

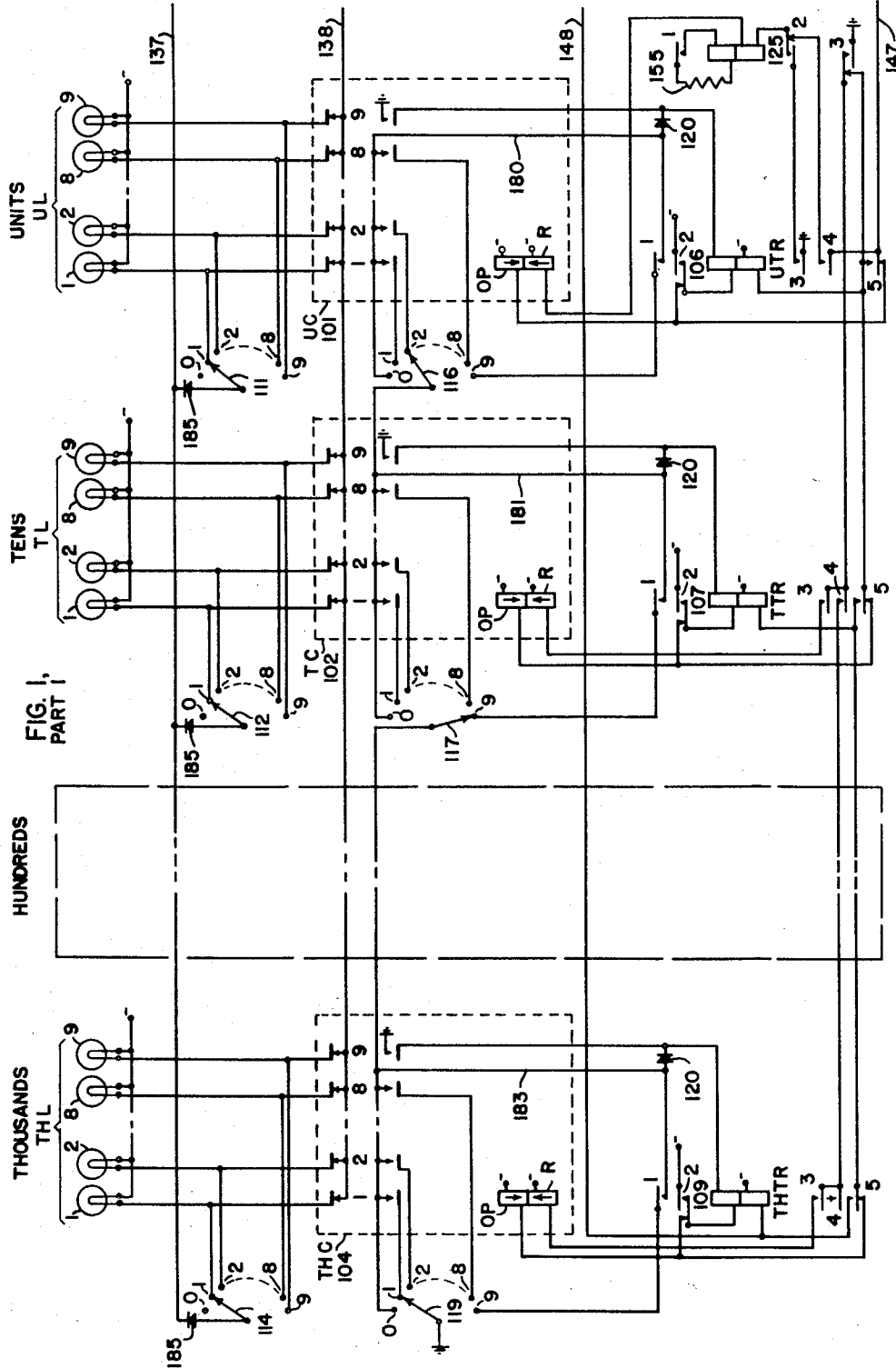
May 17, 1960

R. H. WILLIAMSON
DECADE COUNTING DEVICE

2,936,955

Filed May 10, 1955

4 Sheets-Sheet 1



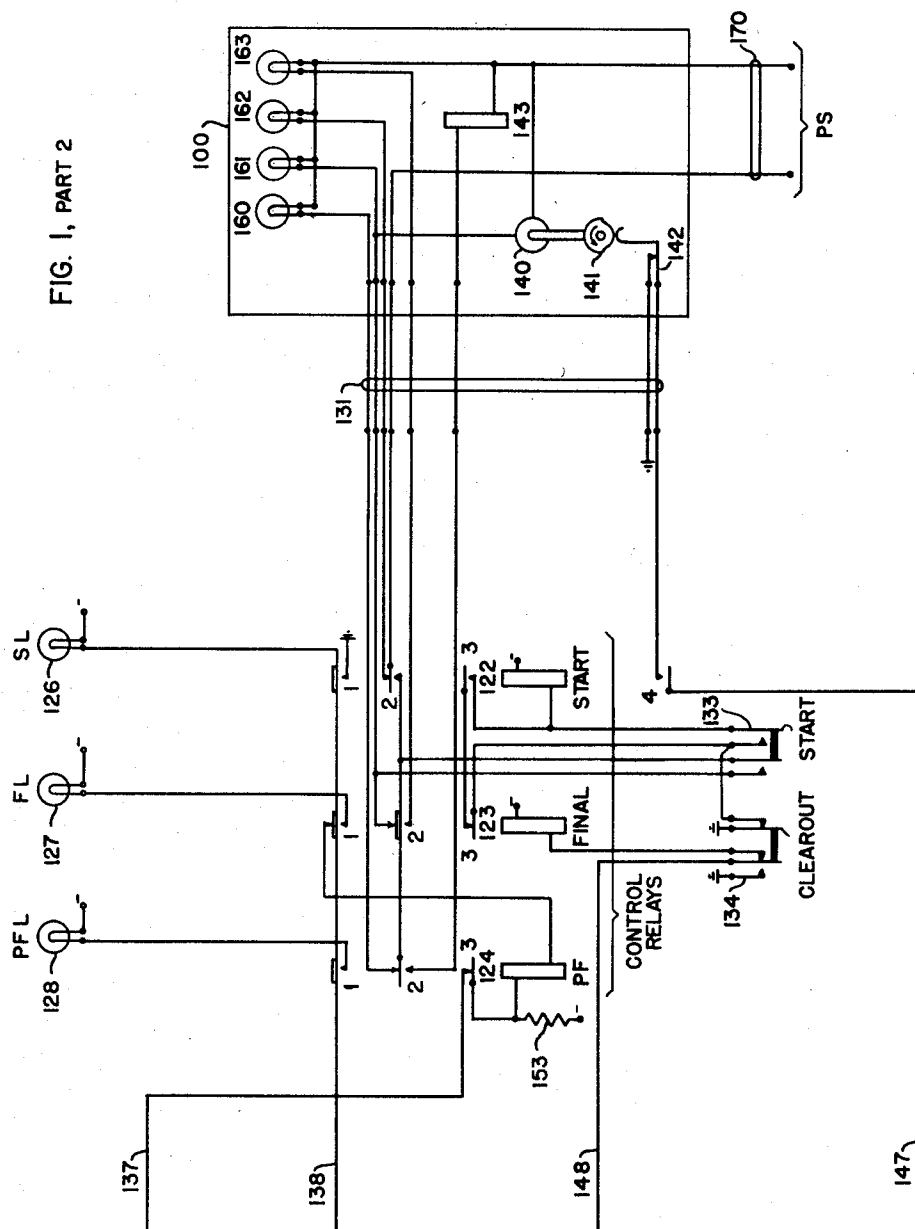
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4 Sheets-Sheet 2



