

[54] **WATTHOUR METER INDICATOR
WITH IMPROVED CAM AND
MICROSWITCH OPERATOR
STRUCTURE**

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200/56 A, 61.83, 153 T**

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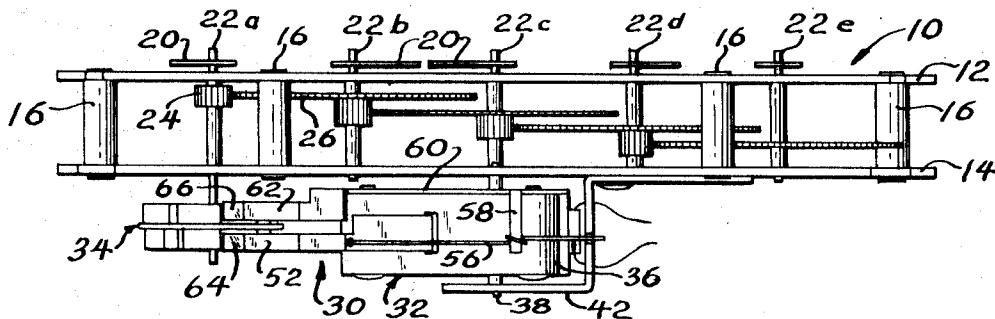
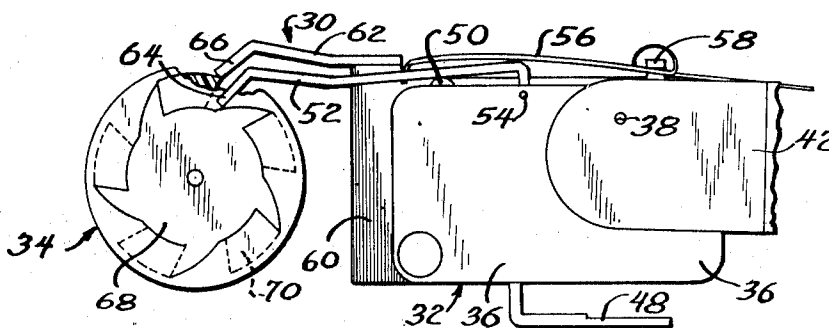
Primary Examiner—J. R. Scott

