

May 8, 1962

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3,034,033

SELECTOR SWITCH

Filed March 17, 1958

4 Sheets-Sheet 1

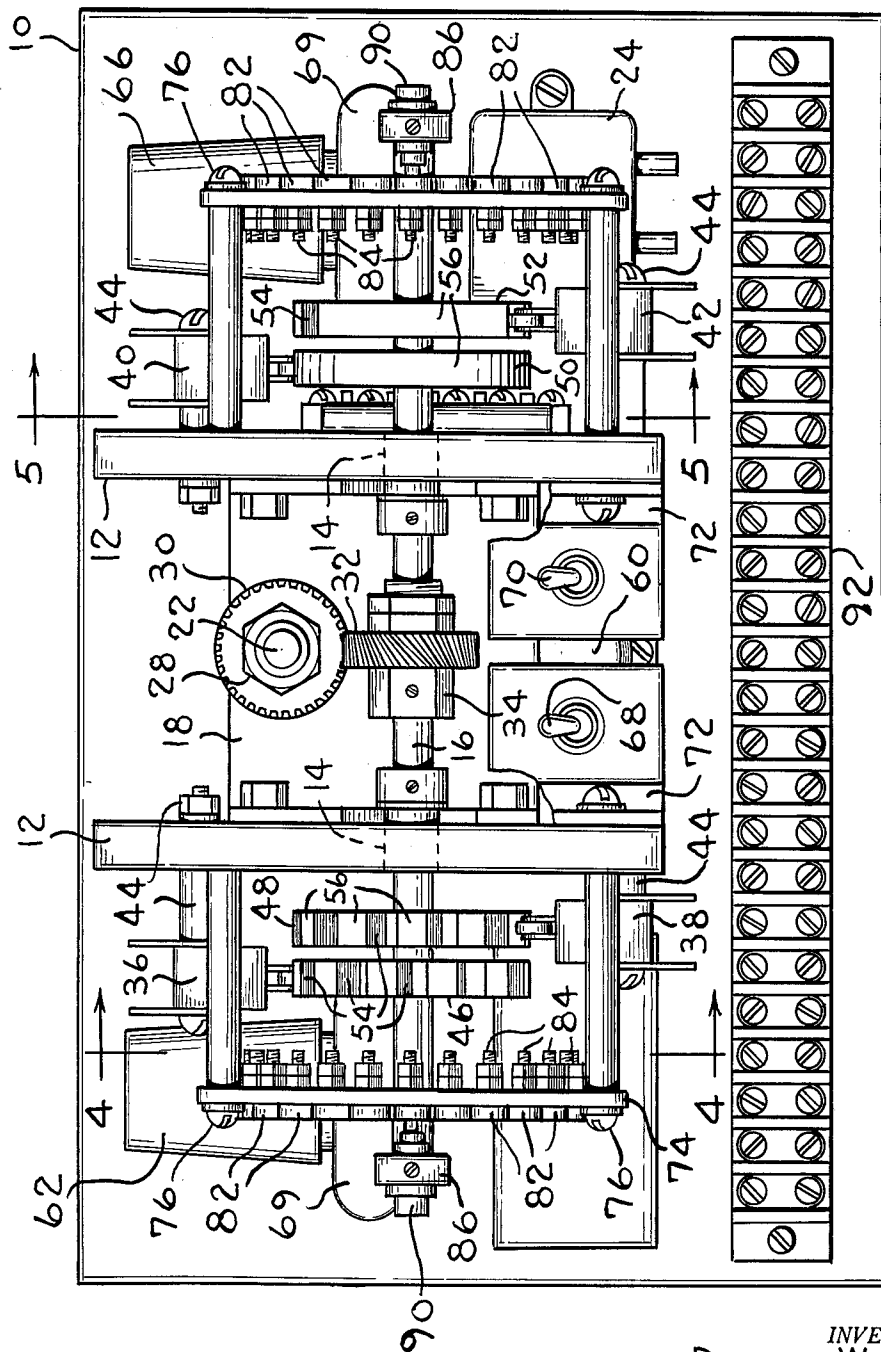


FIG. 1

