March 19, 1957 R. L. GATES 2,786,153

ROTARY STEP-BY-STEP ACTUATING MECHANISM

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Fig. 1

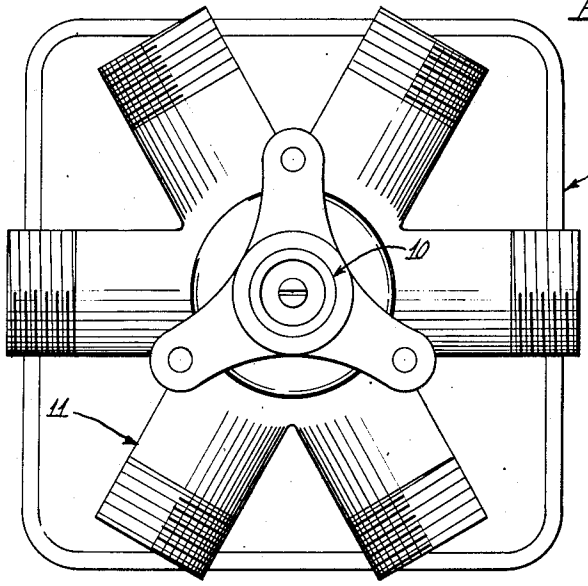
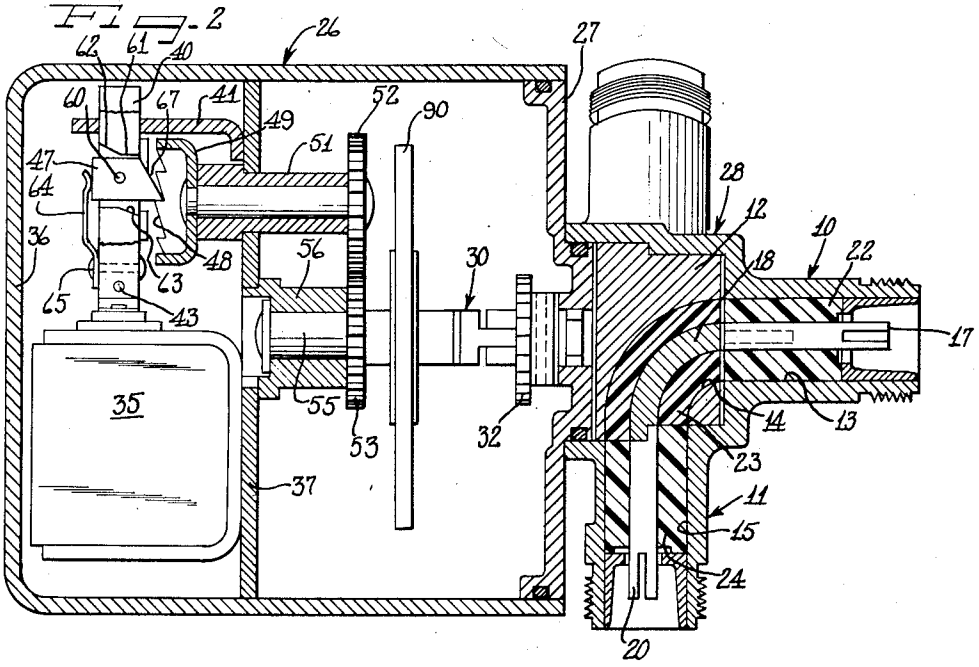