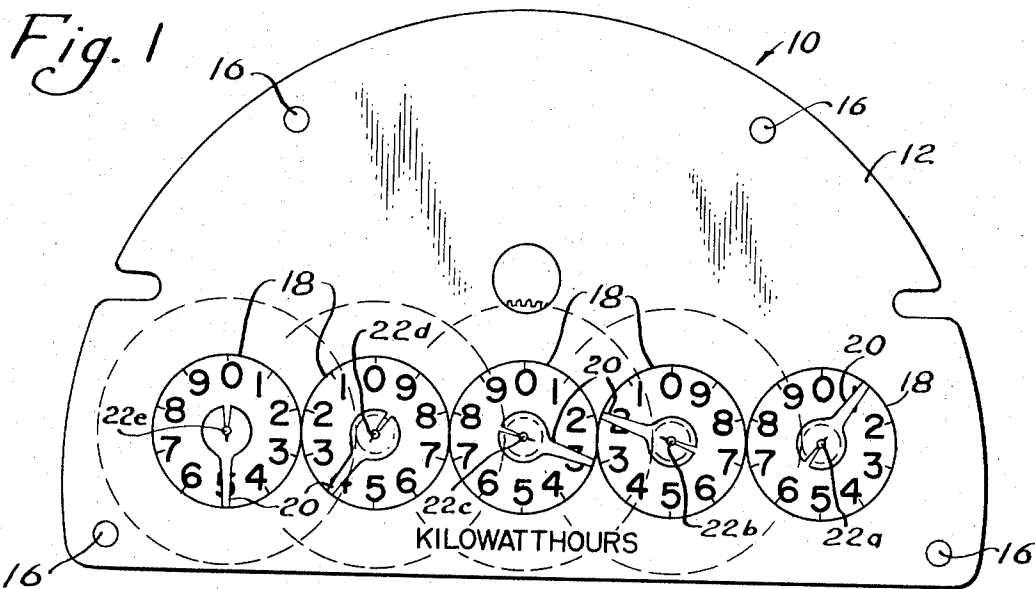
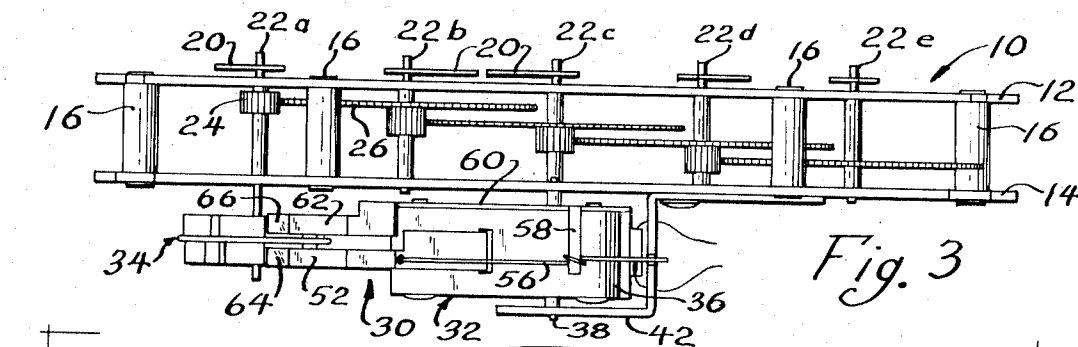
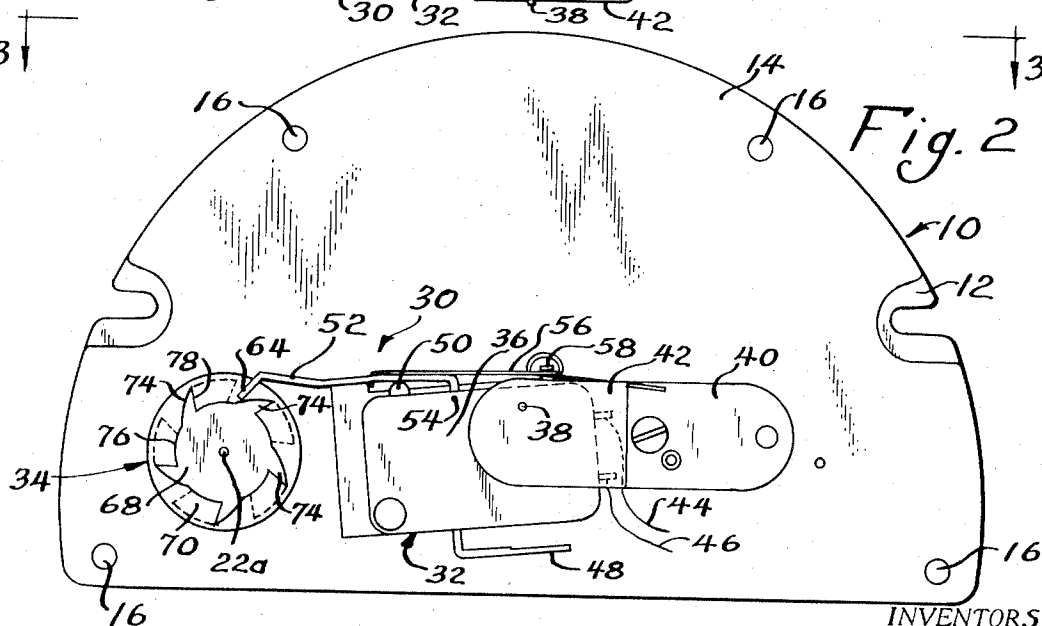
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[57] **ABSTRACT**