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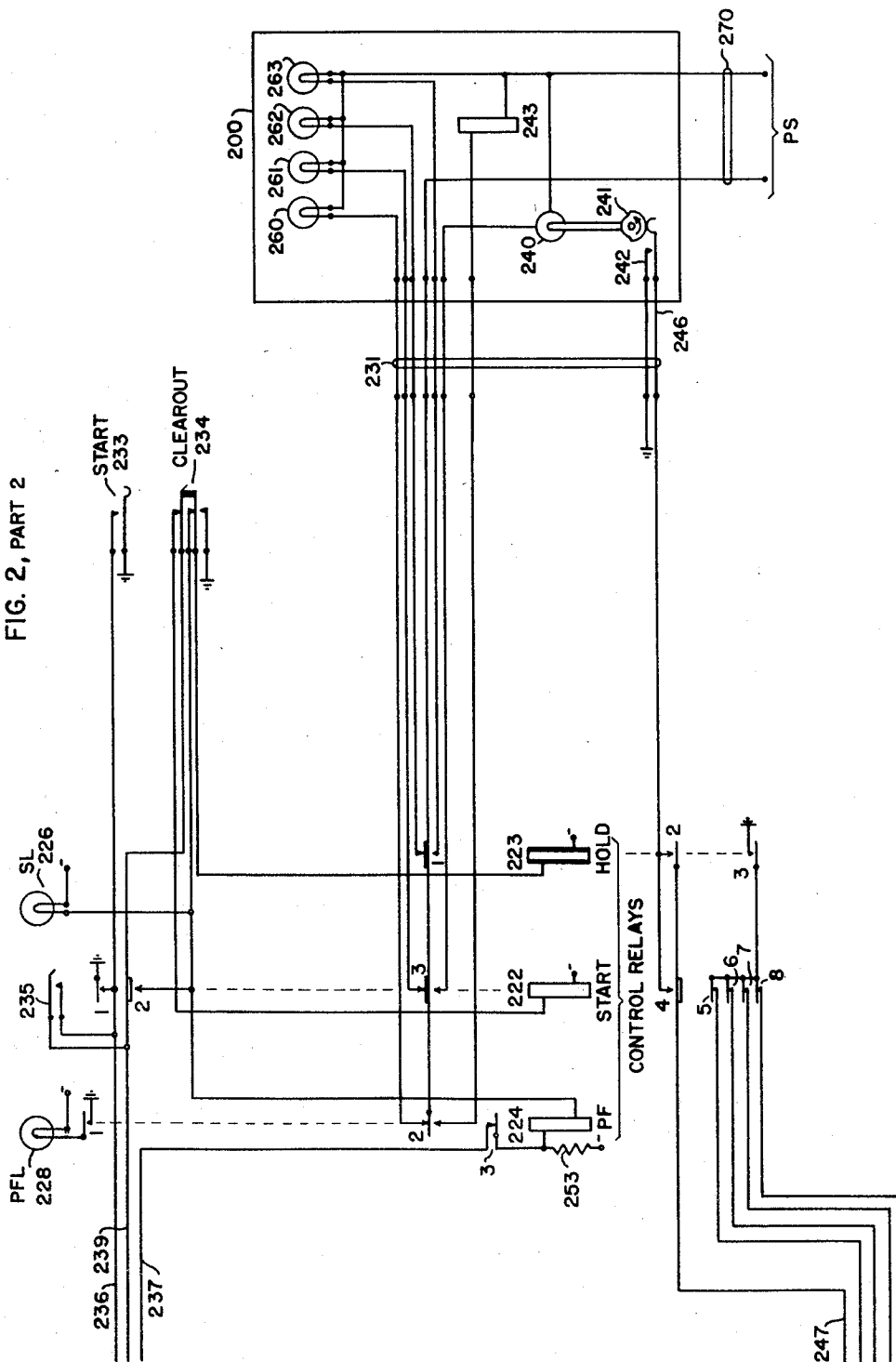
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4 Sheets-Sheet 4

FIG. 2, PART 2



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2,936,955

DECADE COUNTING DEVICE

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Application May 10, 1955, Serial No. 507,276

22 Claims. (Cl. 235—132)

This invention relates to a decade counting device, and particularly to a multi-digit pulse-counting device of the decade type wherein the counting cycle may be changed at will. The principal object of the invention is to provide an improved counting device of the foregoing type which is of a simple, more-reliable, and economical construction.

Another object of the invention is to provide a decade counting device which may be readily adjusted according to the number of pulses to be counted, and which is automatically returned to its zero counting position for a new count incidental to the receipt of the final counted pulse.

Another object is to provide a multi-adjustable counting device which performs preliminary and final control functions upon counting respective number of pulses for which it has been adjusted.

A feature of the invention is that the decade counting device uses, at any decade position, a simple counting device which is pulse operated step-by-step over one circuit to its ninth position, and which is restored to its normal (or zero) position over another circuit, a transfer relay being used for the necessary circuit shift. A related feature is that the noted transfer relay is utilized to send a stepping pulse to the next succeeding decade position incidental to the restoration of the local counting device.