Fig. 2



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Fig. 3

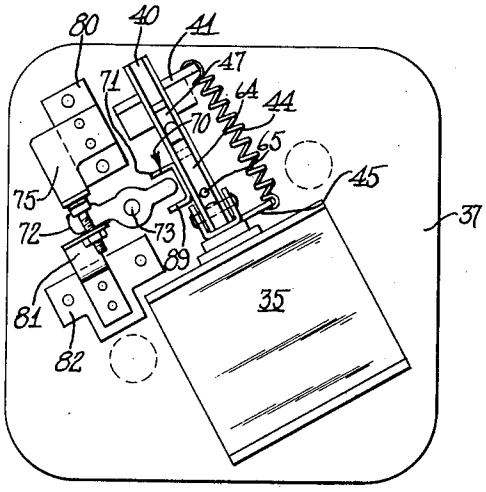


Fig. 4

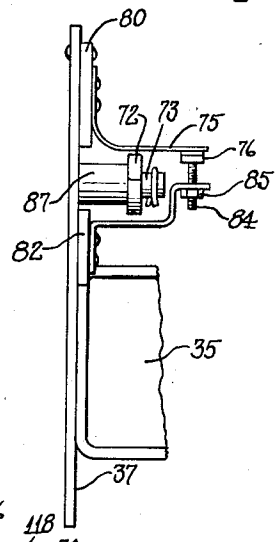


Fig. 5

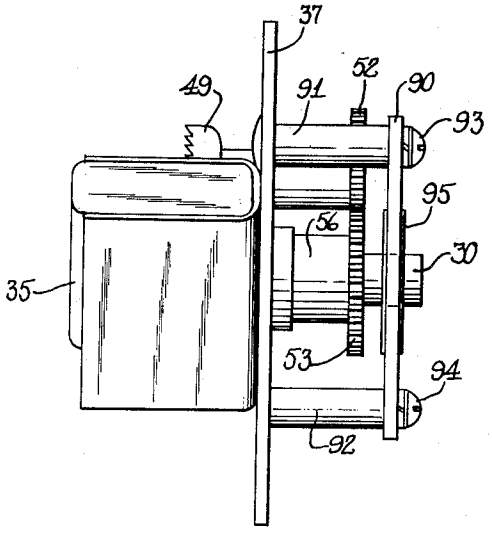
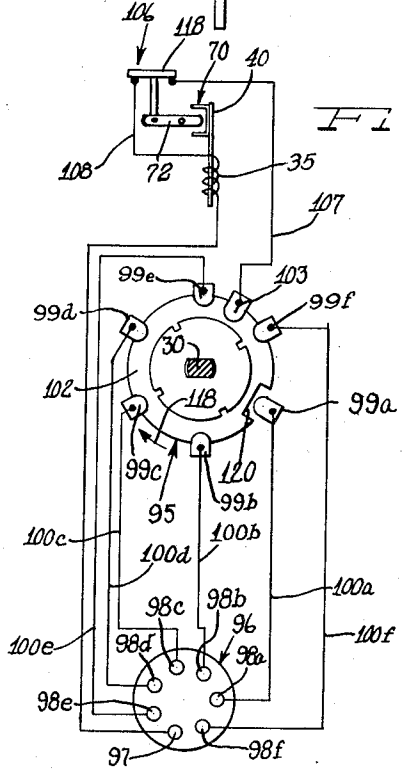


Fig. 6



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2,786,153

ROTARY STEP-BY-STEP ACTUATING MECHANISM

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Application July 30, 1952, Serial No. 301,654

5 Claims. (Cl. 310—23)

This invention relates to a step-by-step actuating mechanism and especially to such an actuating mechanism for a rotary coaxial switch.

Heretofore, an actuating mechanism such as disclosed in the Leland Patent No. 2,430,940, issued November 18, 1947, has been commonly utilized for driving the rotor of a coaxial switch. This mechanism utilizes a cam and groove structure for translating the axial thrust of a solenoid on an armature into a rotary movement of the armature, rotary driving jaws being utilized to transmit the rotary movement of the armature to a rotor shaft for positioning the rotor of the switch.

It is an object of the present invention to provide a novel actuating mechanism wherein a straight non-rotary movement of an armature is translated into a rotary movement of the rotor shaft.

It is a further object of the present invention to provide a novel solenoid and armature step-by-step driving mechanism which is mounted transversely to the rotary drive shaft.

It is a further object of the present invention to provide a novel actuating mechanism including a reciprocating non-rotary armature for driving a shaft which is parallel to but spaced from the central actuating shaft and may thus be connected to the central shaft by any desired gearing.

It is a still further object of the present invention to provide a novel switching arrangement for controlling the step-by-step energization of a reciprocal non-rotary armature.

It is a yet further object of the present invention to provide a novel step-by-step actuating mechanism which is compact and rugged, yet economically manufactured.

Other novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization, manner of construction and method of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a plan view of a coaxial switch with which the actuating mechanism embodying the novel principles and teachings of the present invention may be employed;

Figure 2 is a longitudinal sectional view of the coaxial switch shown in Figure 1, and illustrating an actuating mechanism embodying the novel principles and teachings of the present invention;

Figure 3 is an elevational view of the actuating mechanism shown in Figure 2;

Figure 4 is an oblique elevational view taken along a line parallel with the axis of the armature looking from the left in Figure 3, and illustrating the switching mechanism for controlling the step-by-step actuation of the solenoid;

Figure 5 is an oblique bottom plan view taken at right angles to the armature axis in Figure 3 and viewing the actuating mechanism of Figure 3 from below; and

Figure 6 is a diagrammatic view illustrating the electrical operation of the actuating mechanism.