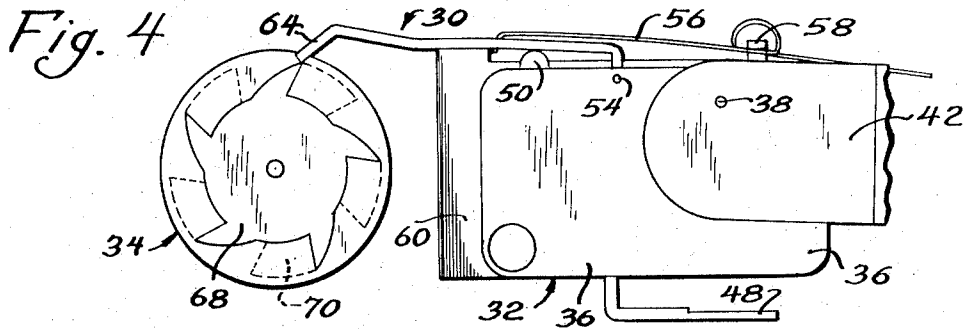
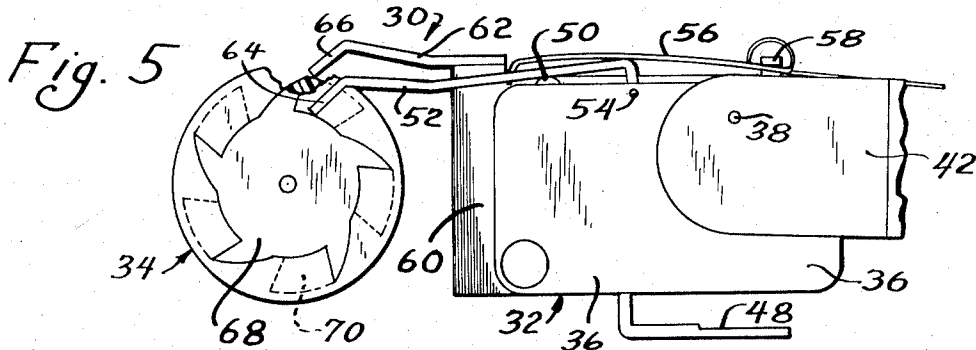
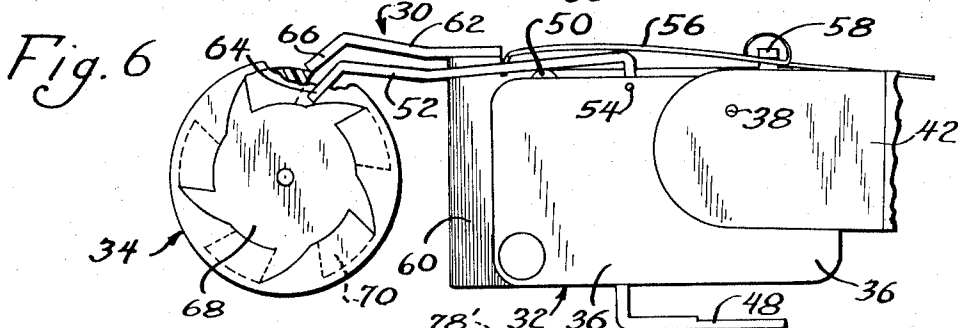
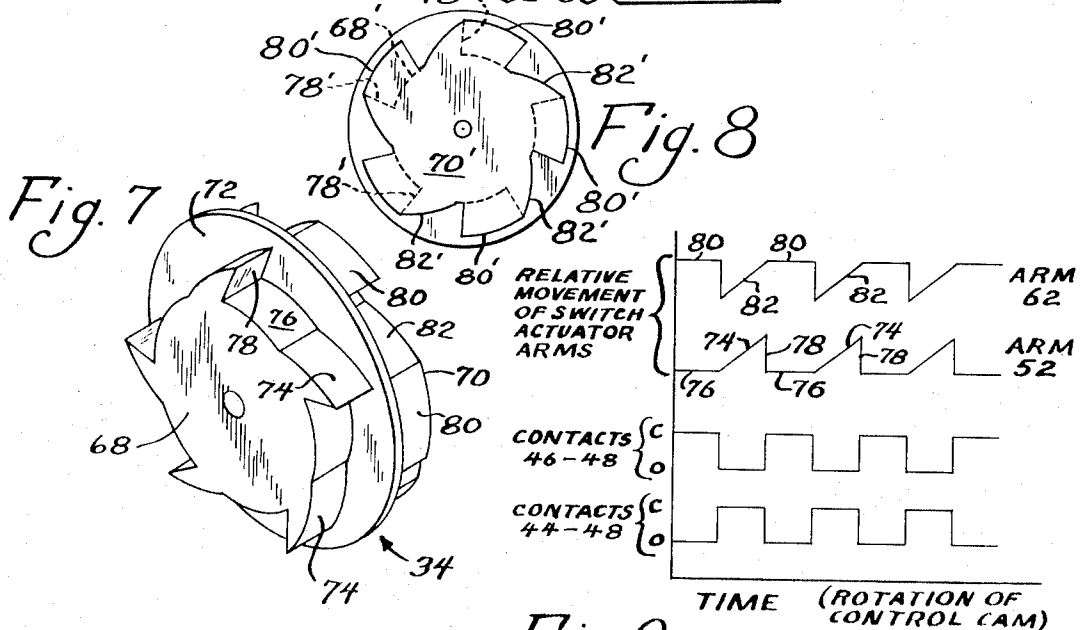
An arrangement for effecting snap-action transfer of a switch between first and second switch conditions in response to movement of a slowly rotating control cam. The switch has a pair of actuating arms secured thereto one of which is movable to effect snap-action transfer of the switch from a first to a second switch condition in response to movement of the control cam, the other of arms being movable to effect snap-action transfer of the switch from the second back to the first switch condition in response to further movement of the control cam.