The foregoing and other objects and features of this invention and the manner of attaining them will become more apparent and the invention itself will be best understood, by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings comprising Figs. 1 and 2, wherein:

Fig. 1 is a schematic circuit diagram of one embodiment of the invention associated with a machine controlled thereby; and

Fig. 2 is a desirable improved form of the invention as shown in Fig. 1.

Referring to the drawings, each of the counting devices 101 to 104 (Fig. 1) and 201 to 204 (Fig. 2) is preferably a magnetic impulse counter which may be of the type disclosed in the U.S. Patent No. 2,538,818, granted January 23, 1951. A magnetic impulse counter of this type operates, and holds, its contact sets (for example, contact sets 1 to 9 of device 101) successively responsive to the respective energizations of its operate winding OP and restores all of its operated contact sets responsive to a demagnetizing impulse delivered to its release winding R.

A. Operation of Fig. 1

Referring now to Fig. 1, parts 1 and 2, of the drawings, the operation of the decade counting device shown therein will now be described.

The decade counting device of Fig. 1 is connected to a functional machine 100 by conductor group 131, over which it receives the impulses to be counted, and over which it transmits signals for controlling the machine.

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Machine 100 which performs successive operations of any desired kind, is driven by motor 140. Pulse cam 141 is assumed to make one revolution for each operation of the machine, thus opening the normally closed pulse contacts 142 once for each machine operation. Machine 100 further includes signal lamps 160 to 163, and shift magnet 143 which may be used to divert the machine output to a new container or to shift to a new operation. Machine 100 is connected to a suitable power source PS over conductors 170.

The decade counting device of Fig. 1 has general control apparatus comprising relays 122 to 124, pulse-stretch relay 125 which lengthens the release pulse for all counters, signal lamps 126 to 128, start and clearout keys 133 and 134. It further comprises a desired number of similar counting combinations (units, tens, hundreds and thousands as illustrated). The units combination, for example, comprises magnetic impulse counter 101, transfer relay 106, pre-final and final multi-position switches 111 and 116, and signal lamps UL.

It will be readily understood that additional counting combinations may be added to increase the counting capacity beyond the disclosed four-digit capacity.

When the machine 100 of Fig. 1 is to be operated under control of the decade counting device, the attendant sets final brushes 119 to 116 (hundreds brush 118 not shown) according to the respective digits in the number representing the number or quantity of machine operations desired. For example, setting the brushes 119 to 116 respectively at 1, 0, 9, and 2, conditions the counter to cause the machine to execute 1,092 operations.

If a pre-final function of the machine (operation of shift magnet 143) is desired, the pre-final brushes 114 to 111 (brush 113 not shown) are set for a corresponding lower number, such as 1,011.

With final and pre-final brushes set, locking-type start key 133 is operated for an interval, thereby operating start relay 122 from ground at clearout key 134.

At its contacts 1, start relay 122 grounds wire 138, lighting local start lamp 126 and all of the pilot lamps THL to UL; at its contacts 2, it extinguishes machine lamp 162 and lights lamps 160 and 161, also completing an operate circuit for the motor 140 through back contacts 2 of relay 123. At its contacts 3, relay 122 locks itself to ground through contacts 3 of final relay 123, and at its contacts 4, it energizes pulse wire 147 from ground through the normally closed pulse contacts 142. Thus the first pulse of the series used to control the counter is delivered before the machine 100 has performed the corresponding operation. As will appear, the final relay 123 is so controlled that the overall count made is of the interruptions at contacts 142.

The ground placed on wire 138 by relay 122, besides lighting the noted lamps, supplies an operating path for pre-final relay 124 through back contact 1 of relay 123, but relay 124 does not now operate because it is shunted by ground supplied to the junction of its winding and its supply resistor from wire 138, and over wire 137, by each of the pre-final brushes 114 to 111.

On the noted closure of its circuit, motor 140 operates the machine 100 to perform its functional operations in a continuing succession. The cam 141 opening pulse contacts 142 at the end of each such operation, thereby delivering a succession of pulses over pulse wire 147 to the counting combinations.

Rectifiers 185 are provided to prevent the ground on wire 137 from interfering with the orderly extinguishing of the associated pilot lamps THL to UL, to be described.

In the units counting combination, the first nine pulses over wire 147 are delivered through back contact 5 of relay 106 to the operate winding OP of counter 101, wherefore the contact sets 1 to 9 thereof are operated,

and held, in a corresponding succession. The lamps UL are thus progressively disconnected and extinguished by the normally closed counter contacts as a pilot signal of the machine operations. Ground is thereby disconnected progressively from the contacts 1 to 9 of pre-final brush 111. At the same time, the normally open contacts 1 to 8 of counter 101 are connected to contacts 1 to 8 of brush 116 to the associated zero wire, connected to the zero contact of brush 116. These operations, however, are of only momentary effect until either the pre-final, or the final, setting is reached.

The operation of contact set 9 of 101, extends ground from its make contacts 9 to the upper winding of units-transfer relay 106. Units-transfer relay 106 does not operate immediately, being shunted by the ground pulse on wire 147.

At the end of the ninth pulse, however, units-transfer relay 106 operates from ground at contacts 9 of 101, through its winding, its transfer contacts 2, and the operate winding OP of 101 to battery.

At its contacts 1, units transfer relay 106 connects the ninth contact of brush 116 to its zero contact to mark the digit 9 at that brush; at its transfer contacts 2, it transfers to its own battery source; at its contacts 3, it prepares a holding circuit for relay 125; at its contacts 4, it prepares an operate circuit for relay 125; and at its back contacts 5, it opens the operate path for units counter 101 and at its front contacts 5, it prepares a holding circuit through its lower winding and prepares an operate circuit from wire 147 to the operate winding OP of tens counter 102 via contacts 5 of relay 107.

The receipt of the tenth pulse over wire 147, is delivered to the operate winding OP of tens counter 102, wherefore the contacts set 1 thereof is operated, and held. Ground is thereby disconnected from contact 1 of pre-final brush 112 and lamp TL1 is extinguished. At the same time, normally open contacts 1 of counter 102 is connected to contact 1 of brush 117 to the associated zero wire, connected to the zero contact of brush 117.

The tenth pulse also operates relay 125 in series with release winding R of counter 101, from ground on wire 147, contacts 4 of 106, transfer contacts 2 of 125, winding of 125, and winding R of 101 to battery.