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4 Sheets-Sheet 2

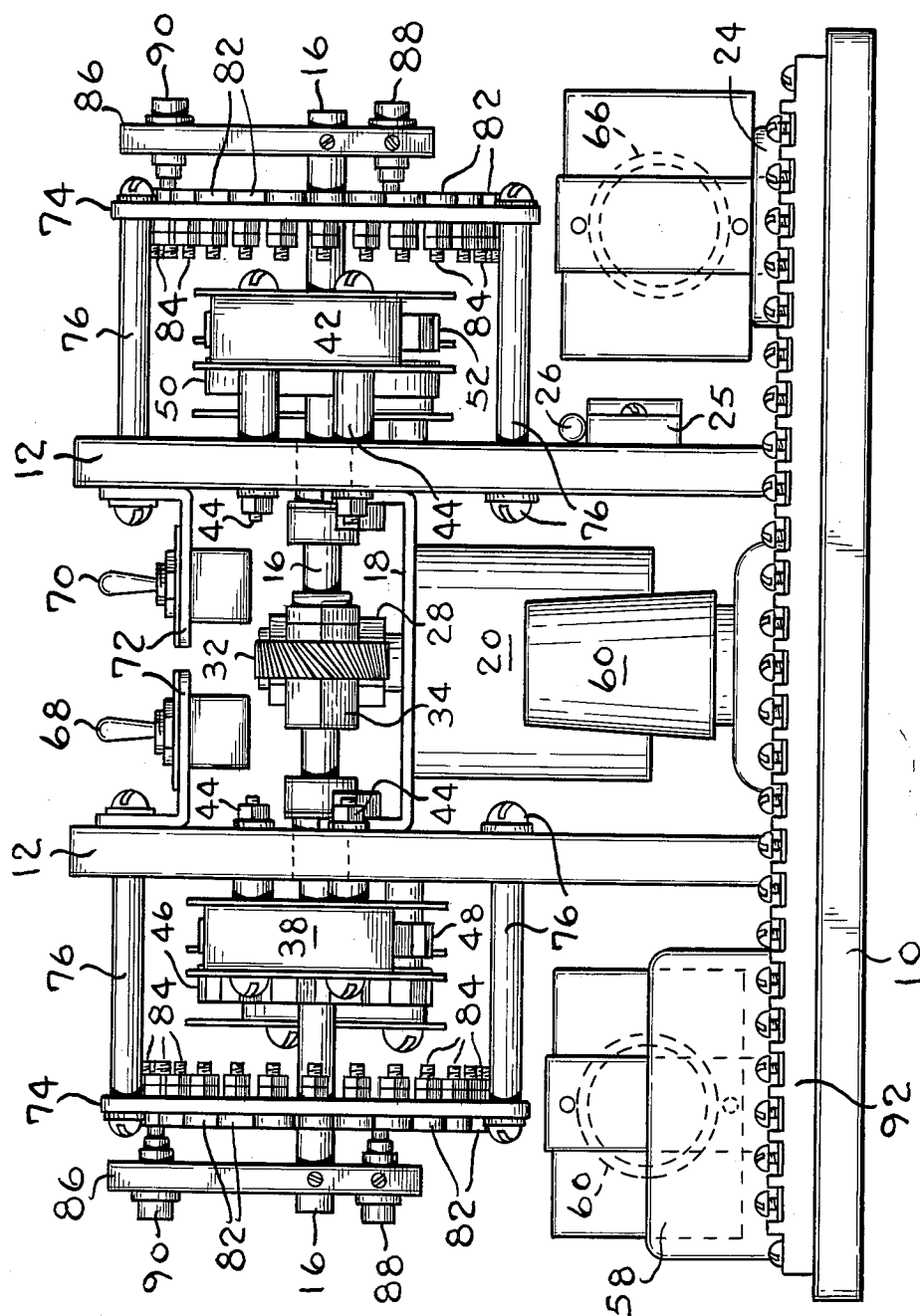


FIG. 2

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4 Sheets-Sheet 3