12 Claims, 9 Drawing Figures





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WATTHOUR METER INDICATOR WITH IMPROVED CAM AND MICROSWITCH OPERATOR STRUCTURE

BACKGROUND OF THE INVENTION

The present invention relates generally to switch actuating arrangements, and more particularly to novel means for effecting snap-action transfer of a switch between first and second switching conditions in response to a slowly moving operating control member.

It is a conventional practice to actuate switch devices between first and second switch contact conditions by means of an operating cam which is rotatably driven and operatively connected to a switch contact arm movable to establish connection of a switch contact with either of two fixed switch contacts each of which may be connected in a separate electrical circuit. Generally in this type of switch actuating arrangement, the switch body is fixedly supported and an actuator arm is moved by an operating control cam to establish a snap-action transfer of the switch when transferring from a first to a second switch condition, but establishes a slow or gradual transfer when transferring back to the initial switch condition. In applications wherein the operating cam is rotated at an extremely slow rotational speed, switching function reliability is substantially reduced. The known methods of switch actuation employing slowly rotating control cams effect snap-action movement of the switch actuators when an actuator reaches a raised lobe on its associated cam and rapidly "drops off" into a valley or recess in the cam contour. As the actuator is subsequently raised by engagement with the upwardly inclined slope of a cam lobe to transfer the switch to another switch condition, chatter occurs at the interface of the movable switch contact arm and the fixed switch contact which causes arcing between and deterioration of the contact surfaces. This phenomenon substantially reduces the life of the switch and greatly lessens its reliability and efficiency. It is pointed out that the operation of mechanical counters on utility meter registers is characterized by slow speed rotation of associated indicator shafts. Recent advances in meter register reading systems have provided means for translating indicator shaft rotation into pulse signals which are selectively transmitted to a remote monitoring or reading station to enable remote reading of utility power meters. An example of such a system may be found in the co-pending application of James N. Bruner, Ser. No. 53,745, filed July 10, 1970, and assigned to the assignee of the present invention. The referenced system utilizes an encoder with each on-site power meter for converting indicator shaft position into data pulse signals. The data pulse signals represent power meter registrations and are stored as meter reading data. The data is then read-out at selective intervals in response to read-out or interrogate signals from the remote reading station.

The present invention provides an improved actuating arrangement which may serve as an encoder in the above-referenced system of co-pending application, Ser. No. 53,745, and which provides distinct pulse signals representing power meter registrations irrespective of the rotational speed of the indicator shaft.

SUMMARY OF THE INVENTION

In accordance with one embodiment of our invention, we employ a transfer switch in combination with a recording or indicator shaft of a watthour power meter. The transfer switch serves as an encoder for converting indicator shaft position into data pulse signals which represent power meter registrations and are stored as meter reading data readable by a remote reading station. The switch establishes first and second switch conditions, and includes a switch body having a first actuator arm member pivotally mounted thereon and biased to a position establishing one of the switch conditions. A second actuator arm is fixedly secured to the switch body and is pivotal to effect pivotal movement of the switch body. An operating control cam having dual cam contours is secured to a recording shaft of the watthour meter for rotation therewith, each of the cam contours engaging an outer end portion of one of the first and second actuator arm members. The peripheral contours of the cam surfaces effect movement of the associated switch actuator members during rotation of the cam to establish a first switch condition, thereafter establish a second switch condition through snap-action of one of the actuator arm members, and thereafter re-establish the first switch condition through snap-action movement of the other actuator arm member. The sequential snap-action transfer of the switch between its first and second switch conditions is independent of the rotational speed of the control cam, the control cam being adapted to transfer the switch at predetermined rotational advances of the power meter recording shaft.