At its contacts 1, relay 125 connects resistance 155 in series with its upper winding to render it slow releasing; at its contacts 2, it transfers its operate circuit from wire 147 to a holding circuit from ground at contacts 3 of relay 106; and at its contacts 3, it prepares a final release circuit for the succeeding counters as will hereinafter be described.

Upon the energization of its release winding R, counter 101 restores its contact sets 1 to 9 thereby opening the operate circuit for relay 106.

Relay 106 remains operated until its operate circuit is opened at contacts 9 of 101, or until the end of the pulse to insure the restoration of the counter 101.

Upon restoring, at its contacts 3, relay 106 opens the holding circuit for relay 125 and the release circuit for counter 101; at its front contacts 5, it opens the operate circuit for 102; and at its back contacts 5, it prepares the operating circuit for counter 101.

The next succeeding series, of nine pulses, over wire 147 operates counter 101 in the manner described. At the end of that series of pulses, units-transfer relay 106 again operates to extend the twentieth pulse to the operate winding OP of counter 102 and restores counter 101 in the manner as described.

The succeeding pulses over wire 147 are delivered to the units and tens combination wherein its tens counter 102 counts only every tenth pulse and the hundreds counter counts only every tenth pulse counter by the tens counter 102.

At the end of the 99th pulse, tens-transfer relay 107 operates from ground at contacts 9 of 102, through its

winding, its transfer contacts 2, and the operate winding OP of 102 to battery. Units-transfer relay again re-operates in the manner described.

At its contacts 1, relay 107 connects the ninth contact of brush 117 to its zero contact to mark digit nine at that brush; at its transfer contacts 2, it transfers to its own battery source; at its contacts 3, it prepares a release circuit for 102; at its contacts 4, it prepares a release circuit for the next succeeding counters as will hereinafter be described; and at its front contacts 5, it opens the operate circuit for 102; and at its back contacts 5, it prepares a holding circuit through its lower winding and prepares an operate circuit for the hundreds counter.

With transfer relays 106 and 107 operated the one-hundredth pulse is extended to the operate winding of the hundreds counter (not shown) and also operates relay 125 in the manner described.

At its contacts 3, relay 125 transfers the release circuit for 102 to ground at its contacts through operated contacts 3 of relay 107 to the release winding R of 102. At the end of the one-hundredth pulse to insure the restoration of counter 102 relay 125 has been rendered slow-releasing by having its contacts 1 short-circuiting its upper winding thereby stretching the release pulse. Transfer relay 107 remains operated until its operate circuit is opened at contacts 9 of 102, or until the end of the pulse over wire 147.

The next succeeding pulses over wire 147 operate the counters and their associated transfer relays in the manner described until the 999th pulse has been received. At the end of that pulse, the hundreds, tens, and units transfer relays operate, preparing an operate circuit from wire 147 for the thousands counter 104 via their front contacts 5 and back contact 5 of relay 109. Also, the operated transfer relays prepares a release circuit in the manner described as for the tens combination.

The thousandth pulse over wire 147, is delivered to the operate winding OP of thousands counter 104 thereby operating its contact set 1, and also reoperates relay 125 to restore the hundreds, tens, and units counters in the manner as described for restoring tens counter 102.

At its break contacts 1, counter 104 extinguishes pilot lamp THL1 and disconnects ground from contact 1 of brush 114, and at its make contacts 1, it connects contact 1 of brush 119 to its zero contact.

Pre-final relay 124 remains shunted because ground is extended from wire 138 to wire 137 via break contacts 1 of counters 102 and 101, contacts 1 of brushes 112 and 111, and rectifiers 185.

The operation of make contact set 1 of 104, extends ground from brush 119 to the upper winding of thousands-transfer relay 109. Relay 109 does not operate immediately being shunted by the ground pulse extended from wire 147.

At the end of the pulse, however, thousands-transfer relay 109 operates from ground at brush 119, contacts 1 of 119, wire 183, rectifier 120, through its winding, its transfer contacts 2, and the operate winding OP of 104 to battery.

At its contacts 1, thousands-transfer relay 109 connects the ninth contact of brush 119 to its zero contact; at its transfer contacts 2, it transfers to its own battery source; at its contacts 3, it prepared a restoring circuit for 104; at its back contacts 5, it opens the operate circuit for 104; and at its front contacts 5, it prepared a holding circuit through its lower winding and an operate circuit for final relay 123.

The operation of make contacts 1 of 104 also extends ground to the upper winding of the hundreds-transfer relay and extends ground through the zero wire of the final brush of the hundreds combination to brush 117. The hundreds transfer relay being operated when contact set 1 of 104 is actuated remains operated by virtue of its final brush being connected to its zero wire. Hundreds-trans-

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fer relay remains operated in a manner as described for relay 109.

The 1,010th pulse over wire 147, delivered to the operate winding OP of tens counter 102 causes its contact set 1 to be operated thereby removing ground from contact 1 of brush 112.

The next pulse, the 1,011th, over wire 147 is extended to the operate winding OP of units counter 101 causing its contact set 1 to be operated. At its break contacts 1, it removes shunting ground from wire 137 to allow pre-final relay 124 to operate.

The operate circuit for relay 124 is from ground on wire 138, back contacts 1 of 123, its winding, and supply resistor 153 to battery.

At its contacts 1, the pre-final relay 124 lights local pre-final lamp 128; at its contacts 2, it extinguishes machine lamp 160 and operates shift magnet 143; and at its contacts 3, it opens its shunting circuit to prevent its premature restoration.

The operation of shift magnet 143 performs the pre-final function, such as shifting the output of machine 100 from one container to another.

The machine continues to perform its functional operations and delivering pulses over wire 147 in continuing succession.

The delivery of the 1,090th pulse over wire 147 restores counter 101 and steps tens counter 102 to its ninth position. At the end of the pulse, units-transfer relay 106 restores and tens-transfer relay 107 operates from ground at contacts 9 of 102.

At its contacts 1, relay 107 locks itself operated from ground at contact 9 of brush 117 and extends ground to contact 2 of brush 116; at its contacts 3, it prepares a release circuit for 102; at its contacts 4, it prepares a release circuit for the hundreds and thousands counters. At its back contacts 5, it opens the operate circuit for 102, and at front contacts 5, it prepares a holding circuit through its lower winding and prepares an operate circuit for final relay 123.