The actuating mechanism of the present invention is especially adapted for use in a rotary coaxial switch and has been so illustrated in the drawings by way of example and not by way of limitation. In Figures 1 and 2, a coaxial switch is illustrated of the single pole type wherein a coaxial cable connected to a central terminal 10 is selectively connected with one of a plurality of branch terminals such as 11 by means of a rotor 12. As shown in Figure 2, when the rotor is registered with the branch terminal 11, continuity of the outer conductor of a cable connecting with the main terminal 10 with the outer conductor of a cable connected to terminal 11 is established by means of the interior wall 13 of the main terminal 10, the interior wall 14 of the elbow rotor passage and the interior wall 15 of the branch terminal 11. Continuity of the inner conductor is established through the inner conductor 17 of the main terminal 10, rotor elbow conductor 18, and inner conductor 20 of the branch terminal 11. These inner conductor members are mounted coaxially with the interior walls by means of insulating sleeves 22, 23 and 24.

It will thus be understood that in order to selectively connect a coaxial cable, connected to the main terminal 10, with a cable connected to one of the branch terminals, the rotor 12 must be rotated on its axis which coincides with the axis of the main terminal 10, until the inner conductor elbow 18 registers with the inner conductor of the selected branch terminal. The actuating assembly of the present invention is especially adapted to this selective positioning of the switch rotor. As shown in Figures 1 and 2, the actuating mechanism is mounted in a square cup-shaped housing 26 having at its open end a closure plate 27 which in turn centrally mounts the coaxial switch housing 28. The rotor shaft 30 projects centrally through the closure plate 27 and is provided with a detent means for accurately positioning the rotor in each of its selected switching positions. This detent means may include a detent wheel indicated at 32, which may be a toothed gear having twelve teeth so as to define twelve positions of the shaft 30, six of which correspond to the six branch terminals of the housing 28. Suitable spring-pressed rollers (not shown) may cooperate with the detent wheel 32 for centering the shaft in each switching position.

For driving the rotor shaft 30, which may be termed the switch actuating shaft, a solenoid 35 is mounted within the housing 26 on a mounting plate 37 which extends transversely and in spaced relation to the end wall 36 of the housing. The solenoid 35 has an armature 40 operatively associated therewith and guided for axial reciprocation transversely to the rotor shaft by means of a bracket 41 secured to the mounting plate 37. As indicated in Figure 3, a spring 44 is connected between the bracket 41 and a flange 45 on the armature 40 for normally urging the armature upwardly away from the solenoid 35 to the position shown in Figure 2. In this position, a pawl 47 operatively engages a tooth 48 of a drive wheel 49. Thus, when the solenoid 35 is energized, the armature 40 is pulled downwardly against the action of the spring 44, and the pawl 47 is operative to turn the drive wheel 49 through a predetermined arc. This arcuate movement is transmitted by means of the shaft 51 extending through the mounting plate 37 to a gear 52 which is in mesh with a gear 53 affixed to the rotor shaft 30. As indicated in Figure 2, the end portion 55 of the rotor shaft 30 is supported by means of a hub member 56 which in turn is mounted by means of the mounting plate 37. It will be understood that the drive member 49 may have twelve teeth to correspond with the detent member 32 so that each arcuate movement of the drive

member 49 will shift the detent means correspondingly by one tooth.

Upon deenergization of the solenoid 35, the spring 44 is operative to raise the armature 40 away from the solenoid 35, the pawl means 47 pivoting on its mounting pin 60 to ride over the next succeeding tooth of the drive wheel 49 to reassume the position shown in Figure 2. It will be seen that the pawl 47 is mounted in a recess in the armature 40 and that the armature provides a wall 61 preventing counter-clockwise rotation of the pawl during the driving stroke of the armature 40 as well as walls 62 and 63 limiting clockwise rotation of the pawl during the return stroke. A leaf spring 64 is fixed to the armature 40 by means of a pin 65 and bears on one end of the pawl to tend to pivot it counter-clockwise into its operative position. The opposite operative end of the pawl is provided with a sloping face 67 which is adapted to ride over the trailing edges of the teeth 48 of the drive wheel 49 during the return stroke of the armature 40, the sloping face 67 accommodating pivoting of the pawl against the action of the leaf spring 64 out of engagement with the drive wheel teeth.

