferred successively to successive relays of the second series, whereby the number of relays energized in the second series in any cycle is a function of the number of cycles completed in the first series.

6. In a counting system, the combination

with an impulse-receiving circuit, of a digit series of relays comprising means for transferring successive impulses to successive relays throughout the series, a resetting and transfer relay connected at the end of said series to be energized by an impulse succeeding the impulse energizing the last relay of said series, a tens series of relays comprising means for transferring successive impulses from one relay to the next throughout said series, said tens series of relays being operatively connected to receive individual impulses upon the conclusion of each cycle of digit impulse transfers in the first series, a resetting device common to both series and adapted to re-initiate the cycling thereof, and energizing connections for said resetting device comprising switches energized by successive relays in the respective series, a selecting switch for each switch having terminals connecting the switches of particular relays therein, and a moving contactor engageable with the respective terminals, and circuit connections for energizing the resetting device through the selector switches and the respective relays of each series designated thereby, whereby a new cycle may be initiated upon the completion of successive series of impulses of predetermined number.

7. The device of claim 6 in further combination with supplemental switches connected to be closed by certain of said relays, another selector switch having a moving contact and terminals engaged selectively thereby and connected respectively with the supplemental switches aforesaid, and a power switch having connections including said last mentioned selector switch and the supplemental switch designated thereby for initiating a power operation at a predetermined point in each cycle.

8. A counter of the described class comprising the combination with a system adapted to receive successive impulses to be counted, of a series of relays and circuit connections therefor, each relay being provided with means adapted upon the energization of such relay to cut such relay out of the circuit and to transfer impulse receiving circuit connections from the energized relay to the next successive relay in the series, and means including a selector switch and a resetting switch for transferring impulse receiving circuit connections from any predetermined relay of the series back to the first relay of such series, said selector switch including terminals respectively connected with the several relays.

9. A counter as defined in claim 8 in further combination with a power relay and means including a selector switch for selectively coupling said power relay to any of the relays of said system to be operated coincidentally therewith.

10. In a counter, the combination with a plurality of sets of relays and switch contacts and circuit connections in one of said sets for the transfer of successive impulses from the last relay of said one set to the first relay of the next, a normally open control switch in operative connection with each of said relays to be closed upon the energization of such relay, separate selector switches having separate contacts respectively connected in series with the control switches of the respective relays, each of said selector switches including a movable contact adjustable for selective engagement with one of the contacts connected with a particular control switch, and circuit means con-

necting the respective selector switches in series with each other and with selected control switches of each set of relays, whereby said circuit means will be closed only by concurrent energization of specific relays in the respective sets as determined by the respective selector switches.

11. The counter defined by claim 10 in which said circuit means includes a clearing relay adapted upon the closing of said circuit means through the successive selector switches to clear the relays of both of said sets and to return the next successive impulse to the first relay of the first of said sets.

12. The device of claim 10 in which the relays of the respective sets comprise resetting means operatively connected to reset each relay upon the energization of the next successive relay.

13. In a counter, the combination with a plurality of sets of relays, at least the first such set comprising ten relays, each of which comprises an electromagnetic coil and armature means, pulsing means for generating impulses, circuit means for leading successive impulses to successive relays, each of the first nine relays of the first set including an armature-connected switch for disconnecting its own coil with said circuit means and connecting to said circuit means the coil of the next successive relay, the tenth relay including switch means for disconnecting its coil from said circuit means and connecting to said circuit means the coil of the first relay of the first set, said tenth relay also including a pulsing switch for the relays of the second set, said last mentioned relays comprising switch means and circuit connections for transferring successive impulses to successive relays, and each of

said relays other than the first relay of each set comprising means for resetting the preceding relay.

14. The device of claim 13 wherein each of the several relays comprises a control switch normally open and adapted to be closed upon the energization of such relay, selector switches for the respective sets each provided with a movable contact and with relatively fixed contacts respectively connected in circuit with the control switches of the several relays of the respective sets, and circuit means connecting the respective selector switches and the particular control switches of specific relays determined by the positions of the movable contacts of the respective selector switches in circuit, said last mentioned circuit means including a power relay.

15. The device of claim 13 wherein each of the several relays comprises a control switch normally open and adapted to be closed upon the energization of such relay, selector switches for the respective sets each provided with a movable contact and with relatively fixed contacts respectively connected in circuit with the control switches of the several relays of the respective sets, and circuit means connecting the respective selector switches and the particular control switches of specific relays determined by the positions of the movable contacts of the respective selector switches in circuit, said last mentioned circuit means including a power relay, and means for clearing the last energized relays of the respective sets and for returning the next successive impulse to the first relay of the first set.

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