Rectifiers 120 are provided to prevent the premature operation of the next succeeding transfer relay, from ground on contacts 9 of the preceding operated counter via its operated contacts 1 to 8, and its associated brush.

The 1,092nd pulse delivered over wire 147 energizes the operate winding OP of units counter 101 to operate its contact sets 2.

At its break contacts 2, counter 101 extinguishes lamp UL2; and at its make contacts 2, it extends ground from contact 2 of brush 116 to the upper winding of units-transfer relay 106. Units-transfer relay 106 does not operate immediately being shunted by the ground pulse extended from wire 147.

At the end of the pulse, however, relay 106 operates from ground at contacts 2 of brush 116, contacts 2 of 101, wire 180, rectifier 120, through its winding, its contacts 2, and the operate winding OP of 101 to battery.

Relay 106 operates as described, and at its front contacts 5, it prepares an operate circuit for final relay 123 in series with front contacts 5 of the other transfer relays 107 to 109.

The receipt of the final pulse (the 1,093rd) is extended from wire 147, from contacts 5 of relays 106 to 109, wire 148, clearout key 134, winding of final relay 123 to battery to operate it.

The receipt of the final pulse also operates relay 125 in series with the release winding R of 101, in the manner described, to restore the counters.

At its contacts 1, final relay 123 lights local final lamp 127 and restores pre-final relay 124; at its contacts 2, it extinguishes machine lamp 161, opens the operate circuit for motor 140, and lights machine lamp 163; and at its contacts 3, it restores start relay 122.

At its contacts 1, relay 124 upon restoring extinguishes local lamp 128; at its contacts 2, it opens the operate circuit for shift magnet 143, and prepares an operate cir-

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cuit for machine lamp 160 controlled by start relay 122; and at its contacts 3, it prepares its own shunting circuit for the next counting cycle.

At its contacts 1, start relay 122 upon restoring extinguishes local lamp 126 and removes ground from wire 138; at its contacts 2, it extinguishes machine lamp 163, and lights machine lamp 162; at its contacts 3, it opens its holding circuit; and at its contacts 4, it disconnects wire 147 from the pulse source.

During the time motor 140 is operated, connected pulse cam 141 made 1,092 revolutions thereby opening pulse contacts 142 1,092 times which corresponds to the number of operations of the machine 100.

Pulse cam 141 is arranged so that its lobe portion stops in its illustrated position to allow pulse contacts 142 to be in a normally closed position.

If the attendant at any time during the counting cycle desires to increase the number of machine operations, he may do so by locking start key 133 operated thereby controlling motor 140. The number of machine operations may be readily noted by observing the pilot lamps.

If the counting cycle has been started, and for any reason it is necessary to stop machine 100, start key 133 is restored to its normal position and clearout key 134 is operated to stop the machine and return the decade counting device to zero.

The operation of clearout key 134 which may be of a non-locking type, restores start relay 122, opens the operate path for final relay 123, and grounds wire 148.

The grounding of wire 148 operates thousands transfer relay 109 through its lower winding to battery.

At its contacts 5, thousands transfer relay 109 extends the ground from wire 148 to operate the hundreds transfer relay and thereby successively operating all of the transfer relays and extends the ground from wire 148 through contacts 5 and 4 of relay 106 to operate relay 125 which upon operating restores the counters as previously described.

B. Operation of Fig. 2

Referring now to Fig. 2, parts 1 and 2, of the drawings, the operation of a desirable improved form of decade counting device shown therein will now be described.

The decade counting device of Fig. 2 is connected to a functional machine 200 by conductor group 231, over which it receives the pulses to be counted. Machine 200 which performs successive operations is driven by motor 240. Pulse cam 241 is assumed to make one revolution for each operation of the machine, thus closing the normally open pulse contacts 242 once for each machine operation, machine 200 further includes signal lamps 260 to 263, and shift magnet 243 being similar to shift magnet 143 of Fig. 1. Machine 200 is connected to a suitable power source PS over conductors 270.

When the machine 200 is connected to power source PS, signal lamps 260 to 262 are lighted through the back contacts 2, 3, and 1 of relays 224, 222 and 223.

The decade counting device of Fig. 2 has general control apparatus comprising relays 222 to 224, signal lamps 226 and 228, control keys 233 to 235. It further comprises a desired number of similar counting combinations (units, tens, hundreds, and thousands as illustrated). The units combinations, for example, comprises magnetic impulse counter 201, transfer relay 206, pre-final and final brushes 211 and 216, and signal lamps UL.

Rectifiers 221 are provided to prevent interacting ground between wires 239 and 237. Rectifier 220 has been provided to prevent the premature operation of the transfer relay as will be hereinafter described.

When the machine 200 of Fig. 2 is to be operated under control of the decade counting device, the attendant sets final brushes 219 to 216 (hundreds brush 218 not shown) according to the respective digits in the number representing the machine operations desired. For

example, setting brushes 219 to 216 respectively at 1, 0, 8, and 2 conditions the counter to cause the machine to execute 1,082 operations.

If a pre-final function (operation of shift magnet 243) is desired, the pre-final brushes 214 to 211 are set for a corresponding number, such as 1,001.

With final and pre-final brushes set, start key 233 is operated for an interval, thereby operating start relay 222 from ground at key 233 via wire 236, strapped upper back contacts 1A, 1B, 2 to 9 of counters 204 to 201, brushes 219 to 216, rectifiers 221, wire 239, clearout key 234, through the winding of relay 222 to battery. The ground on wire 236 is also extended through break contacts 1A and 1B of counters 201 to 204, conductor groups 259 to 256, to light pilot lamps ULO, TLO, HLO, and THLO.

At its contacts 1, start relay 222 further grounds wire 236; at its contacts 2, it lights local start lamp 226 and extends ground from wire 239 to one side of the winding of pre-final relay 224, and extends ground through clearout key 234 to operate hold relay 223; at its contacts 4, it prepares an operate path for counter 201; at its contacts 5 to 8, it opens the release circuit for counters 201 to 204; and at its contacts 3, it extinguishes lamp 261 and completes the operate circuit for motor 240.

Ground placed on wires 237 and 239 shunts pre-final relay 224 to prevent its operation until ground is removed from wire 237.

At its contacts 1, hold relay 223 extinguishes machine lamp 262 and lights machine lamp 263; at its contacts 3, it prepares a release circuit for counters 201 to 204; and at its contacts 2, it completes the operate path for counter 201 under control of cam 241.