For deenergizing the solenoid after each driving stroke thereof so as to enable the solenoid to drive the rotor to any selected position, the armature 40 is provided with a U-shaped bracket 70 having an upper leg 71 for engaging a switch actuating pivot arm 72 at the end of the driving stroke of the armature. As indicated in Figures 3 and 4, pivotal movement of the arm 72 about its mounting pin 73 separates a spring contact arm 75 from fixed contact 76 to open the energizing circuit for the solenoid. As illustrated in Figure 3, the contact assembly is mounted alongside the armature 40 on the mounting plate 37. The spring contact arm 75 is mounted by means of a base plate 80 and the contact 76 is carried by a bracket 81 mounted by means of a base plate 82 to the mounting plate 37. The contact 76 is adjustable by means of screw 84 and nut 85. A spacer sleeve 87 mounts the pivot arm 72 in spaced relation to the mounting plate 37 so as to properly engage spring arm 75.

The lower leg 89 of the U bracket 70 may serve to insure pivoting of the arm 72 into its switch closed position upon deenergization of the solenoid. It will thus be apparent that the solenoid will be successively energized and deenergized to actuate the drive wheel 49 and the rotor shaft in a step-by-step fashion.

As illustrated in Figure 5, a wafer switch 90 is mounted in spaced relation to the mounting plate 37 on the side thereof away from the end wall 36 by means of spacer sleeves 91 and 92 and bolts 93 and 94. The rotor 95 of the wafer switch 90 is fixed to the shaft 30 by means of a rectangular slot therein receiving a flat portion of the shaft 30, as indicated diagrammatically in Figure 6. The function of the wafer switch which is diagrammatically illustrated at 95 in Figure 6 will now be readily understood by reference to that figure. A terminal plate 96 has a plurality of positions including common position 97 and positions 98*a*, 98*b*, 98*c*, 98*d*, 98*e*, and 98*f* corresponding to the six switching positions of rotor 12 of the coaxial switch. Stationary contacts 99*a*—*f*, are peripherally spaced about the rotor 95 and correspond in relative positions to the switching positions of the rotor. The contacts 99*a*—*f* are connected respectively with positions 98*a*—*f* of the terminal plate 96 by means of conductors 100*a*—*f*. Thus if it is desired to index the rotor to the position corresponding to 99*f*, supply voltage is applied between common position 97 and position 98*f*. The solenoid represented at 35, then has an energizing circuit extending from 98*f*, through conductor 100*f*, contact 99*f*, rotor annular conducting portion 102, contact 103, conductor 107, switch 106 meant to represent the control switch assembly for the solenoid including contact arm 75 and contact 76, and conductor 108 to common position 97. When the solenoid 35 is energized, it will be seen that the armature 40 is pulled downwardly against the action of spring 44, Figure 3. Toward the end of the stroke of the solenoid 35, the U bracket 70 engages the arm 72 to raise contact member 118 of switch 106 (corresponding to the movement of spring arm 75 away from contact 76 in Figures 3 and 4) to open the switch and deenergize the solenoid. Energization and deenergization of the solenoid 35 continues, the shaft 30 and wafer switch rotor 95 moving step-by-step in a clockwise direction as indicated by arrow 118, until the slot 120 in the conducting rotor portion 102 reaches the contact 99*f*, at which time the energizing circuit is opened and the step-by-step actuation ceases. For six branch terminals such as shown, the selection of any switching position is analogous to that just described and need not be specifically described.

The operation of the actuating mechanism will now be readily understood. When a position on terminal plate 96 is selected, the solenoid is energized to retract the armature 40 against the action of the spring 44, the bracket 70 pivoting arm 72 at the end of the stroke to open contacts 75, 76 in the actuating circuit for the solenoid. The solenoid is thereby deenergized, and the spring 44 is then operative to withdraw the armature from the solenoid, thus releasing pivot arm 72 and allowing contacts 75, 76 to close to allow the solenoid to be energized and the cycle to be repeated. During the reciprocation of the armature 40, the pawl 47 is operative to engage successive teeth 48 of the drive wheel 49 and to move them downwardly on the driving stroke of the armature, the pawl 47 pivoting out of engagement with the drive wheel 49 against the action of the leaf spring 64 during the return stroke of the armature under the action of the spring 44.

While I have shown a particular embodiment of my invention, it will, of course, be understood that I do not wish to be limited thereto, since many modifications may be made, and I, therefore, contemplate by the appended claims to cover all such modifications as fall within the spirit and scope of my invention.