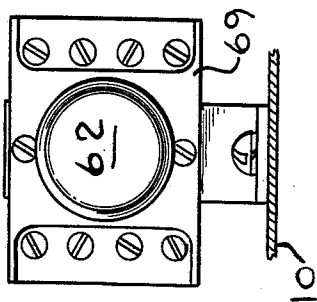
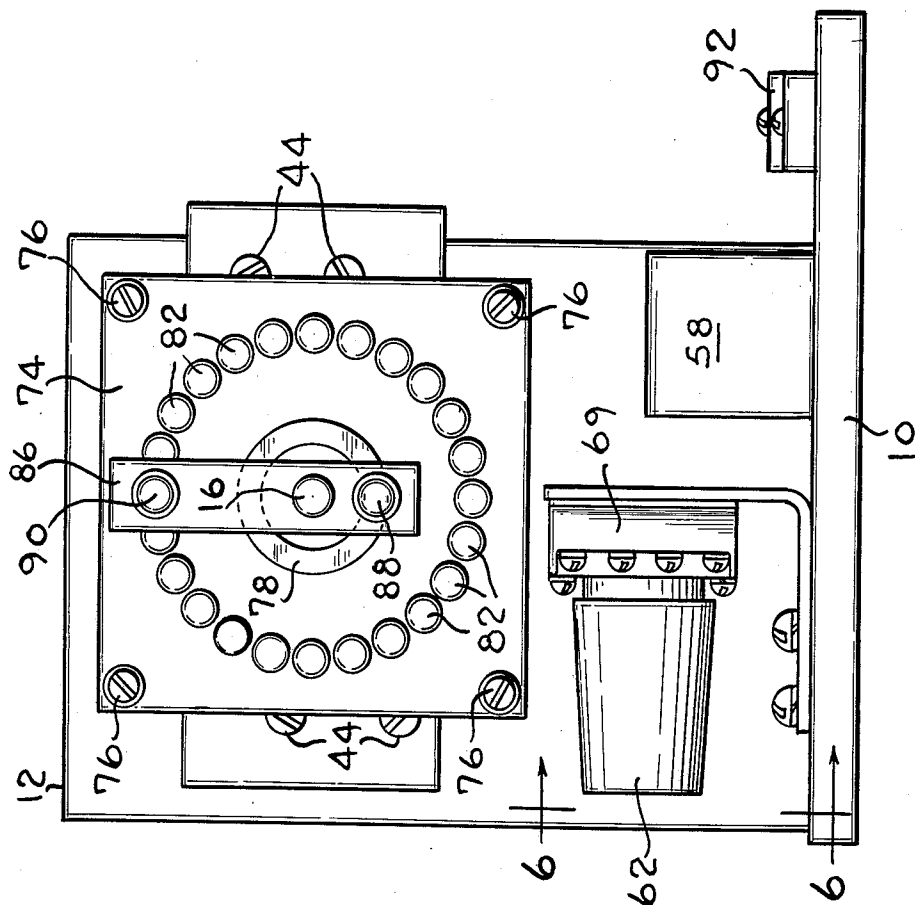


FIG. 6

FIG. 3

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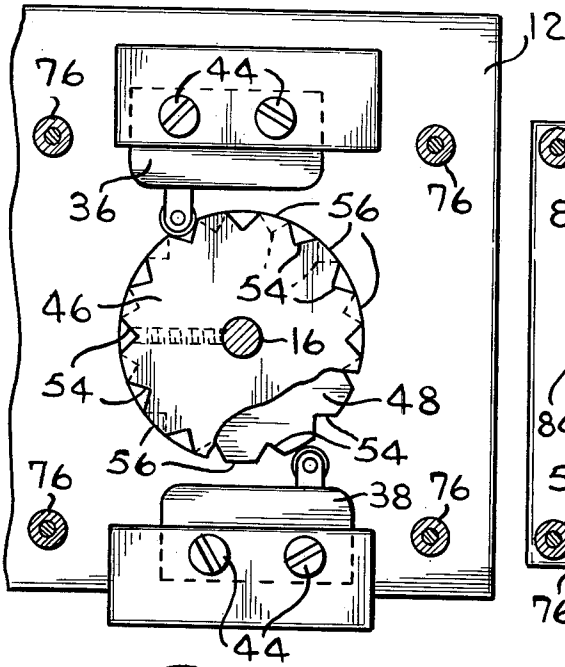