On the noted completion of its circuit, motor 240 (similar to motor 140 of Fig. 1) operates the machine to perform its functional operations in succession. The cam 241, closing pulse contacts 242 at the end of each such operation thereby delivering a succession of pulses over pulse wire 247 to the counting combinations.

Counters 201 to 204, being similar to counters 101 to 104 of Fig. 1, except that they are arranged in such a manner that their contact sets 1A and 1B are operated together in response to the first pulse delivered to their operate winding OP. Contact sets 2 to 9, of counters 201 to 204 operate successively in response to further energization of its operate winding OP. The operation of its contact sets progressively connects and extinguishes the lamps as a pilot signal of the machine operations. Ground is thereby disconnected progressively from the contacts 1 to 9 of pre-final and final brushes 211 and 216. These operations, however, are of only momentary effect until the pre-final or the final setting is reached.

The receipt of the first pulse over wire 247 results in the operation of contact sets 1A and 1B of counter 201.

At its break contacts 1A and 1B, counter 201 extinguishes units lamp ULO and disconnects ground from contacts 1 of brushes 211 and 216; at its make contacts 1A, it extends ground to the zero contact of brushes 211 and 216; and at its make contacts 1B, it lights units lamp UL1 from ground on wire 236 via break contacts 2 of 201.

Pulses 2 to 9 progressively operate and hold contact sets 2 to 9 of counter 201 in the manner described.

The operation of contact set 9 of 201, extends ground from wire 236 to the upper winding of units-transfer relay 206. Units-transfer relay 206 does not operate immediately, being shunted by the ground pulse on wire 247.

At the end of the ninth pulse, however, units-transfer relay 206 operates in the manner as described for units-transfer relay 106 of Fig. 1.

Rectifiers 220 are provided to prevent the premature operation of transfer relays 209 to 206, in series with their associated ninth pilot lamp upon the receipt of pulses over wire 247.

At its transfer contacts 1, units transfer relay 206 opens its operate path and locks itself operated to battery; at its contacts 2, it prepares a release circuit for counter 201; and at its back contacts 3, it opens the operate path for 201; and at its front contacts 3, it prepares a holding circuit for relay 206 during the receipt of the next pulse through its lower winding to battery and prepares an operate circuit for tens counter 202.

The tenth pulse over wire 247, is extended to the operate winding OP of tens counter 202 causing it to actuate its contact sets 1A and 1B. The tenth pulse over wire 247 is also extended through contacts 2 of 206 to the release winding R of counter 201 to restore it.

Units transfer relay 206 remains operated until its operate circuit is opened at make contacts 9 of 201, or until the end of the pulse. This insures the restoration of counter 201.

At the end of the tenth pulse, or when counter 201 restores, units transfer relay 206 restores to its normal illustrated position. Receipt of the eleventh pulse over wire 247 is again extended to the operate winding OP of 201.

At the end of the nineteenth pulse units transfer relay 206 is again reoperated over the previously described path to extend the twentieth pulse to the operate winding OP of tens counter 202 thereby actuating its contact set 2 and again restoring units counter 201 in the manner described.

The succeeding pulses over wire 247 are delivered to the combinations which operate in the manner described.

At the end of the 999th pulse, transfer relays 206, 207, and the hundreds transfer relay (not shown) are operated, the 1,000th pulse is delivered via front contacts 3 of the operated transfer relays to the operate winding OP of counter 209 thereby actuating its contact sets 1A and 1B. The 1,000th pulse is also delivered to release windings R of the hundreds, tens, and units counters to restore them.

At its contact sets 1A and 1B, thousands counter 204 extinguishes thousandths lamp THLO and lights lamp THL1, and removes ground from contacts 1 of brushes 214 and 219.

At the end of the 1,000th pulse thousands counter 204 has its contact sets 1A and 1B operated and with all other counters restored, pre-final relay 224 remains shunted under control of units counter 201 at its contact sets 1A and 1B by extending ground from wire 236, terminal 1 of brush 211, rectifier 221, to wire 237.

With pre-final brushes 211 to 214 set at 1,001, the receipt of the next pulse to the operate winding OP of 201 operates its contact sets 1A and 1B thereby removing shunting ground from wire 237 to allow pre-final relay 224 to operate.

The operate circuit for relay 224 is from ground on wire 239, contacts 2 of relay 222, through its winding and resistor 253 to battery.

At its contacts 1, pre-final relay 224 lights local pre-final lamp 228; at its contacts 2, it extinguishes signal lamp 260 and operates shift magnet 243; and at its contacts 3, it opens its shunting path to prevent its premature restoration.

Shift magnet 243 being similar to magnet 143 of Fig. 1 performs its pre-final function as described.

Succeeding pulses are delivered over wire 247 to operate the counting combinations as described.

The final pulse (1,082) of the series is delivered to the operate winding OP of units counter 201. At its contact sets 2, counter 201 extinguishes lamp UL1, lights lamp UL2, and disconnects ground from contact 2 of brush 216 to restore start relay 222.

At its contacts 1, start relay 222 upon restoring removes ground from wire 236, at its contacts 2, it extinguishes lamp 226 and opens the operate circuits for pre-final relay 224 and hold relay 223. Hold relay 223

does not immediately restore having a copper sleeve surrounding its core to render it slow-restoring.

At its contacts 3, start relay 222 upon restoring re-connects machine lamp 261 and opens the operate circuit for motor 240; at its contacts 4, it places the pulsing circuit over wires 246 and 247 under control of hold relay 223 at its contacts 2; and at its contacts 5 to 8, it completes a restoring circuit for counters 201 to 204.

The interval with start relay 222 restored and with hold relay 223 still operated, ground is extended from contacts 3 of 223, contacts 5 to 8 of 222 to the release windings R of counters 201 to 204 to restore any of them that were operated.

Upon restoring pre-final relay extinguishes pre-final lamp 228, opens the operate circuit for shift magnet 243, and reconnects lamp 260.

After a momentary delay, hold relay 223 restores. At its contacts 1, hold relay 223 upon restoring extinguishes lamp 263 and reconnects lamp 262; at its contacts 2, it opens the pulse wire for counters 201 to 204; and at its contacts 3, it removes ground from the release windings OP of counters 201 to 204.

The operate circuit for motor 240 was opened when start relay 222 was restored. During the time it was operated cam 241 made 1,082 revolutions thereby closing pulse contacts 242, 1,082 times which corresponds to the number of operations of machine 200. Pulse cam 241 is arranged so that its lobe portion normally stops in its illustrated position to hold pulse contacts 242 in its normally opened position.

