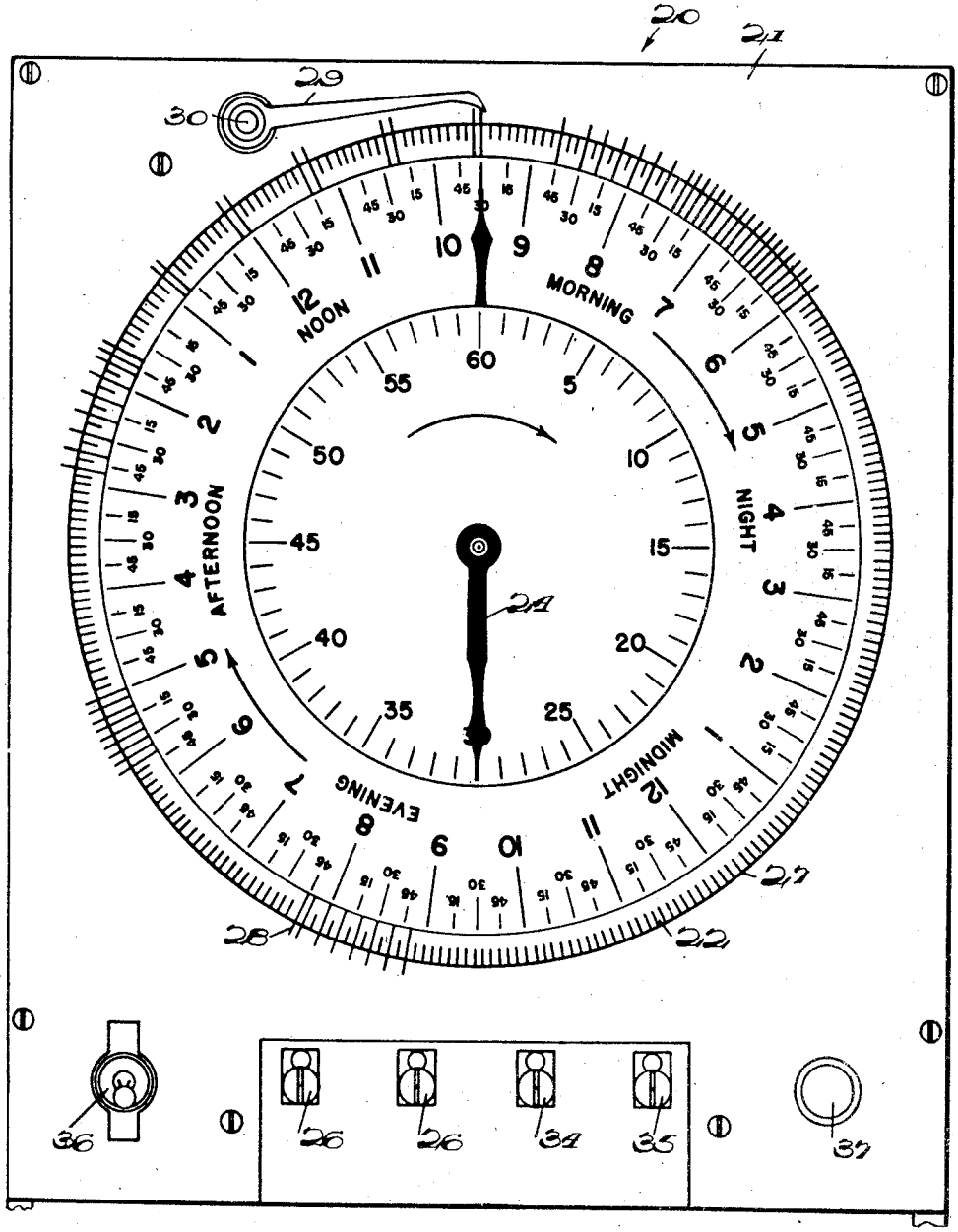
Dec. 1, 1953 S. J. OTIS 2,661,060

ELECTRICAL SYSTEM FOR CYCLIC CONTROLS

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FIG. 1.



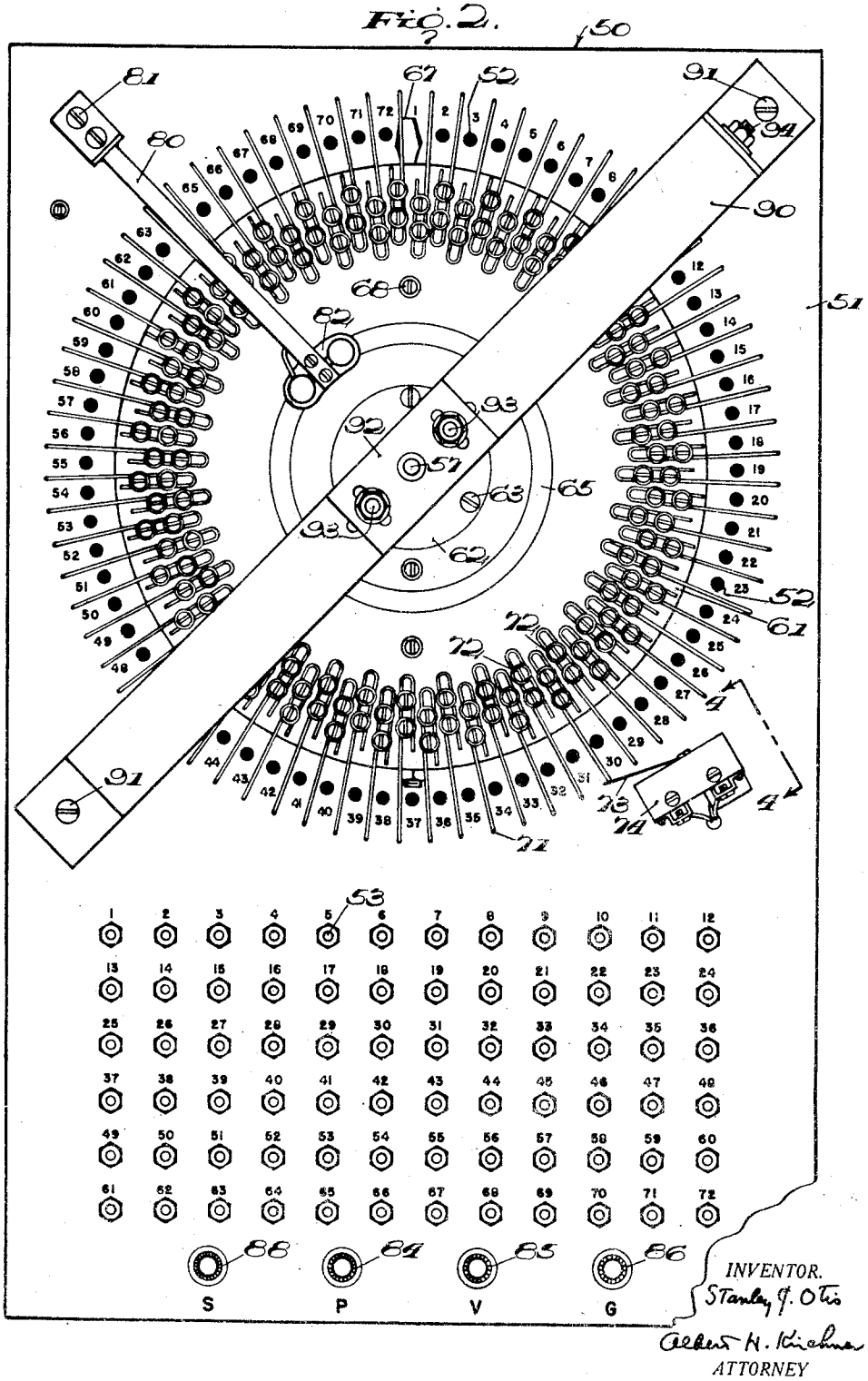
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ELECTRICAL SYSTEM FOR CYCLIC CONTROLS

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Fig. 2.