FIG. 4

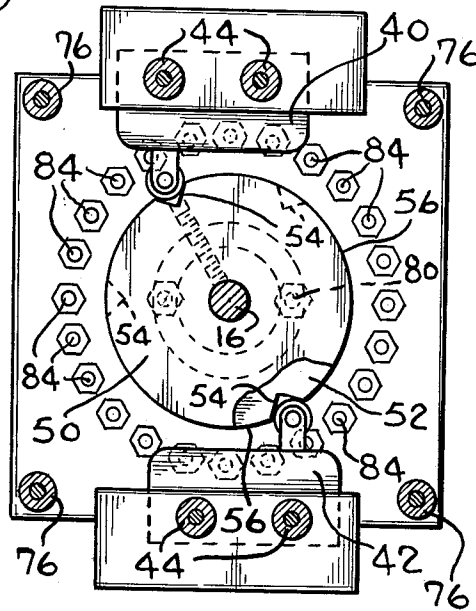


FIG. 5

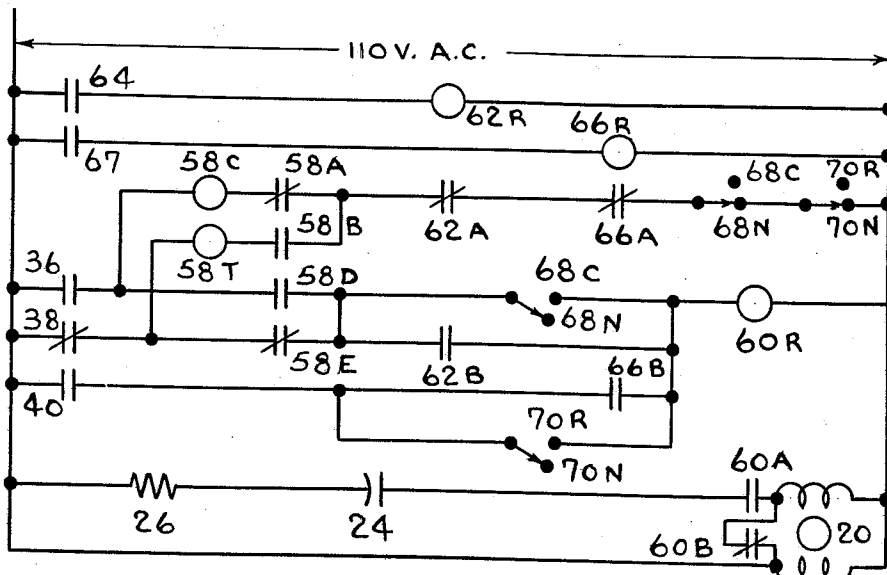


FIG. 7

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SELECTOR SWITCH

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13 Claims. (Cl. 318—467)

This invention relates to motor operated switches. Switches of this type have application, for example, in blast furnace charging control systems. In general, they are used to successively make and break a large number of circuits with intermittent steps controlled by outside pulses. These switches can be used to count and indicate the number of dumps placed on the large bell of the blast furnace.

One object of this invention is to provide a switch of this type which is compactly arranged with its components mounted to form an easily handled unit to which the circuits to be controlled may be readily attached.

Another object of this invention is to provide a switch of this type which is accurate, relatively inexpensive to manufacture and of flexible usage.

In the accomplishment of these objects a single automatic dynamic braking A.C. pilot motor drives a control shaft on which is mounted the operating cams of snap switch assemblies and the brush carrying levers of rotary switch arrangements. The drive, snap switch assemblies, rotary switch arrangements, as well as gear transmission, relays, capacitor, terminal blocks, and manual control switches are compactly mounted on a mounting plate with an outer terminal block extending along one side. Separate adjustments are provided for each snap switch so that the operation of them can be properly timed with respect to rotary switches. The driving motor and helical gear transmission are coupled to the shaft by bushings which permit an initial adjustment for proper orientation. Two of the snap switches control the stepping travel of the motor by alternate operation. A third snap switch is used to establish and break a reset circuit. A fourth snap switch is available for use as an interlock with outside circuits. In connection with the alternate operation of the motor control snap switches a latching relay is used. Three other relays mounted on the unit are used (1) to complete the motor relay circuit in response to an outside signal for counting, (2) to complete the motor circuit relay for reset in response to an outside signal and (3) to energize the motor circuit. A pair of toggle switches are used to temporarily circumvent the automatic relay operation for (1) resetting and (2) counting under manual control. With this arrangement the motor can be driven to rotate the control shaft to 24 positions in one revolution. The two rotary switch arrangements thus have 24 buttons controlling circuits which may be utilized in sequence either separately or conjointly for a variety of applications, one of which is the energizing of neon tubes to visibly show the count.

A switch embodying the present invention is hereinafter described in detail and shown in the drawings, in which:

FIG. 1 is a plan view in front elevation of such switch with the cover removed;

FIG. 2 is a bottom plan view thereof;

FIG. 3 is a left end plan view thereof;

FIG. 4 is a fragmentary sectional view taken on the line 4—4 of FIG. 1;

FIG. 5 is a fragmentary sectional view taken on the line 5—5 of FIG. 1;

FIG. 6 is a fragmentary view taken from the line 6—6 of FIG. 3; and

FIG. 7 is a schematic wiring diagram of the circuits and components used in the operation of the switch.