Further objects and advantages of the present invention, together with the organization and manner of operation thereof, will become apparent from the following detailed description of a preferred embodiment of the invention, when taken in conjunction with the accompanying drawings wherein like reference numerals designate like elements throughout the several views.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front elevational view of a portion of a watthour meter showing a plurality of register scales and associated indicator pointers supported forwardly of a front register plate;

FIG. 2 is a rear elevational view of the portion of the watthour meter illustrated in FIG. 1 and showing a cam-operated switch device in accordance with the present invention supported on the rear register plate;

FIG. 3 is a plan view taken substantially along the line 3-3 of FIG. 2 looking in the direction of the arrows;

FIGS. 4-6 are enlarged detail elevational views of the cam-operated switching device of FIG. 2, showing the switch actuating arms in various operative positions during rotation of the control cam;

FIG. 7 is a detail perspective view of the operating control cam shown in FIGS. 2-6;

FIG. 8 is a detail elevational view of an alternative embodiment of the operating control cam; and

FIG. 9 graphically illustrates movement of the switch actuator arms and the electrical paths completed by the switch contacts in relation to rotational position of the control cam.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to the drawings, and in particular to FIGS. 1-3, the present invention is illustrated, by way of example, in combination with a watthour meter register, a portion of which is indicated generally at 10. The watthour meter register 10 is of known design and operation and includes front and rear parallel register plates 12 and 14 supported in generally fixed spaced relation by spacer pins 16. The front register plate 12 includes a plurality of circular register scales 18 thereon each of which has associated therewith an indicator pointer 20 mounted on a corresponding register shaft 22a-22e for rotation therewith. Each of the circular register indicators 18 has a plurality of digits from "0" to "9" disposed in circumferential spaced relation thereabout, it being understood that the digits are positioned to indicate increasing magnitude of measurement as the associated indicator pointer 20 is rotated through one revolution upon its associated register shaft 22.

Each of the register shafts 22a-22e is connected to the register shaft of the next higher order register indicator through a gear train, such as pinion gear 24 on the register shaft 22a which engages a spur gear 26 secured on the register shaft 22b, so that the register shaft 22e of the highest order register is interconnected to the register shaft 22a. In this fashion, driving rotation of the register shaft 22a will effect rotation of the remaining register shafts in accordance with the speed ratios established by the respective pairs of pinion and spur gears interconnecting adjacent register shafts as is known. The right-hand register shaft 22a, as considered in FIG. 1, is connected to means which effects rotational movement of the register shaft 22a in accordance with electrical energy being metered, the register scale 18 associated with the register shaft 22a indicating the basic unit of measure, such as a kilowatt hour, for each movement of the indicator pointer to its next higher digit. The remaining indicator registers 18 indicate predetermined multiples of the basic unit measured.

The portion of the watthour 10 thus far described is generally known and widely used in electrical energy measuring systems. Recent advances in meter register systems, such as disclosed in the above referenced copending application of James N. Bruner, Ser. No. 53,745, employ remote read-out stations which send interrogate signals to the on-site power meters of measuring instruments, such as the watthour meter 10. Encoder means are provided at the on-site meters to provide distinct data pulse signals representing power meter registrations. The data pulse signals are stored as meter reading data and may be "read-out" in response to the interrogate signals from the remote station.

The present invention is directed to a switch actuating arrangement for effecting snap-action transfer of a switch device between switch conditions so as to establish, when employed as an encoder on watthour power meters, data pulse signals representing units of power measured by the meter.