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ELECTRICAL SYSTEM FOR CYCLIC CONTROLS

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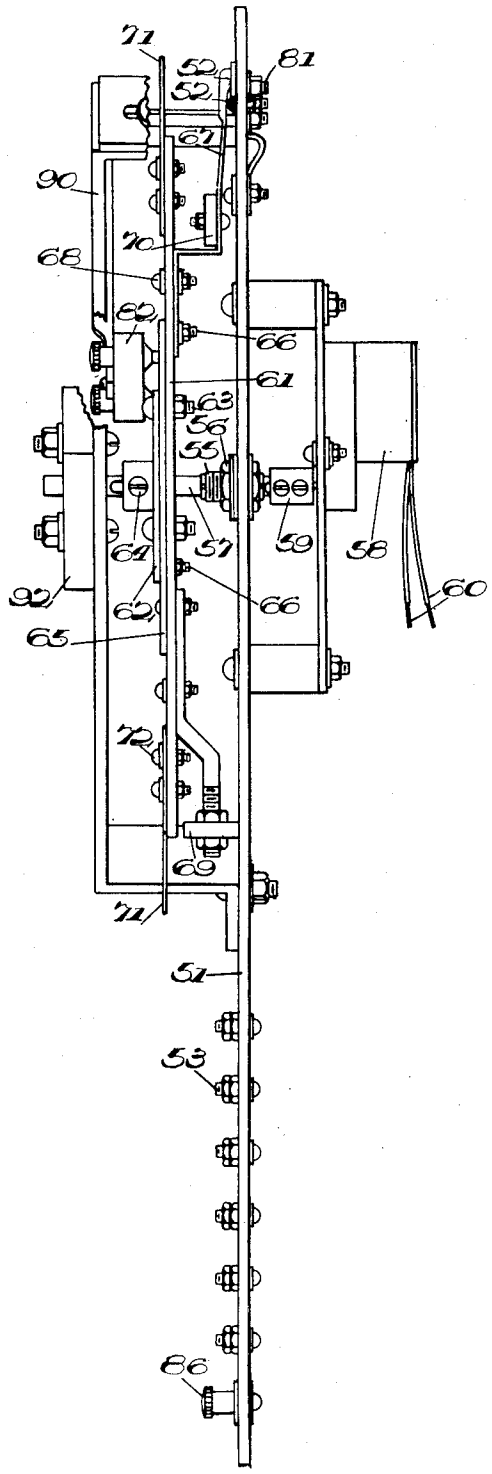
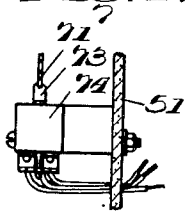


FIG. 3.

FIG. 4.



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ELECTRICAL SYSTEM FOR CYCLIC CONTROLS

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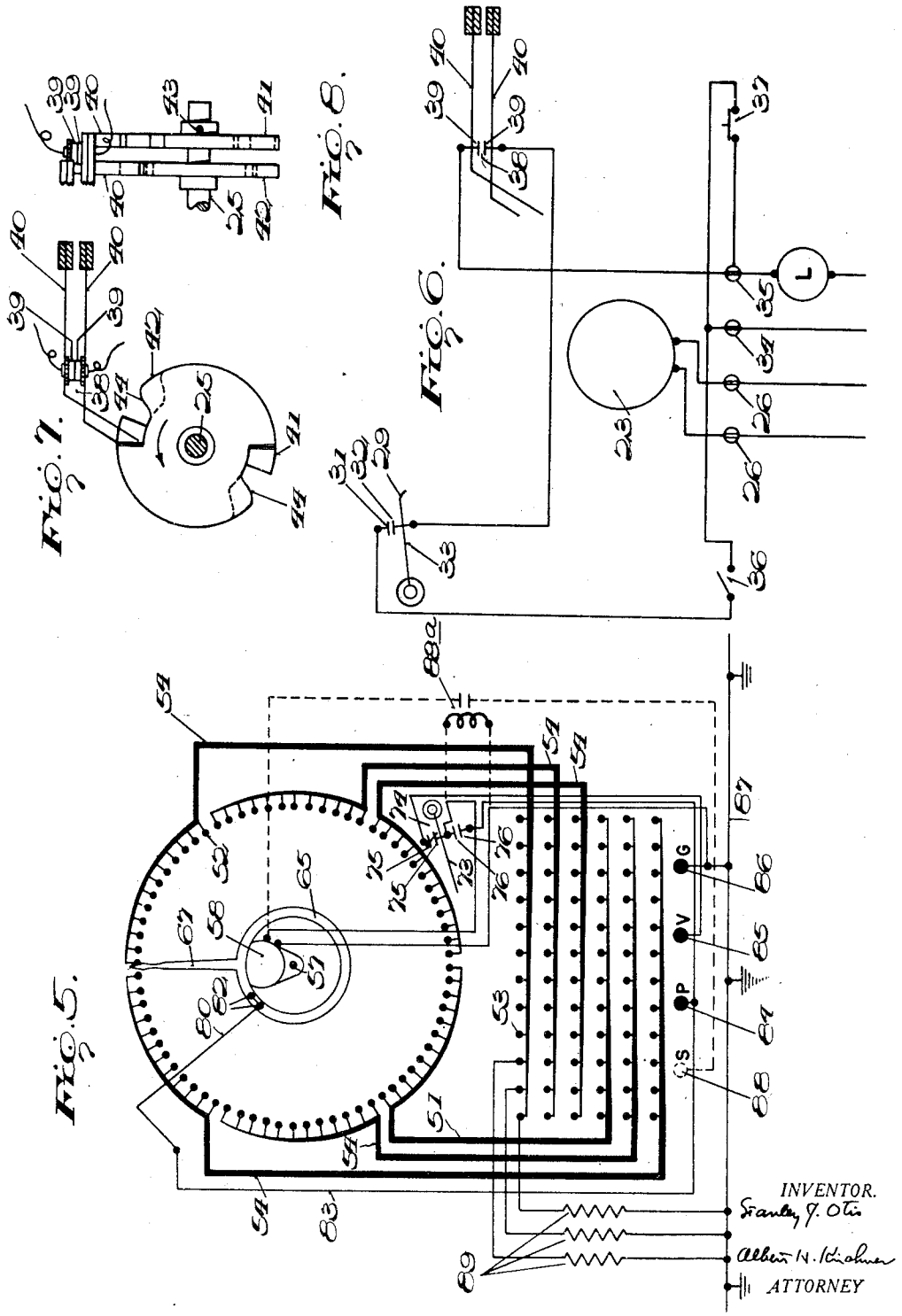


FIG. 5.