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The switch shown in the drawings has a mounting plate 10 by which the unit may be secured to a control panel. A pair of mounting blocks 12 projecting from this panel have bushings 14 in which a control shaft 16 is rotatively mounted. The ends of this shaft extend laterally outwardly of the blocks 12 for the purpose hereafter explained. Behind the shaft 16 is a motor mounting bracket 18 which extends between and is secured to the blocks 12. An electric motor 20 is secured to the back of the bracket 18 with its drive shaft 22 extending forwardly through such bracket to beyond the control shaft 16. This motor is a standard A.C. pilot motor with automatic dynamic braking and built in reduction gearing. A capacitor 24 on the plate and a resistor 26 on a terminal block 25 are connected under the control of a relay in the field circuit to shift the phase for start and run and are disconnected to place the fields in phase for dynamic braking. On the drive shaft 22 there is mounted by a coupling bushing 28 a helical gear 30 which meshes with a helical gear 32 mounted on control shaft 16 by a similar coupling bushing 34 whereby the motor operates the control shaft.

Two snap switch assemblies are mounted next to the mounting blocks 14. The left assembly (see FIGS. 1 and 4) includes two snap switches 36 and 38 and the right assembly (see FIG. 5) includes snap switches 40 and 42. These switches are secured to the blocks 14 by bolts, nuts and spacers indicated at 44 and each may be adjusted to proper operating position. The switches are placed in closed position by the high areas of cams fixedly mounted on the control shaft 16. Cam 46 operates snap switch 36 and cam 48 operates snap switch 38. These cams and switches are used in the counting action of the device. Reset cam 50 operates snap switch 40. Special cam 52 operates snap switch 42. As shown in FIG. 4, cams 46 and 48 are identical and have twelve notches 54 into which the snap switch roller will drop to open the snap switch and twelve tops or high areas 56 which hold the snap switch in closed position. The tops or peaks 56 are spaced angularly 30° from each other. The same is true of the notches 54. The notches 54 and the rollers of the snap switch are designed so that the roller is in the notch and the snap switch remains in the open position for only 8° to 10° of the angular travel of 30° from peak to peak. The cam 46 is angularly shifted 15° relative to cam 48 so that in the starting position, as shown, snap switch 36 will be open and snap switch 38 is closed. As the control shaft 16 rotates clockwise, as viewed in FIG. 4, snap switch 36 will first close and then snap switch 38 will open at the end of an angular travel of 15°. The reverse action takes place during the next 15° step. This alternating action is used to count up to 24 positions. The reset cam 50 has only one notch 54 and it is aligned with the start position notch of the cam 46 so that the control shaft 16 will always come to rest in the start position shown. Snap switch 40 will close during the first step to keep the reset circuit ready for operation at the proper signal. The special cam 52 may have as many notches 54 as desired. Such notches can be aligned with any of the notches of either of cams 46 and 48. Thus, the snap switch 42 may be opened at any selected positions of the switch.

The alternate operation of the snap switches 36 and 38 controls a latched alternating counting relay 58 which includes a closing coil 58C, a tripping coil 58T and four contacts 58A, 58B, 58D and 58E. The contacts 58A and 58B control the alternate energization of such coils and the contacts 58D and 58E operate alternatively to connect the circuits from the snap switches 36 and 38 to a motor relay 60R. These and other circuits are diagrammatically shown in FIG. 7. The contacts which are

closed when the system is energized and in the start position shown are indicated in the usual manner as normally closed. When the control shaft 16 under influence of an outside signal and a count relay moves from start position to position one, no change will take place in the latched alternating count relay 58 until the outside count signal is removed at which time the position of contacts 58 will reverse to disconnect the circuit from snap switch 38 and connect the circuit from snap switch 36 for control by the next outside signal.

The split field circuit of the motor 20 and the capacitor 24 and resistance 26 are controlled by the motor relay 60R and two contacts 60A and 60B. When relay 60R is energized, the contacts reverse position and the capacitor and resistor are placed in circuit to place the windings out of phase and start running of the motor. When the relay 60 is deenergized, the capacitor and resistor drop out and both windings are placed in parallel and in phase to dynamically brake the motor.

The energization of motor relay 60R for advancing one step is accomplished by a count relay 62R with contact 62A in the alternating latch count relay circuit to open such circuit during motor operation and contact 62B in the circuit from the snap switches 36 and 38. The counting relay 62R is energized and maintained energized by the closing of a contact 64 by an outside signal such as the opening of a small bell to dump a charge in the large bell of a blast furnace. However, the control shaft 16 will not move more than one step because the snap switches 36 and 38 shift position to open the circuit as previously explained. When the outside signal is terminated, such as by the closing of the small bell, counting relay 62R is deenergized by the opening of contact 64. The circuit to motor relay 60R is opened by contact 62B and the alternating latched count relay 58 closed to then shift the contacts 58A, 58B, 58D and 58E from the position shown for the next stepping or counting movement.