With reference to FIGS. 2 and 3, taken in conjunction with FIGS. 4-6, the switch actuating arrangement in accordance with the present invention is indicated generally at 30 and includes switch means, indicated generally at 32, and operating control cam means, indicated generally at 34. The switch means 32 includes a

switch body 36 of generally rectangular configuration. The switch body 36 is pivotally supported on the rear register mounting plate 14 for a pivotal movement about a pivot axis 38. The pivot axis 38 is defined by a pivot pin which may comprise a through-pin or pair of axially aligned pivot pins secured to opposite side surfaces of the switch body, the ends of the pivot pin 38 being received in suitably aligned apertures in the register plate 14 and a support bracket 40 having an arm portion 42 spaced outwardly from and parallel to the register plate 14. The pivot axis 38 is offset from the center of gravity of the switch housing 36 so that the switch means 32 is normally urged by gravity in a counterclockwise direction about the pivot axis 38, as considered in FIG. 2.

The switch means 32 may comprise a single pole, double throw switch and includes a pair of spaced fixed switch contacts and a switch contact arm (not shown) movable to contact either of the fixed contacts within the switch body 36. The switch means 32 has electrical leads 44 and 46 from the fixed contacts and an external common lead 48 which may be connected, for example, to the contacts 206, 208 and the ground of the encoder 46 of the system disclosed in the referenced copending application of James N. Bruner, Ser. No. 53,745, filed July 10, 1970. The movable switch arm of the switch means 32 has a non-conducting actuating member 50 supported for vertical movement within the housing body 36, the lower end of the actuating member 50 serving to effect movement of the movable switch arm to transfer the switch arm between the switch fixed contacts within the switch body. Means (not shown) are cooperative with the movable switch arm of the switch 32 to bias it to a position wherein the actuating member 50 is urged outwardly from the switch housing 36.

The switch means 32 has a first actuator arm 52 pivotally supported on the switch body 36 as through a pivot pin 54 secured in the switch housing and pivotally supporting the inner end of the first actuator arm. The actuator arm 52 is positioned to overlie the upper outer end of the actuating member 50 and is biased downwardly by a spring wire member 56 to normally depress the actuating member 50. The spring wire 56 has one end bent downwardly through an opening in the actuator arm 52 and its opposite end engaging an upper edge surface of the bracket 40, the intermediate portion of the spring wire being looped about an outwardly directed support arm 58 affixed to or formed integral with a side plate 60 secured to the inner side surface of the switch body 36.

The switch means 32 includes a second actuator arm 62 preferably formed integral with the side plate 60 so as to be affixed to the switch body 36 and pivotally movable therewith about the pivot axis 38. The outer ends of the first and second actuator arms 52 and 62, respectively, depend downwardly at 64 and 66, respectively, and serve as cam followers for engagement with the operating control cam means 34.

The operating control cam means 34 is secured to an end of the first register shaft 22a adjacent the outer surface of the rearward register plate 14 and includes a pair of axially aligned cam portions 68 and 70 separated by a generally disc shaped divider portion 72. The cam portion 68 includes a plurality of raised lobes 74, there being five equidistantly circumferentially

spaced lobes 74 shown. The upper surface of each lobe 74, considered in a clockwise direction about the cam axis, rises from a surface portion 76 concentric with the axis of rotation of the cam and terminates in a negative angle "drop-off" surface 78 which intersects the next succeeding surface portion 76, the negative angle of each drop-off surface 78 being considered relative to a radius drawn from the axis of the cam and passing through the upper horizontal edge of the associated lobe 74. In this manner, it can be seen that counter-clockwise rotation of the cam means, considered in FIGS. 2-6, will cause the follower portion 64 of the first actuator arm 52 to rise upwardly on the rising surface of a lobe 74 and drop off the uppermost radial height of the lobe and fall to the next surface portion 76, this cycle being effected five times for each revolution of the cam means 34.

The cam portion 70 includes five raised lobe portions 80 which have rising slope surfaces 82 identical to and in axial alignment with the rising slopes of the cam lobes 74. The rising slope surfaces 82 of the lobes 80 terminate in dwell surfaces which are concentric with the axis of the cam 70 to maintain the associated cam follower 66 of the second actuator arm 62 in its maximum raised position for a predetermined dwell period, after which the cam follower 66 "drops off" the lobe 80 to thereafter begin a subsequent rise on the next cam lobe surface 82. In this manner, it can be seen that upon driving counter-clockwise rotational movement of the cam means 34, considered in FIG. 4, as a result of rotational movement of the units register shaft 22a, both the first and second actuator arms 52 and 62 will be raised simultaneously on their associated cam lobes 78 and 80 until both of the actuator arms reach the position of maximum vertical lift. During such simultaneous movement of both of the actuator arms to maximum raised positions, the actuator member 50 remains in its outward position.