FIG. 6.

FIG. 7.

FIG. 8.

Dec. 1, 1953 S. J. OTIS 2,661,060

ELECTRICAL SYSTEM FOR CYCLIC CONTROLS

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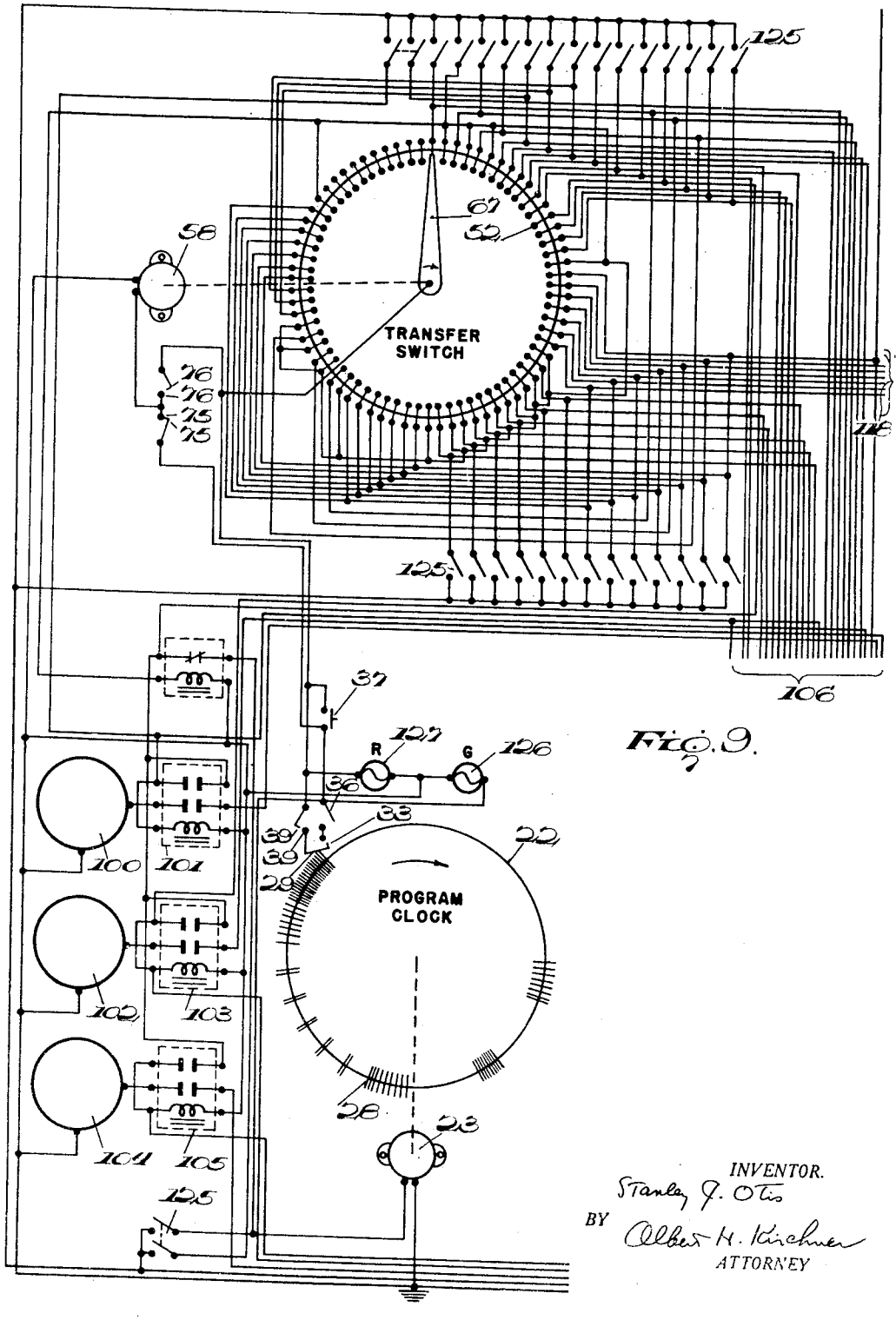


FIG. 9.

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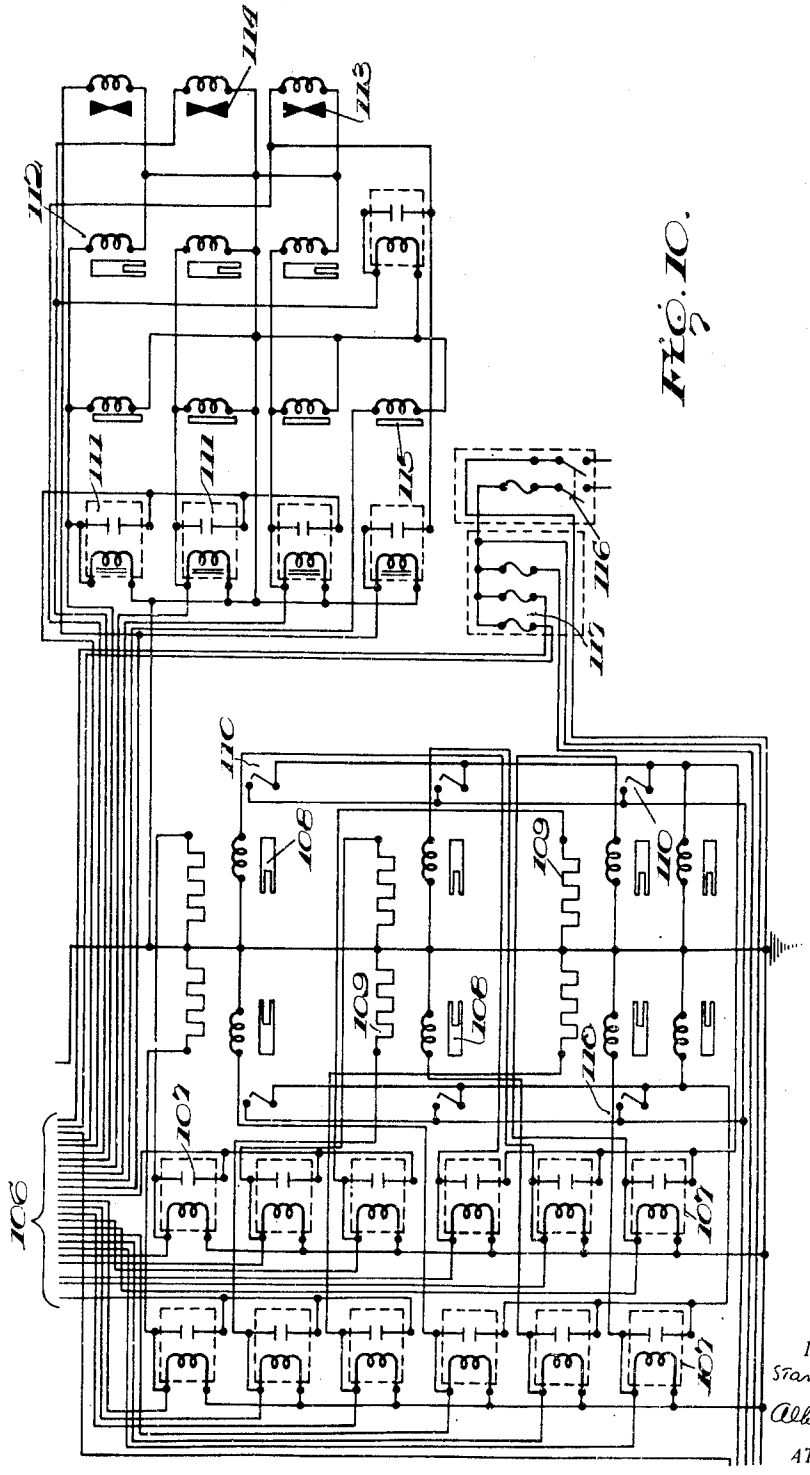