I claim as my invention:

1. A coaxial switch construction comprising a housing having a side wall and opposite end walls, rotor shaft means extending centrally through one end wall and axially within said housing, a mounting plate disposed transversely in said housing intermediate the end walls thereof and having a central journal for one end of said rotor shaft means, a solenoid mounted on the side of said plate between said plate and the other end wall of said housing and having armature means disposed for reciprocation generally parallel to said mounting plate, bracket means carried by said plate for guiding the free end of said armature means, drive shaft means journaled in said plate and extending in spaced parallel relation to said rotor shaft means, a control assembly carried by said mounting plate and said armature means having switch means for deenergizing said solenoid at the end of each stroke of said armature means, means carried by said armature means and said drive shaft means for converting the reciprocation of the armature means into rotary movement of said drive shaft means, means carried by said drive shaft means and said rotary shaft means for driving said rotor shaft means from said drive shaft means, indexing switch means having a rotor carried by said rotor shaft means and a stator mounted by said mounting plate in spaced relation thereto, and selector means for connecting said control assembly switch means in circuit with the respective terminals of the indexing switch for actuating said rotor shaft means step-by-step to selected angular positions.

2. A switch construction comprising a cup-shaped housing having a closed end and side walls, a partition plate of configuration conforming to the cross section of said housing and disposed therein in spaced parallel relation to said closed end wall, a solenoid disposed between said closed end wall and said partition plate and

secured to said partition plate, said solenoid having armature means disposed for reciprocation generally parallel to said partition plate, a pawl carried on said armature means, a drive wheel journaled in said partition plate and disposed in operative relation to said pawl for actuation thereby upon successive actuations of said armature means by said solenoid, a drive gear mounted coaxially of said drive wheel and connected for rotation therewith, and rotor shaft means journaled at one end in said partition plate and extending centrally and axially of said cup-shaped housing toward the open end thereof, said rotor shaft means having gear means thereon driven by said drive gear for incremental rotation of said rotor shaft means upon each actuation of said solenoid.

3. A switch construction comprising a cup-shaped housing having a closed end wall and rectangularly related side walls defining a generally rectangular interior space, a partition plate of rectangular configuration conforming to the cross section of said housing and disposed therein in spaced parallel relation to said closed end wall, a solenoid secured to said partition plate and disposed between the plate and said closed end wall of said housing, said solenoid having armature means disposed obliquely to said partition plate for reciprocation generally parallel to the plane of said plate, drive shaft means extending through said plate and generally axially of said housing, means carried by said armature and said drive shaft means and disposed between said closed end wall and said partition plate for converting the reciprocation of the armature means into rotary movement of said drive shaft means, rotor shaft means journaled at one end by said partition plate and extending centrally and axially of said cup-shaped housing toward the open end thereof, and means carried by said drive shaft means and said rotor shaft means for driving said rotor shaft means from said drive shaft means.

4. An actuating unit for a coaxial switch comprising a mounting plate, a solenoid mounted on one side of said mounting plate and having an armature for reciprocation generally parallel to the plane of said plate, a pawl carried on said armature, a drive wheel journaled in said mounting plate and disposed on the same side of said plate as said armature and in operative relation to said pawl for progressive actuation by said pawl upon successive actuations of said armature by said solenoid, a

drive gear mounted coaxially of said drive wheel and on the opposite side of said plate therefrom and connected for rotation therewith, rotor shaft means journalled at one end by said mounting plate and extending centrally and axially therefrom and away from said solenoid, said rotor shaft means having gear means thereon driven by said drive gear for incremental rotation of said rotor shaft means by each successive actuation of said solenoid.

5. An actuating unit for a coaxial switch comprising a mounting plate, a solenoid mounted on one side of said mounting plate and having an armature for reciprocation generally parallel to the plane of said plate, a pawl carried on said armature, a drive wheel journaled in said mounting plate and disposed on the same side of said plate as said armature and in operative relation to said pawl for progressive actuation by said pawl upon successive actuations of said armature by said solenoid, a drive gear mounted coaxially of said drive wheel and on the opposite side of said plate therefrom and connected for rotation therewith, rotor shaft means journalled at one end by said mounting plate and extending centrally and axially therefrom and away from said solenoid, said rotor shaft means having gear means thereon driven by said drive gear for incremental rotation of said rotor shaft means by each successive actuation of said solenoid, indexing switch means having a rotor carried on said rotor shaft means and having a stator secured to said mounting plate to provide a unitary sub-assembly for insertion in a cup-shaped housing of cross section corresponding to the cross section of said mounting plate.

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