The reset of the control shaft 16 to the start position is accomplished by a reset relay 66R with a normally closed contact 66A in the alternating latched count relay circuit and an open contact 66B in the circuit from reset snap switch 40 to motor relay 60R. After the control shaft is moved from the start position, snap switch 40 closes. Thus, upon the energization of reset relay 66R the motor relay will be energized (or maintained energized if energized) to continually operate the motor 20 until cam 50 brings its notch 54 under the roller of reset snap switch 40. The device then stops in the start position. During such time the alternating latched count relay circuit is broken by contact 66A. Enough time delay is built into the reset relay to maintain such condition during the reset cycle (say 10 seconds). When the reset is complete, the reset relay 66R is deenergized and the alternating latch count relay will operate through the normally closed contact 66A to shift the contacts 58 into the position shown for the start position. The reset relay 66R may be energized under control of an outside source such as a program control for the charging of the large bell. When such program causes the opening of the large bell, a contact 67 is closed to energize relay 66R and commence reset action.

The relays 60R, 62R and 66R are of standard plug-in type and plug into socket assemblies 69 provided with terminal posts as shown in FIGS. 3 and 6. These assemblies are mounted either directly or by brackets (as shown) to the plate 10.

Manual operation for testing, forward stepping, and reset is accomplished by toggle switches 68 and 70 mounted on the blocks 12 by brackets 72. These are double pole switches spring loaded so that the contacts 68N and 70N in series in the alternating latched count relay circuit are normally closed when the switches are released. Switch 68 has a normally open contact 68C in a circuit which is manually closed to shunt the normally open count relay contact 62B to move the control shaft step

by step. Switch 70 has a normally open contact 70R which closes a circuit to shunt the normally open reset relay contact 66B for resetting operation.

The snap switch 42 is not illustrated in the circuit diagram of FIG. 7 as it has no direct effect on the step-by-step operation of this switch. One use of snap switch 42 is to limit the number of loads that may be placed on the large bell. For example, the snap switch 42 may open a holding circuit after a predetermined number of counts and stop the action of an outside program and bring about a return to start position as previously described.

The rotation of the control shaft 16 operates a pair of rotary switch arrangements. These are of identical construction and the parts are identically numbered. Panels 74 of insulating material are rigidly secured to the mounting blocks 12 by screw and spacer arrangements 76. Each panel has an opening through which the control shaft 16 extends. A contact ring 78 shown in FIG. 3 is secured to the outer face of each panel 74 and has a terminal 80 shown in FIG. 5 on the inner face. Twenty-four contact buttons 82 are spaced at 15° angular intervals in a circle about the ring 78 on the outer face of the panel 74. Each button has its own terminal 84 on the inner face of the panel. The ring 78 is connected consecutively to each button by a lever 86 secured to the control shaft 16 and rotating therewith which carries a brush 88 in sliding engagement with said ring and a brush 90 in alignment with and engaging the buttons 82. The brushes 88 and 90 are electrically connected. One operation of the rotary switch arrangements may be the successive lighting of special neon tubes so that they show a total of the number of dumps made by a small bell in the large bell of the blast furnace. For example, each tube may contain 10 digits and the combustion of the two tubes is connected so that a maximum possible count of 19 can be indicated. Other circuits can be energized by the rotary switch arrangements as the motor operated switch advances step by step under the influence of the outside signal.

A terminal block 92 is secured to the lower edge of the plate 10 to facilitate the connection of outside wiring to the motor operated switch. The internal wiring from the terminals of the rotary switch assemblies, the count relay 62R, reset relay 66R, and special snap switch 42 leads to such terminal block but has been omitted from the drawing in order to make the views clear. This is also true of the internal wiring between the snap switches 36, 38, 40, alternating count relay 58 and its contacts, toggle switches 68 and 70, the sockets 69, capacitor 24 and resistor 26, some of which wiring is interconnected at the terminal block 25 mounted on the block 12.