FIG. 10.

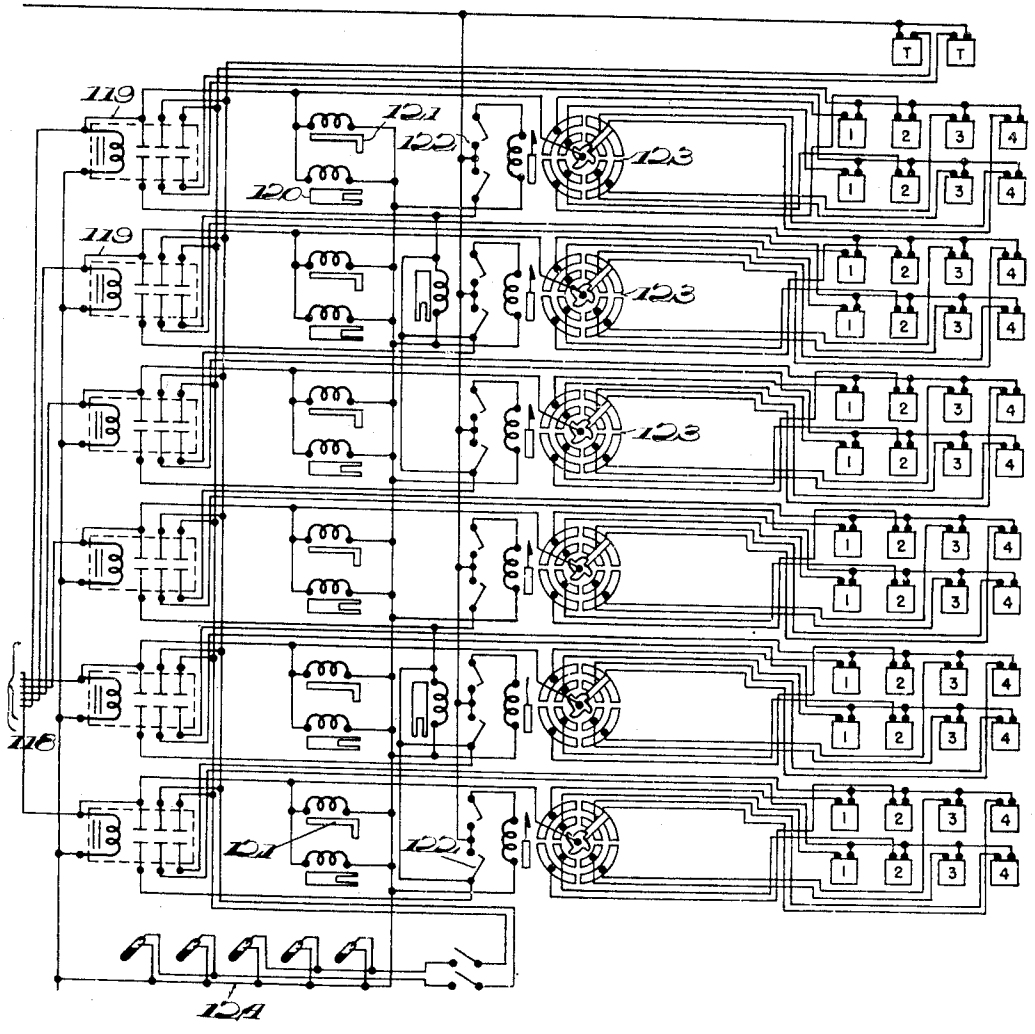
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FIG. 11.



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UNITED STATES PATENT OFFICE

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ELECTRICAL SYSTEM FOR CYCLIC CONTROLS

Stanley J. Otis, Madison, Wis.

Application June 21, 1951, Serial No. 232,793

16 Claims. (Cl. 161—1)

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The present invention relates to electrical systems and apparatus and more particularly to means for effecting the sequential operation of a plurality of instrumentalities in accordance with a predetermined time cycle.

The system includes a program clock or equivalent control which may be adjustably set to the predetermined cycle so as to close a control circuit at selected time intervals, in combination with a transfer switch which will be actuated by the clock and will close circuits to the several instrumentalities in accordance with the predetermined desired sequence.

Program clocks, and electrical energization systems controlled by them, are old in the art, both individually and in combination. The present invention may and preferably does contemplate the use of a known type of program clock, but it differs from the prior art in including in the system a novel transfer switch and novel circuits combining the transfer switch with the program clock.

Principal objects of the invention are to eliminate costly parts (such, for example, as a multiplicity of heavy duty contact points) and complex wiring, elements and connections, to facilitate and simplify resetting to changed instrumentalities to be energized or changed sequences, to insure unfailing operation, to distribute loads so as to minimize peak demand, and generally to improve the mechanical construction of the operating parts.

In a particular form of embodiment, which has been reduced to practice and operated satisfactorily, and which is used in the present application to illustrate the invention, the system and structure are used to control automatically the operation of laying battery of the kind disclosed and claimed in my copending application Serial No. 210,015, Automatic Feeding and Watering Apparatus for Laying-Batteries, filed February 8, 1951, in which chickens are sequentially supplied with feed and fresh drinking water, drinking cups are flushed, droppings are removed and dried, and eggs are collected, weighed and graded, with each operation being performed as many times per day as may be desired, for a considerable number of individual cages, all under the control of a single integrated electrical system including a single program clock and a single transfer switch. But this embodiment of the invention is illustrative merely, and the principles of the invention are not limited to such use but are of broad application to substantially all arts and field in which a plurality of different appliances which are capable of being electrically actuated must be operated sequentially in accordance with some predetermined time cycle.