Continued rotational movement of the control cam 34 causes the first actuator arm 52 to drop off the peak of the corresponding lobe 74 and fall to the adjacent surface portion 76, while the second actuator arm 62 is maintained in its raised position through engagement with the outer dwell surface portion of its associated cam contour, as shown in FIGS. 5 and 6. Dropping of the first actuator arm 52 is assisted by the bias force of the spring 56 and serves to depress the switch actuator member 50 which transfers the internal switch contact arm (not shown) to the other of the two fixed switch contacts resulting in a snap-action movement of the switch to a second switch condition. Still further rotational movement of the cam means 34, irrespective of the rotational speed thereof, causes the second actuator arm 62 to drop off the dwell surface of its associated cam lobe 80, due to the weight of the switch body 36, onto the base of the upwardly inclined surface 82 of the next upcoming cam lobe, as in FIG. 2. At this point, the first and second actuator arms are positioned at the same radial distance from the axis of the control cam means 34. Downward movement of the second actuator arm 62 and the switch body 34 from the dwell surface of a cam lobe 80 effectively raises the first actuator arm 52 relative to the switch body and allows outward movement of the switch actuator member 50 to effect a snap-action return transfer of the switch to its

initial switch condition. The first and second actuator arms 52 and 62, respectively, are thus simultaneously raised to maximum lift positions on their respective cams 68 and 70 and thereafter sequentially moved to effect snap-action transfer of the switch means 34 between its first and second switch conditions. The "drop off" points of the respective cams 68 and 70 are selected such that snap-action movement of the actuator arms 52 and 62 is effected in alternating order as the register indicator 20 on the units register shaft 22 reaches each succeeding higher measured unit of energy. In this fashion, a distinct snap-action movement of the switch contact arm is effected between both of the fixed switch contacts without gradual separation of the switch contacts which would result in arcing and deterioration of the switch contacts.

FIG. 8 illustrates an alternative cam operating control member, indicated generally at 86, which is generally similar to the operating control cam means 34. The operating control cam 86 is adapted to effect a reversal in the sequential movement of the actuator arms 52 and 62 when the cam means 86 is used in conjunction with the above described switch means 32. The cam means 86 includes cam portions 68' and 70' which are axially separated by a disc-like divider 72' formed integral with the cams 68' and 70'. The "drop off" surfaces associated with each of the lobes 80' on the cam 70' are more greatly relieved in a negative direction, considered relative to a radius from the axis of rotation of the control cam through a drop off point on a cam lobe, than the drop off surfaces 78 on the cam 68. When using the operating control cam 86 in the switch actuating arrangement 30, it will be seen that the sequence of snap-action movement of the actuator arms 52 and 62 will be reversed from the sequence of movement described above with respect to the operating control cam means 34.

FIG. 9 illustrates graphically relative movement of the actuator arms 52 and 62 during rotational movement of the control cam 34. FIG. 9 also illustrates graphically the electrical paths completed by the switch contacts during rotational movement of the control cam, the ordinate axis of the paths indicating open (O) and closed (C) switch contact conditions. Relative movement of the actuator arm 52 is shown during engagement of the outer end portion 64 thereof with the surfaces 74 and 76 of the cam portion 68, and at the point of drop-off surface 78. Relative movement of the actuator arm 62 is shown as its outer end portion 66 engages the cam surfaces 80 and 82 of its control cam portion 70, with drop-off of the actuator arm 62 being effected following engagement with the cam surface 80. It can be seen that when the actuator arm 52 "drops off" at the drop-off surface 78 of the control cam portion 60, the electrical path is closed over conductor contacts 46-48 and remains closed until the actuator arm 62 "drops off" its cam surface 80. As the actuator arm 62 drops off its cam surface 80, the electrical path over the conductor contacts 44-48 is closed and remains closed until the actuator arm 52 drops off the next consecutive drop-off surface 78 reached on its cam portion. The control cam means 34 herein described effects alternate closing of the electrical paths over the conductor contacts 44-48 and 46-48 five times for each revolution of the control cam

means. Thus, FIG. 9 graphically illustrates the snap-action transfer of the switch means 32 between its first and second switch conditions in relation to rotational movement of the control cam means 34.