A typical operation, based on the previous description, starting with the cams, snap switches, relays and contacts in the positions shown in FIGS. 4, 5 and 7, will now be explained. An outside signal closes contact 64 to energize counting relay 62R which remains energized until such outside signal is terminated. Contact 62A opens to keep the circuit to the latched alternate counting relay coils 58C and 58T from being completed until the outside signal is terminated. No change takes place in the contact of relay 58 upon the closing of contact 64. The counting relay contact 62B is closed completing the circuit to motor relay 60R through closed snap switch 38 and closed latched relay contact 58E. The energization of relay 60R closes contact 60A and opens contact 60B and the motor starts operation turning shaft 16 and the counting cams 46 and 48 and reset cam 50 in a clockwise direction as viewed in FIGS. 4 and 5. As previously described during first part of a 15° angular travel of such shaft snap switch 36 and reset snap switch 40 will close. Snap switch 38, however, remains closed until the end of the 15° angular travel at which time it opens breaking the circuit to relay 60R to open contact 60A and close contact 60B to dynamically brake the motor. The motor remains stopped even though the

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outside signal keeps contact 64 closed. There is enough time delay built into the relay 62R to hold during the time required for a 15° angular step even though the outside signal opened contact 64. However, snap switch 36 is now closed and snap switch 38 is now open and the circuit is in condition for another outside signal.

Assume for case 1 that the next outside signal opens the contact 64 or that such opening took place during the 15° angular travel. Upon such opening or at the end of such travel the counting relay 62R will be deenergized to close contact 62A and open contact 62B. Contact 62A places closing coil 58C in circuit through the then closed snap switch 36 and closed contacts 58A, 66A, 68N and 70N. The energization of coil 58C opens contacts 58A and 58E and closes contacts 58B and 58D. The closing of contact 58B places the tripping coil 58T in a circuit to be controlled by the next closing of snap switch 38. The closing of contact 58D completes a circuit through closed snap switch 36 to open contact 62B. Such changes do not affect the motor relay 60R and no operation results. However, the circuit is now in condition for another outside signal.

Assume for case 2 that the next outside signal again closes the contact 64 to energize relay 62R thereby to open contact 62A and close contact 62B. The relay 60R is then placed in circuit through closed snap switch 36 and contacts 58D and 62B with the result that the motor again starts operation as above described. No change takes place in the latching relay and contacts. During the first part of this next step or angular movement, snap switch 38 closes. Snap switch 36, however, remains closed until the end of this 15° angular travel at which time it opens breaking the circuit to the motor relay 60R which then stops the motor at the set place. The snap switches are now in the starting position shown in FIG. 7. However, the latching relay coils 58C and 58T and their contacts will remain in the end position described in case 1 until the outside signal again opens contact 64. When this occurs, contact 62A closes and contact 62B opens. Closing contact 62A energizes tripping coil 58T through closed snap switch 38 and closed contact 58B. This changes the latching relay back to the position shown in FIG. 7. The circuit is now ready for another outside signal.

If at any time after reset snap switch 40 is closed by the first part of the first step of angular travel from the starting position an outside signal closes reset contact 67, the motor will either start and run or, if running, continue to run until snap switch 40 is opened by the cam 50 returning to the start position shown in FIG. 5. The closing of contact 67 energizes relay 66R to open contact 66A and to close contact 66B. The opening of contact 66A prevents any change from occurring in the position of the latching relay and its contacts during the running of the motor to the initial start position. When this start position is reached and contact 64 is open (no outside signal), the latched relay, if in the position shown in FIG. 7, will remain in such position and, if in the position described in case 1 above, will then move to the position shown in FIG. 7 by the same operation as described in case 2 above. If upon reaching the start position contact 64 is still closed by an outside source, no change will occur in the position of the latching relays and contacts because contact 62A will be open. If the latching relay is in the positions shown in FIG. 7 the first 15° of angular movement will immediately start in the manner above described. However, if the latching relay and contacts are in the position described in case 2, no operation of the motor can occur until the outside signal first opens and then closes contact 64.

Since the manual operation of the system by the toggle switches 68 and 70 is identical with the operation under relays 62R and 66R, each toggle switch must be held closed for the time required to complete one forward step or an entire reset (just as in the case of the

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time delay built into the relays). In manual counting or step-by-step advance contact 68C of switch 68 must be opened at the end of a step and again closed to start the next step (just as in the case of relay 62R).

We claim:

1. A motor operated switch comprising a mounting plate having a pair of mounting blocks, a control shaft rotatively mounted in said blocks, a dynamic braking electric motor carried by a bracket secured to said blocks, transmission means interconnecting said motor and said control shaft, a snap switch assembly carried by one of said blocks and operated by said control shaft to alternately make and break circuits to a motor relay, a motor relay carried by said plate and energizable to start said motor and deenergizable to stop and brake said motor, an alternating count relay on said plate for changing the circuits from said snap switch assembly to said motor relay, and a count relay mounted on said plate and controlled by an outside signal to close the circuits to said motor relay and open the circuit to said alternating count relay.

2. A motor operated switch as claimed in claim 1 in which there is rotary switch arrangement carried by one of said mounting blocks and operated by said control shaft.