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Other objects and advantages of the invention will be sufficiently evident to those skilled in the art from the following description of a preferred embodiment as illustrated in the accompanying drawings, in which

Figure 1 is a front elevational view of a type of program clock that is well adapted to be used in the present inventive combination;

Fig. 2 is a front elevational view of the preferred form of transfer switch provided by the invention;

Fig. 3 is an end elevational view, with certain of the parts broken away, of the transfer switch;

Fig. 4 is a detail sectional view taken on the line 4—4 of Fig. 2;

Fig. 5 is a diagrammatic elevational view of the transfer switch, showing the connections at the rear thereof, as if viewed through the front;

Fig. 6 is a wiring diagram of the program clock;

Fig. 7 is a sectional view through the cam drive shaft of the program clock showing the related cam mechanism in generally diagrammatic form;

Fig. 8 is a side elevational view of the parts shown in Fig. 7;

Fig. 9 is a wiring diagram of the combined program clock and transfer switch;

Fig. 10 is a wiring diagram of electrical controls for an automatic mechanism for supplying feed and drinking water to a laying battery, and for removing and drying droppings therefrom, which mechanism is typical of the kind of apparatus with which the invention may be used; and

Fig. 11 is a wiring diagram of electrical controls for mechanism for collecting, counting and weighing eggs in the laying battery.

The program clock 20 shown in Fig. 1 is standard item No. P5–24 manufactured by Zenith Electric Company, Chicago, Illinois, and comprises a panel 21 on which an hour face 22 is journaled for one complete rotation in each 24-hour period by a synchronous motor 23 (Fig. 9). Also driven by this motor are a minute hand 24 which makes one revolution per hour and a cam drive shaft 25 (Figs. 7 and 8) which rotates once each 10 minutes. The clock face is suitably inscribed as shown for cooperation with the hands to indicate the correct time and the motor is supplied with standard A. C. house current from terminals 26.

Cut into the outer peripheral edge of the rotatable hour face 22 are a plurality of equally spaced radial slots 27, each of which is adapted

to receive and hold any one of a plurality of clips 28. In the illustrated embodiment the slots 27 are spaced at five minute intervals, making a total of 288 slots. This is a convenient and adequate number for all purposes for which the present invention has actually been used, but obviously the number is not critical and may be increased or decreased to suit varying needs.

Each clip 28 inserted in a slot 27 projects radially or otherwise from the hour face 22 so that as the hour face rotates the clips will successively engage and swing an arm 29 which is pivoted on shaft 30 mounted on the panel 21. The arm 29, when moved by a clip, closes the normally open contacts 31 and 32 of switch 33 which is mounted on the back of the panel 21 and is shown diagrammatically in Fig. 6, thus momentarily completing through these contacts a circuit to the terminals 34 and 35 which are accessible from the front of the panel 21 for connection respectively to an ungrounded signal-circuit supply line lead and to a signal-circuit load lead, as will be hereinafter described.

Complete closing of the circuit shown in Fig. 6 is, as will be evident from that figure, dependent on more than mere engagement of the contacts 31 and 32. As there shown, the circuit includes a toggle switch 36 which is normally kept closed but which may be opened whenever it is desired to disconnect the signal circuit without stopping the program clock, and it includes also a push-button switch 37 which is normally open but which may be closed at any time to complete the signal-circuit independently of the switch 33.

The circuit includes also a switch 38 formed by contacts 39 fixed on spring arms 40 which are anchored in fixed relation to the panel 21 and each of which has a free end riding on one of a pair of cam discs 41, 42 which are fast on the shaft 25. One of these discs is permanently locked on the shaft and the other is adjustably fixed thereon, as by a setscrew 43, so that the discs may be relatively rotated on the shaft and fixed in such position as to vary the effective size of the openings made by the valleys 44 formed at diametrically opposite locations in the disc peripheries.

It will be remembered that the shaft 25 makes one complete rotation every ten minutes. Consequently the switch 38 will close every five minutes if the discs 41 and 42 be so positioned on the shaft that the upper spring arm 40 will drop into a valley 44 while the lower spring arm continues to be held up by the high part of its disc. It will be evident that this closed condition will be maintained until continued rotation of the shaft brings disc 41 to a position in which lower spring arm 40 will drop into it. It will also be evident that both the make and the break can be made to occur so quickly as to prevent objectionable arcing by simply so shaping the leading edges of the valleys that the arms will snap down with quick and sudden action. As shown in Fig. 7 these leading edges are made substantially radial, or they may even be made slightly undercut. The rise at the trailing edge of each valley may be formed to present a gradual slope by which the upper arm is first lifted and then the lower arm is raised to maintain the open circuit condition until, slightly less than five minutes later, the diametrically opposite valleys 44 reach the arm ends for again closing the switch.

The relative positioning of the cam discs 41, 42 on the shaft 25, and the resulting time lag between descent of the upper spring arm 40 into the valley of disc 42 and descent of the lower arm into the valley of disc 41, determines the time during which the switch 38 is closed. It will be evident from Fig. 6 that the circuit to the terminals 34, 35 can be completed by closing of the switch 33 only at such time as the contacts 39 of switch 38 are engaged. In other words, the program clock clips 28 may close the switch 33 at any five minute interval in the clock's operation, but completion of the circuit through this switch depends on the switch 38. As has been explained, the switch 38 closes once each five minutes. By appropriately adjusting the relative positions of the cam discs 41, 42 on the shaft 25, the switch 38 is made to close a few seconds after the moment at which arm 29 moves to close switch 33 under the influence of any clip 28, and is made to open a few seconds before the arm moves back to open switch 33. In this way the signal circuit of Fig. 6 is made and broken always at the switch 38, and it results that only the contacts 39, which are quick operating as has been explained, need be specially made to withstand damage from arcing.

As will be understood from Fig. 6, the normally open pushbutton switch 37 can be actuated at any time to close the signal circuit independently of the switches 33 and 38. This is for the purpose of energizing such instrumentality as may at the time be connected in the circuit by the transfer switch which will now be described.

The purpose of the transfer switch 50, which is best shown in Figs. 2, 3, 4 and 5, is to effect, by a step by step movement, the establishment of a circuit sequentially and successively through each of the several instrumentalities that are to be operated, and to make advance preparation of these circuits for completion and energization upon the delivery of an impulse from the program clock. Use of the transfer switch in the system thus confines the function of opening and closing the energizing circuits to the contacts 39 of switch 38, so that only these contacts, and none in the transfer switch or elsewhere in the system, need be specially, and hence expensively, made and designed to withstand damage from arcing. The invention accomplishes this desirable result, using for most of the instrumentalities a parallel source of control power provided by such means as a limit switch or a relay automatically and immediately upon closing of the signal circuit (Fig. 6) by the program clock.