While the switch means 32 has been described as being pivotally supported by the rear register plate 14 with the actuating arms 52 and 62 effectively being maintained in engagement with their associated operating cams by gravity, it will be understood that the switch means 32 could be readily supported so that the switch actuating arms engage the operating control cam at diametrically opposed positions from those illustrated, it being then necessary that means be provided to urge the spring body to a position wherein the actuating arm 62 is urged against the control cam contour surface. Similarly, while the switch actuating arrangement 30 has been described as being supported on the outer surface of the rear register plate 14, the switch actuating arrangement could also be supported between the register plates 12 and 14.

While preferred embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made therein without departing from the invention and its broad aspects.

We claim:

1. In combination with a meter device having a mounting plate and at least one rotatable recording shaft; at least one switch means transferable between first and second switch contact conditions and including a switch body pivotally supported by the mounting plate, first actuator arm means pivotally supported by said switch body and movable to effect transfer of said switch between its said first and second switch conditions, second actuator arm means fixedly secured to said switch body and movable therewith, and control means rotatably movable with the recording shaft and engaging said first and second actuator arm means to move said actuator arm means to positions establishing said first switch contact condition during rotation of the recording shaft, said control means thereafter effecting a snap-action movement of one of said actuator arm means to transfer the switch to said second switch contact condition during continued rotation of the recording shaft, and said control means thereafter effecting a snap-action movement of the other of said actuator arm means to transfer the switch back to said first contact condition during continued rotation of the recording shaft.

2. The combination of claim 1 including means biasing said first actuating arm means to a position establishing one of said first and second switch conditions.

3. The combination of claim 1 wherein said control means comprises cam means mounted on the recording shaft for rotation therewith, said cam means having actuating lobes engageable with said first and second actuating arm means to effect said snap-action movement of said first and second actuating arm means.

4. The combination of claim 3 wherein said cam means includes a plurality of circumferentially spaced actuating lobes to effect sequential transfer of said switch between its first and second switch contact con-

ditions during rotation of said cam means.

5. The combination of claim 3 wherein said cam means comprises a pair of axially aligned cam members each of which is cooperative with one of said first and second actuator arm means, each of said cam members having at least one actuating lobe thereon adapted to effect said snap-action movement of the associated actuator arm means.

6. The combination of claim 1 wherein said control means is engageable with said first and second actuator arm means to simultaneously move both of the actuator arm means to positions establishing one of said first and second switch conditions, thereafter effect snap-action movement of one of said actuator arm means to a position transferring said switch to the other of its switch conditions, and thereafter effect snap-action movement of the other of said actuator arm means to a position transferring said switch back to its initial switch condition, said snap-action movement of said actuator arm means being sequentially effected during rotation of the recording shaft.

7. The combination of claim 1 wherein said switch body is supported for pivotal movement about an axis off-set from the center of gravity of the switch body so that said second actuator arm means is urged against said control means by gravity.

8. In a switch actuating system for use with a switch having a switch body, two fixed spaced contacts, and a contact arm movable between the fixed contacts to selectively establish first and second switch conditions, the combination comprising means supporting the switch body for pivotal movement, first actuator arm means pivotally supported by the switch body and movable to effect transfer of the contact arm between its first and second switch conditions, second actuator arm means secured to the switch body and movable therewith, and movable control means engaging said first and second actuator arm means to move said actuator arm means to positions establishing said first switch condition, said control means during continued movement thereof effecting a snap-action movement of one of said actuator arm means to transfer the contact arm to establish said second switch condition, and said control means during further movement thereof effecting a snap-action movement of the other of said switch actuator arm means to transfer the contact arm back to its first switch condition.

9. The combination of claim 8 including means biasing said first actuator arm means to a position establishing a pre-determined switch condition.

10. The combination of claim 8 wherein said control means comprises rotatable cam means having at least one actuating lobe thereon cooperative with each of said actuating arm means to establish said snap-action movement thereof.

11. The combination of claim 10 wherein said cam means comprises at least two axially aligned cam members each of which is cooperative with one of said first and second actuating arm means.

12. The combination of claim 11 wherein said cam members are formed integral with each other and are rotatable about a common axis.

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