If it is desired to increase the number of machine operations, as described for Fig. 1, start key 233 is locked, thereby grounding wire 236.

Start relay 222 is normally operated from ground at start key 233 and held operated from ground at its contacts 1 controlled by the settings of final brushes 219 to 216. After the desired number of machine operations, according to the setting of brushes 219 to 217, has been completed, start relay 222 restores thereby restoring counters 204 to 201. Upon restoring, counters 204 to 201 complete the operate circuit for start relay 222 from ground on wire 236.

If it is desired at any time, after having started the counting cycle, to stop the machine 200 and reset the device to its normal (zero) position, start key 233 is opened and clearout key 234 is operated.

At its break contacts, clearout key 234 restores start relay 222; at its break-make contacts, it holds relay 223 operated to extend ground from its contacts 3, contacts 5 to 8 of relay 222, to the release windings R of counters 201 to 204 to restore any of them that may have been operated.

Upon restoring start relay 222 restores relay 224 (if operated) and stops machine 200.

Normally, devices of this type will count up to four digits (9,999). If it is desired to count 10,000 pulses, final brushes 216 to 219 are set at zero and start key 233 is operated and locked to extend ground to wire 236. Key 235 is then held operated until the first pulse is delivered to the units counter 201.

With brushes 216 to 219 set at zero the ground on wire 236 is normally not extended to wire 239 to operate start relay 222. Key 235 extends the ground from wire 236 to wire 239 thereby operating start relay 222.

As previously described, the operation of start relay 222 operates hold relay 223, and completes the operate circuit for winding OP of counter 201.

The receipt of the first pulse to the operate winding OP of counter 201 operates its contact sets 1A and 1B as previously described to extend ground from wire 236, make contacts 1A of 201, to brush 216 through rectifier 221 to wire 239 to complete a holding circuit for start relay 222.

The attendant may then release key 235, which is of

a non-locking type, after lamp UL0 has been extinguished and lamp UL1 has been lighted.

At the end of the ninth pulse over wire 247, units transfer relay 206 operates in the manner described to prepare a release circuit for counter 201 and to prepare an operate circuit for tens counter 202.

The receipt of the tenth pulse over wire 247 is delivered to counter 202 and restores counter 201. The counters are adjusted, in a manner that counter 202 will actuate its contact sets 1A and 1B before units counter 201 is restored. Counter 202 at its make contacts 1A holds start relay 222 operated from ground on wire 236 through its brush 217 to wire 239.

The interval before the receipt of the ten thousandth pulse, with all counters having operated their ninth contact set and with all transfer relays operated, a restoring circuit is prepared for counters 201 and 204 through contacts 2 of operated transfer relays 206 to 209.

The receipt of the ten thousandths pulse delivered to the release winding R of counters 201 to 204 restores them thereby removing ground from wire 239 to restore start relay 222. The restoration of relay 222 opens the operate circuit for motor 240.

When using this arrangement to count ten-thousand pulses, the pre-final brushes 211 to 214 may be set at any desired lesser number to perform its normal pre-final function as previously described.

While I have described above the principles of my invention in connection with specific apparatus, it is to be clearly understood that this description is made only by way of example and not as a limitation to the scope of my invention.

I claim:

1. A counting combination comprising a source of pulses of electric current, a device for counting the pulses in groups, and a transfer relay having a normal position and an alternate position, each pulse group comprising a series of stepping pulses and a restoring pulse, the counting device having a normal position corresponding to the restoring pulse of any counted group and having a succession of off-normal positions corresponding respectively to the stepping pulses of any connected group, a stepping circuit for the counting device including the pulse source, means responsive to a pulse over the stepping circuit when the counting device is in normal position, or is in any off-normal position preceding the last, for advancing the counting device to its next succeeding position, means including switching means controlled by the advance of the counting device to the off-normal position corresponding to the last stepping pulse of a series and of its group, for operating the transfer relay to its alternate position responsive to the termination of such pulse, means responsive to such operation of the transfer relay for disabling the stepping circuit from receiving the restoring pulse of the group under count, means including the transfer relay in its alternate position for rendering effective a restoring circuit for the counting device, means controlled over the restoring circuit for restoring the counting device to its normal position during the interval which includes the restoring pulse of the group under count, and means controlled from the pulse source for returning the transfer relay to its normal position responsive to the end of the restoring pulse.

2. In combination, a succession of counting combinations according to claim 1, the said source of pulses for any counting combination succeeding the first including an alternate contact of the transfer relay of the immediately preceding counting combination, whereby only such succeeding combination counts the cycles of the immediately preceding combination.

3. In a combination according to claim 2, the pulse source for any said succeeding combination further including the pulse source for the first combination in series with the said alternate contact.

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4. In a counting combination according to claim 1, the said means for returning the said relay to its normal position including means for delaying such return until restoration of the counting device to normal position is assured.

5. In a succession of counting combinations according to claim 2, wherein the said source of pulses for the last counting combination of the succession of counting combinations includes an alternate contact of the transfer relay of each preceding counting combination.

6. In a combination according to claim 5, a control relay having a normal position and an alternative position, means controlled from the pulse source including an alternate contact of the transfer relay of each counting combination for operating the control relay to its alternate position during the said interval which includes the restoring pulse of the group under count, and means controlled from the pulse source for returning the control relay to its normal position.

7. In a combination according to claim 2, the stepping circuit for any counting combination succeeding the first including a parallel connected restoring circuit of the preceding combinations.

8. In a combination according to claim 2, each said counting combination includes a selector switch having a plurality of positions corresponding respectively to the said normal position and the said off-normal positions of said counting device, means including said selector switch for controlling the source of pulses to said counting device, whereby only a predetermined number of pulses are counted.

9. In a combination according to claim 8, each said counting combination includes a final-selector switch and a pre-final selector switch, means including said final switch for controlling the source of pulses to said counting device, a control relay having a normal position and an alternative position, said control relay responsive to means controlled by the setting of its pre-final switch for operating the relay to its alternative position, the setting of said switch corresponding to the number of pulses received by said counting device, and means including the final switch for returning the relay to its normal position responsive to the end of the restoring pulse.

10. In a combination according to claim 9, means controlled by the pre-final switch including an operate circuit for said control relay, said operate circuit including a pre-final switch of each of the succession of counting combinations.