The transfer switch 50 includes a panel 51, of insulating material like the panel 21 of the program clock, in which a plurality of contact points 52 are fixed in a circular pattern. Each point may be a slotless, round-headed copper or brass bolt, and the points may be provided in any number that will afford sufficient circuits for the instrumentalities to be controlled. In the illustrated embodiment seventy-two points are equally spaced on a circle of twelve inch diameter.

Each point 52 is connected to a terminal 53. Fig. 5 shows at 54 each one of six twelve-wire cables which make the connections on the back of the panel 51, and this figure and Fig. 2 show the terminals 53 arranged in a bank on the lower portion of the panel. The connected contacts and terminals may be identified by numerals, as shown. The terminals may be standard plug-receiving jacks of the type used on telephone switchboards. The plugs, as will be explained

hereinafter, are the terminal elements of the instrumentalities to be operated.

At the center of the circle of contact points 52 the panel 51 is formed with an opening in which a bearing 55 is mounted by a nut 56 for journaling a shaft 57 which projects beyond both front and rear faces of the panel. A small synchronous motor 58 is bracketed on the rear of the panel and geared to the shaft by a coupling 59 to rotate it at the rate of one-third revolution per hour. Leads 60 are connected to a supply circuit for the motor which will be later described.

A contact disc 61, which may be made of the same material as the panel is provided with a hub 62 secured to its center by bolts 63, and the hub is locked on the shaft 57 by a setscrew 64. A slip ring 65 is fixed on the front face of the contact disc 61 by three peripherally spaced studs 66.

A spring contact arm 67 has one end secured to the rear face of contact disc 61 by a bolt 68 and by one of the slip ring studs 66, thus fixing the arm radially on the contact disc and electrically connecting it to the slip ring. The free end of the arm has its side radial edges turned up in slight curvature so as to facilitate wiping the contacts 52, which are located the same radial distance from the shaft 57 as the end of the arm, and against which the arm is biased by its inherent resilience. Diametrically opposite the arm 67 a wheel bearing 69 is bracketed on the contact disc 61 to ride on the panel 51 and counteract the thrust of the arm and maintain the disc parallel to the panel. The weight of this bearing 69 and its mounting bracket may be balanced by a counterweight 70 bolted to the arm. It will be appreciated that with this arrangement the torque on the shaft of the motor 58 is maintained constant for all positions of the arm 67, in engagement with any of the contacts 52.

Spaced equidistantly around the periphery of contact disc 61 are tripping prongs 71 provided in the same number as the contact points 52, i. e., 72 in the illustrated embodiment. Each prong may be made, as shown in Fig. 2, of a short length of ordinary steel wire with its inner end rebent to provide parallel runs that can be caught beneath the heads of a pair of radially spaced bolts 72 with a free end of one of the runs projecting radially well beyond the periphery of the disc. The prongs can be individually adjusted radially by loosening the bolts 72.

These prongs, when fixed to project sufficiently, are adapted successively, as the disc 61 rotates, to wipe the spring arm 73 of a double pole limit switch 74 which is mounted on the panel 51 so that the arm 73 stands in the path of the properly projecting prongs, as shown in Fig. 2. This limit switch, as indicated in Fig. 5, comprises normally closed contacts 75 and normally open contacts 76, and the adjustment and relative positions of the parts are such that as the contact disc 61 rotates in a clockwise direction as viewed in Figs. 2 and 5 the outer free end of each projecting tripping prong 71 slides along the spring arm 73 and depresses the arm enough to separate the contacts 75 and close the contacts 76 when the prong is closely approaching the free end of the spring arm. The arm is sufficiently resilient to absorb in bending stress such pressure as the prong may apply in further moving along the arm after the actuating point is reached. Of course as soon as the prong slips off the end of the arm, the arm springs back to its original position shown in Fig. 5, and remains in that position until actuated by the next succeeding prong.

The point of initial actuation of arm 73, at which contacts 75 become separated, is so related to the position of spring contact arm 67 that the contacts 75 separate just after the free end of arm 67 engages a contact point 52.

A tubular brush arm 80 is bolted at 81 to the upper left hand front face of the panel 51 and extends radially inwardly over the contact disc 61 to terminate in a pair of brushes 82 which wipe the slip ring 65. A wire 83 (Fig. 5) connects the brush arm 82 with a terminal 84 mounted in the lower portion of the panel 51, below the bank of jacks 53, into which may be plugged a connection from program clock terminal 35. Terminals 85 and 86 are also disposed adjacent to the terminal 84. Terminal 85 is connected to the fixed one of the normally closed contacts 75 of the switch 74, and terminal 86 is connected through the transfer switch driving motor 58 and thence to the arm 73 of switch 74 (or to those of the contacts 75 and 76 which are movable and are carried on the arm 73). The fixed contact 76 is connected to the terminal 84, and the terminal 86 is grounded at 87. A fourth terminal, shown at 88, may be added and connected in the circuit with a relay 88*a* for use in case the motor 58 is wired for a different voltage from that of the signal circuit output of the program clock.

The terminal 84 is connected, as has been stated, to program clock terminal 35, and the terminals 85 and 86 are connected respectively to program clock terminals 35 and ground.

Connections from the instrumentalities to be operated under control of the program clock are made by plugging into the terminal jacks 53. Three such instrumentalities are indicated diagrammatically at 89 in Fig. 5.

Bridging the contact disc 61 is a metal yoke 90 which is secured to the panel 51 by bolts 91 at its ends so as to straddle the contact disc in a direction substantially normal to the length of the tubular arm 80, as best shown in Fig. 2. This yoke mounts at its center a bearing block 92 for the shaft 57. Accurate adjustment for proper alignment of the shaft can be made by standing the bearing block bolts 93 through slots in the block, and by providing a similar arrangement for a bolt 94 in the leg at one end of the yoke.

It is to be noted that in order to simplify the showing in Fig. 3 there have been omitted from the figure all contact points 52 except the single one at the top, which appears under the spring arm 57, as well as all tripping prongs 71 except the diametrically opposite two at the extreme top and bottom. Broken away are portions of the yoke 90 and bearing block 92. Omitted also are the switch 74, as well as such electrical connections as the leads from the contact points 52 to the jacks 53 and from the terminals 83, 84, 85 and 86 to the various points on the transfer switch as shown in Fig. 5.

It will be understood that the purpose of the transfer switch 59, as used in conjunction with the program clock 39 is (1) to establish energization of the particular instrumentality circuit which is connected to the contact point 52 on which arm 67 is resting, (2) to maintain such energization long enough to permit the limit switch or other locking device of the particular circuit to take over and assume control, and (3) then automatically to rotate arm 67 in a clock-

wise direction and bring it to a stop on the next adjacent contact point 52.