3. A motor operated switch as claimed in claim 2 in which there is a second snap switch assembly carried by another of said blocks and operated by said control shaft to break a reset circuit to said motor relay and stop said motor at the start position.

4. A motor operated switch as claimed in claim 3 in which there is a reset relay mounted on said plate and controlled by an outside signal to cooperate with said second snap switch assembly and energize said motor relay.

5. In a motor operated switch for counting a series of input electrical signals, a sequence switch comprising a plurality of stationary contacts corresponding to successive operating positions of the switch and a movable contact for sequentially engaging said stationary contacts to complete electrical connections therethrough, an electrical motor for driving said sequence switch, and control means for operating said motor comprising signal receiving means, electroresponsive means responsive to said signal receiving means upon the receipt of each input signal for energizing said motor whereby the latter drives said sequence switch from one position toward the next operating position, cam means driven by said motor, control switch means responsive to said cam means for controlling said electroresponsive means to stop said motor in each operating position of said sequence switch, and latching switch means responsive to said signal receiving means upon the termination of each input signal for preparing said electroresponsive means for reoperation when the next input signal is received.

6. The invention defined in claim 5, wherein said signal receiving means comprises a relay energizable in response to each input signal for energizing said electroresponsive means and for preventing operation of said latching means, and said relay being responsive to termination of each input signal for operating said latching means.

7. The invention defined in claim 5, together with resetting control means comprising a cam driven by said motor, a normally open control switch operable to be closed by said cam when said sequence switch is driven from its first position, and resetting signal receiving means responsive to receipt of a resetting signal for energizing said electroresponsive means in a circuit extending through said control switch whereby said motor is energized to reset said sequence switch to its first operating position whereupon said cam opens said control switch to stop said motor.

8. The invention defined in claim 7, wherein said resetting signal receiving means comprises a relay energiz-

able in response to a resetting signal to complete an energizing circuit through said control switch to said electroresponsive means and to prevent operation of said latching means.

9. The invention defined in claim 5, wherein said electroresponsive means is provided with alternative energizing circuits, said control switch means comprising a pair of switches with one such switch in each alternative energizing circuit and being alternately closeable by said cam means, and said latching means comprising a two-winding relay with the windings thereof energizable through the respective switches and further having alternately closeable contacts in the respective energizing circuits, and said signal receiving means being operable to energize said electroresponsive means through each of said alternative circuits.

10. In a sequence device for counting a series of input electrical signals, a sequence switch comprising a plurality of stationary contacts corresponding to successive operating positions of the switch and a movable contact for sequentially engaging said stationary contacts to complete electrical connections therethrough, driving means for operating said sequence switch, and means for controlling operation of said driving means in response to input signals comprising electroresponsive means for energizing said driving means, a pair of alternative control circuits for said electroresponsive means, a pair of control switches in the respective control circuits, one of said control switches being closed when the other is open, a latched device having two stable positions and having a pair of contacts in the respective control circuit, one of said contacts being closed when the other is open, signal receiving means responsive to the receipt of each input signal for energizing said electroresponsive means through the closed control switch and closed contact in a first one of said control circuits thereby to energize said driving means to cause the latter to drive said sequence switch from one position to the next operating position, cam means driven by said driving means for opening the closed control switch thereby to deenergize said electroresponsive means and stop said sequence switch in the next operating position, said cam means being concurrently operable to close the open control

switch in the other control circuit, and means responsive to said signal receiving means upon the termination of each input signal when the control switch in said other control circuit is closed for operating said latched device to its other stable position wherein its closed contact in the first control circuit is opened and its open contact in the other control circuit is closed thereby to prepare said electroresponsive means for reoperation when the next input signal is received.

11. The invention defined in claim 10, together with manually controllable switch means for energizing said electroresponsive means through said alternative control circuits thereof and in shunt of said signal receiving means thereby to afford operation of said sequence switch under manual control.

12. The invention defined in claim 10, together with a reset control circuit for said electroresponsive means, a reset control switch in said reset control circuit, reset cam means driven by said driving means and being operable to close said reset control switch and being operable to close said reset control switch when said sequence switch is driven from its first operating position, and means responsive to a reset signal for energizing said electroresponsive means thereby to energize said driving means, and said reset cam means being effective when said sequence switch reaches its first operating position to open said reset control switch thereby to deenergize said electroresponsive means and stop said driving means.

13. The invention defined in claim 12, together with manually controllable reset switch means for energizing said electroresponsive means through said reset control switch and in shunt of said reset signal responsive means thereby to afford resetting of said sequence switch under manual control.

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