11. In a combination according to claim 2, clearout means including means disconnecting the pulse source, said clearout means for any counting combination except the last including an alternate contact of the transfer relay of the immediately succeeding counting combination, whereby the transfer relays of all combinations are operated rendering effective a restoring circuit for the counting device of all combinations, clearout means including means controlled over the restoring circuit for restoring the counting device of all combinations, means controlled from the clearout means for returning the relay to its normal position.

12. In a counting combination according to claim 1, clearout means including means for opening the stepping circuit for the counting device, means rendering effective a restoring circuit for the counting device, and means controlled over the restoring circuit for restoring the counting device to its normal position.

13. In combination, a succession of counting combinations according to claim 1, the said restoring circuit for any combination succeeding the first including an alternate contact of the transfer relay of the immediately preceding counting combination, whereby the counting device of a succeeding combination is restored to its normal position during the interval the counting device of the preceding counting combination is restored.

14. A counting combination including a series of count-

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ing devices each having a first position and a series of succeeding positions, pulse-responsive means in each counting device for advancing such device into its positions successively and for returning it from its last position to its first for indefinite operation in recurring counting cycles, pulse means for delivering an indefinite series of pulses to the pulse-responsive means of the first counting device, means for sending a pulse to the pulse-responsive means of any counting device succeeding the first incidental to the return of the next preceding counting device to first position, whereby any such succeeding counting device operates to count the counting cycles of the immediately preceding counting device and any respective positions of the counters jointly indicate a corresponding count of the pulses from the pulse means, a pre-final selector and means for adjusting it to select a desired pre-final count which is reached by operating the counting combination from an initial position, a pre-final indicator and means controlled jointly by all of the counting devices and the pre-final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected pre-final count, a final selector and means for adjusting it to select a desired final count which is higher than the selected pre-final count and which is reached by continuing the counting operation from the last said respective positions of the counting devices, and a final indicator and means controlled jointly by all of the counting devices and the final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected final count.

15. In a counting combination according to claim 14, means controlled by the said final selector for restoring all counting devices to first position responsive to the counting combination reaching the selected final-count position.

16. A counting combination including a series of counting devices each having a first position and a series of succeeding positions, pulse-responsive means in each counting device for advancing such device into its positions successively and for returning it from its last position to its first for indefinite operation in recurring counting cycles, pulse means for delivering an indefinite series of pulses to the pulse-responsive means of the first counting device, means for sending a pulse to the pulse-responsive means of any counting device succeeding the first incidental to the return of the next preceding counting device to first position, whereby any such succeeding counting devices operates to count the counting cycles of the immediately preceding counting device and any respective positions of the counters jointly indicate a corresponding count of the pulses from the pulse means, a pre-final selector and means for adjusting it to select a desired pre-final count, a pre-final indicator and means controlled jointly by all of the counting devices and the pre-final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected pre-final count, a final selector and means for adjusting it to select a desired final count which is higher than the selected pre-final count, a final indicator and means controlled jointly by all of the counting devices and the final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected final count, and means controlled by the final selector for restoring all counting devices to first position responsive to the counting combination reaching the selected final-count position, the said means for restoring all counting devices including means controlled by the said final indicator.

17. A counting combination including a series of counting devices each having a first position and a series of succeeding positions, pulse-responsive means in each counting device for advancing such device into its positions successively and for returning it from its last position to its first for indefinite operation in recurring

counting cycles, pulse means for delivering an indefinite series of pulses to the pulse-responsive means of the first counting device, means for sending a pulse to the pulse-responsive means of any counting device succeeding the first incidental to the return of the next preceding counting device to first position, whereby any such succeeding counting device operates to count the counting cycles of the immediately preceding counting device and any respective positions of the counters jointly indicate a corresponding count of the pulses from the pulse means, a pre-final selector and means for adjusting it to select a desired pre-final count, a pre-final indicator and means controlled jointly by all of the counting devices and the pre-final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected pre-final count, a final selector and means for adjusting it to select a desired final count which is higher than the selected pre-final count, and a final indicator and means controlled jointly by all of the counting devices and the final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected final count, each of the said counting devices having two sets of switching members with each set including members actuatable to produce circuit alterations according to the position occupied by the counting device, the sets of switching members being associated respectively with the said selectors and being thereby variably placed in circuit with the said indicators respectively.

18. A counting combination including a series of counting devices each having a first position and a series of succeeding positions, pulse-responsive means in each counting device for advancing such device into its positions successively and for returning it from its last position to its first for indefinite operation in recurring counting cycles, pulse means for delivering an indefinite series of pulses to the pulse-responsive means of the first counting device, means for sending a pulse to the pulse-responsive means of any counting device succeeding the first incidental to the return of the next preceding counting device to first position, whereby any such succeeding counting device operates to count the counting cycles of the immediately preceding counting device and any respective positions of the counters jointly indicate a corresponding count of the pulses from the pulse means, a pre-final selector and means for adjusting it to select a desired pre-final count, a pre-final indicator and means controlled jointly by all of the counting devices and the pre-final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected pre-final

count, a final selector and means for adjusting it to select a desired final count which is higher than the selected pre-final count, and a final indicator and means controlled jointly by all of the counting devices and the final selector for operating it responsive to the counting devices occupying respective positions corresponding to the selected final count, each of the said counting devices having a set of switching members common to both of the said selectors and said indicators, circuit elements providing separate control paths through the common set of switching members for the respective indicators by way of their respective selectors, and rectifiers included in portions of the control paths to prevent current flow over one path from interfering with current flow over the other path.

19. In a counting combination according to claim 18, the control circuit for each of the said indicators including a separate common circuit conductor, each of the said selectors including separately actuatable selector switches for the respective counting devices for making parallel circuit-path connections from a common circuit conductor to selected switching members of the associated counting device, the said rectifiers being connected serially between the common conductors and the selector switches.

20. In combination, a counting combination according to claim 14, a machine for performing successive operations which are to be counted, means for controlling the said pulse means according to the operations of the machine, and means including the said pre-final and final indicators for indicating at the machine that the counting combination has reached respectively the said selected pre-final and final counts.

21. In a combination according to claim 20, the said means for indicating at the said machine that the pre-final count has been reached including shift means for altering the remaining operations of the machine.

22. In a combination according to claim 20, the said means for indicating at the said machine that the final count has been reached including means for stopping the operations of the machine.

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