The manner in which these objectives are accomplished will be evident from a consideration of the manner in which the system operates, which is as follows:

When the program clock 20 registers that particular time of a 24-hour day at which the system is set to operate a given instrumentality, a clip 28 lifts arms 29 of switch 33 and closes contacts 31, 32. Promptly thereafter the cam discs 41 and 42 cause contacts 39 of switch 38 to close, and a signal-circuit impulse flows from the program clock to arm 67 of transfer switch 50. Assuming that at this time the arm 67 is resting on one of the contact points 52, and that the corresponding jack 53 is connected to a particular instrumentality, current flows to that instrumentality and it begins to operate. However, the switch 74 has been actuated by a prong 71 and contacts 76 have been closed. Part of the impulse current consequently flows through the contacts 76 to energize motor 58 and thus turn shaft 57 and contact disc 61 slowly clockwise.

This movement is a slow one. In the illustrated embodiment the shaft 57 turns at the rate of one-third revolution per hour, so that approximately two and one-half minutes elapse before the arm 67 traverses the five degrees of arc between the first engaged contact point 52 and the next one of the seventy-two contact points. The program clock, however, is set to deliver an impulse of approximately forty-five seconds duration. By making the width of the wiping end portion of arm 67 such that the duration of engagement with each contact point 52 is approximately sixty seconds, the signal circuit will inevitably be interrupted by the opening of switch 38 before the arm 67 leaves the particular contact point 52 which it was wiping.

It is to be noted that both sets of contacts 75 and 76 of switch 74 function in the full desired operation of the transfer switch. When the motor 58 first receives a signal-circuit impulse from the program clock, one of the tripping prongs 71 has acted on arm 73 of the switch 74 to open the normally closed contacts 75 and to close the normally open contacts 76. This causes the signal-circuit impulse current to flow through contacts 76 to energize the motor 58. After some ten or fifteen seconds of operation the motor has turned the contact disc 61 sufficiently for the prong 71 to have passed off the arm 73 and released it, thus restoring the contacts of switch 74 to their normal condition so that the motor 58 becomes energized from a source independent of the program clock and the motor continues to operate and does not stop when the signal-circuit impulse from the program clock ends, as it does quite promptly, as for example in some forty-five seconds. The open condition of contacts 76 prevents power from the independent source from energizing the instrumentality circuit which includes or is connected to the next adjacent contact point 52 when the arm 67 engages that point. The motor 58 continues to rotate the contact disc 61 until the arm 67 becomes well seated on the next adjacent contact point 52, at which time the next succeeding tripping prong 71 actuates the switch 74 to open contacts 75 and close contacts 76. This opens the circuit to the independent power source and reestablishes continuity with the signal-circuit of the program clock. However, since the signal-circuit impulse is maintained for only about forty-five seconds, no more power from the program clock can flow to the motor 58 through the closed contacts 76. The motor consequently stops and does not start again until the next signal-circuit impulse is received from the program clock, which of course occurs at such time of day as brings the next tripping clip 28 up to actuate the arm 29. When this occurs, the transfer switch directs power to the instrumentality in circuit with the contact point 52 on which the arm 67 has been brought to rest.

During the switching of the circuits by the moving of the arm 67 from a first to a second contact point 52, it is of course necessary to maintain the operation of the instrumentality connected to the first contact point. This is accomplished by the electrical "locking in" of the original circuit by means of auxiliary contacts on appropriate contactors or relays or by the closing of circuit limit switches. The specific form of such arrangements constitutes no part of the present invention and will readily be understood and supplied by those skilled in the art. However, certain such forms are shown in Figs. 9, 10 and 11, which illustrate diagrammatically an application of the present system to the several instrumentalities of an automatically operated laying battery used in poultry husbandry, as is explained more in detail in my copending application Serial No. 210,015. These figures will now be briefly explained.

Fig. 9 is a schematic representation of the combined program clock and transfer switch, showing the drive motor 100 for supplying poultry feed, its contactor 101, the drive motor 102 and contactor 103 for a droppings collector, and the drive motor 104 and contactor 105 for an egg collector. The transfer switch contact points 52 are shown connected, each through one of a plurality of leads 106, with the relays 107, electric clutches 108, droppings driers 109, and conveyor belt travel limit switches 110, of a system for periodically driving the floor belts of a battery in which twenty-four cages are arranged in three levels each having two rows each four cages long. The droppings removal and drying instrumentalities are shown in Fig. 10, which is a continuation of the showing in Fig. 9 (compare the leads 106 of the two figures), and Fig. 10 shows also the relays 111, electric clutches 112 and solenoid tripping pins 115 of the feeding system, main solenoid valve 113 and flushing solenoid valves 114 of the watering system, as well as the switchboard main disconnect switch 116 and appropriate fuses 117. The electric clutches may be the type which form the subject of copending application Serial No. 197,482, filed November 24, 1950, by the present applicant and Norman J. Wedekind, entitled Clutch Mechanism.

Referring again to Fig. 9, it will be observed that certain of the contact points 52 are connected by leads 118 to the leads 118 in Fig. 11 so as to energize the egg collection, counting and weighing instrumentalities diagrammatically indicated in Fig. 11. These include the relays 119, electric clutches 120, solenoid operated egg barriers 121, egg collection belt travel limit switches 122, ratchet counter relays 123, mercury counter switches 124, and the counters for the individual cages shown as numbered squares at the right hand side of Fig. 11, along with the two totalizing counters (for small and large eggs respectively) shown at T at the top of the figure. It will be understood that a relay 123 is provided for the row of cages of the three

levels and two columns. A counter for large eggs and a counter for small eggs is provided for each of the four cages of each row, as shown in Fig. 11 where the counters are numbered to correspond to the four cages of each row.

Referring again to Fig. 9, manual control switches 125 are shown by which any of the instrumentalities can be operated independently of the transfer switch and program clock. These switches are of course kept open during automatic operation of the system, and switches 116 (Fig. 10), 36 (Fig. 1) and any program clock disconnect switch 125 may be provided as shown in Fig. 9, are kept closed in order that signal circuit impulses from the program clock may reach the transfer switch. Illumination of the green indicator light 126 (Fig. 9) shows that the program clock is operating, and illumination of the red light 127 indicates that a signal circuit impulse is being delivered by the program clock.

It will be understood that the exemplary system diagrammatically indicated in Figs. 9, 10 and 11 involves sixty-two separate operations performed in sequence over a twenty-four hour operation of the program clock. This is less than the capacity of the transfer switch, which is provided with seventy-two contact points 52. Consequently ten of the contact points 52 are shown in Fig. 9 unconnected to any of the leads 106, 118, and the transfer switch is arranged to bring the arm 67 to stop on contact point No. 1 after it leaves contact point No. 62. In this way the day's cycle is repeated on the following day, beginning when the time indicated by the program clock is that at which the first tripping clip 28 has been set to actuate the switch arm 29. To arrange for movement of the arm 67 directly and continuously across the ten contact points 52 which are not used in the illustrated embodiment of the system, the bolts 72 of those ten points are loosened, the ten prongs 71 are retracted slightly, and the bolts are tightened. This setting causes the retracted prongs to pass switch 74 without actuating its arm 73. Thus the normally closed contacts 75 remain closed and motor 58 continues to rotate contact disc 61 until the tripping prong 71 associated with contact point No. 1 is reached. This prong is projecting and actuates the arm 73 of switch 74.

This same expedient of retracting into inoperative position all tripping prongs 71 at the end of the cycle can be used to disable any prong associated with a contact point which is connected to any instrumentality which for any reason it may be desired not to operate.

For any operations which are to be repeated during twenty-four hours of operation of the program clock, jumpers may be run between appropriate terminals 53 of the transfer switch panel.

It is believed that the foregoing description of the preferred embodiment illustrated by the drawings will be found adequate to acquaint those skilled in the art with the manner in which the objects hereinabove stated, and other related objects, are accomplished.

It is to be understood that various details of the exemplary embodiment may be modified, and that not all of them need be used in combination, to practice the invention within the spirit thereof as defined by the appended claims.

I claim:

1. In an electrical system for control of a plurality of instrumentalities in accordance with a predetermined cycle, the combination of a program clock adapted to energize a signal circuit at predetermined time intervals, a transfer switch in said signal circuit having connection to one of said instrumentalities for energizing the same in response to energization of the signal circuit by said clock and means including a limit switch connected with the transfer switch and operative in response to each energization of the signal circuit for shifting connection of said transfer switch to the next instrumentality in the cycle for subsequent energization thereof in response to the next energization of the signal circuit.

2. In an electrical system for control of a plurality of instrumentalities in accordance with a predetermined cycle at time intervals at which a program clock is adjusted to cause successive energizations of the same signal circuit, the combination of a transfer switch operatively connected to said signal circuit and having connection to one of said instrumentalities for energizing the same in response to energization of the signal circuit by said clock and having means including a limit switch operative in response to such energization of the signal circuit for shifting connection of said transfer switch to the next instrumentality in the cycle for subsequent energization thereof in response to the next energization of the signal circuit.

3. The combination claimed in claim 2, in which the system includes an instrumentality energizing circuit independent of the signal circuit.

4. The combination claimed in claim 2, including relay means for connecting to the instrumentalities in succession an energizing circuit independent of the signal circuit.

5. In an electrical system for control of a plurality of instrumentalities in accordance with a predetermined cycle, the combination of a program clock adapted to make successive energizations of a single signal circuit at predetermined adjustable time intervals, a transfer switch connected in said signal circuit for receiving said energizations and adjustably connected to said instrumentalities for energizing them in accordance with a predetermined sequence, whereby the combination of the program clock and the transfer switch determines the order in which the instrumentalities operate and the times at which they operate and means including a limit switch operative in response to each energization of the signal circuit and a manually controlled switch for energizing said signal circuit and said transfer switch independently of said program clock.

6. A transfer switch adapted to receive impulses from a signal circuit and in response thereto to energize a plurality of instrumentalities successively in accordance with a predetermined sequence comprising a plurality of contacts each connected to an instrumentality circuit, a conductor in the signal circuit engaging one of said contacts, means responsive to such engagement for energizing an instrumentality with an independent circuit, and means including a limit switch responsive to such energization for engaging said conductor with the next succeeding contact for energization of the instrumentality connected thereto responsive to the next succeeding impulse in the signal circuit.

7. A transfer switch adapted to receive impulses at predetermined time intervals from a signal circuit and in response thereto to energize a plurality of instrumentalities successively in accordance with a predetermined sequence comprising a plurality of fixed contacts each con-

nected to an instrumentality circuit, a conductor in the signal circuit and movable into successive engagement with each of said contacts, means responsive to each such engagement for energizing with an independent circuit the instrumentality connected to the engaged contact, and means including a limit switch responsive to each such energization for moving the conductor into engagement with the next succeeding contact for energization of the instrumentality connected thereto upon reception by the transfer switch of the next succeeding impulse.

8. A transfer switch comprising a plurality of contacts each connected to an instrumentality to be energized, a conductor element movable successively into engagement with each of said contacts to complete independent circuits to said instrumentalities, and means including a limit switch actuated upon energization of said transfer switch for driving said conductor element to stop in engagement with the next succeeding contact of the plurality in response to completion of an independent circuit on each of said engaged contacts.

9. A transfer switch comprising a plurality of contacts each connected to an instrumentality to be energized, a conductor movable successively into engagement with said contacts, a motor for driving said conductor, a double throw switch connected to said motor, and means cooperating with said conductor and movable therewith for energizing said motor through certain of the points of the double throw switch when the conductor is engaged with a contact and for thereafter, during further movement of the conductor, energizing the motor from an independent source through others of said points and operative when the conductor engages the next succeeding contact to stop the motor and thereby stop the conductor on said last named contact.

10. A transfer switch comprising a plurality of contacts each connected to an instrumentality to be energized, a conductor movable successively into engagement with said contacts, a motor for driving said conductor, limit switch means for energizing said motor through a circuit including the conductor and a contact engaged thereby and adapted to be actuated to energize said motor from an independent source, and means movable with the conductor for actuating said switch means responsive to movement of the conductor from an engaged contact.

11. A transfer switch as claimed in claim 10, in which the contacts are arranged in circular pattern and the conductor is an arm mounted for rotation about the center of said circular pattern.

12. A transfer switch as claimed in claim 10, in which the contacts are arranged in circular pattern, and which includes a contact disc mounted for rotation about an axis at the center of said circular pattern and supporting the conductor on one radius and having elements adjustable on other radii for actuating said switch means.

13. A transfer switch as claimed in claim 10, in which the contacts are arranged in circular pattern, and which includes a contact disc mounted for rotation about an axis at the center of said circular pattern and supporting the conductor on one radius and having its peripheral portion formed to receive in adjustably extended positions a plurality of prong elements on other radii for actuating said switch means.

14. A transfer switch as claimed in claim 10, in which the contacts are arranged in circular pattern on a panel surface, and which includes a contact disc mounted for rotation about an axis at the center of said circular pattern and supporting the conductor and the means for actuating the switch means, in combination with a wheel mounted on the disc diametrically opposite the conductor and bearing on the panel for counteracting thrust of the conductor against the contacts.

15. In an electrical system for control of a plurality of instrumentalities in accordance with a predetermined cycle, the combination of a program clock and a cam operated switch for energizing a signal circuit at predetermined time intervals, a transfer switch in said signal circuit connected to one of said instrumentalities for energizing the same in response to energization of said signal circuit by said clock and said cam operated switch, and means including a limit switch connected with the transfer switch and operative in response to each energization of the signal circuit for shifting connection of the transfer switch to the next instrumentality in the cycle for subsequent energization thereof in response to the next energization of the signal circuit.

16. The combination claimed in claim 15 including a manually operated switch for energizing said signal circuit and said transfer switch independently of said program clock and said cam operated switch.

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