Feb. 2, 1954 M. D. BENNETT 2,668,263

VARIABLE SWITCH OPERATED POSITIONING SYSTEM

Filed Dec. 20, 1952 3 Sheets-Sheet 1

FIG. 1

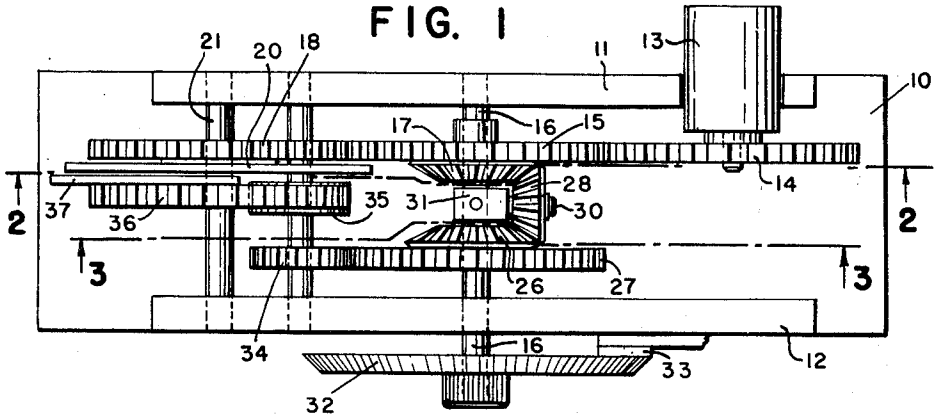


FIG. 2

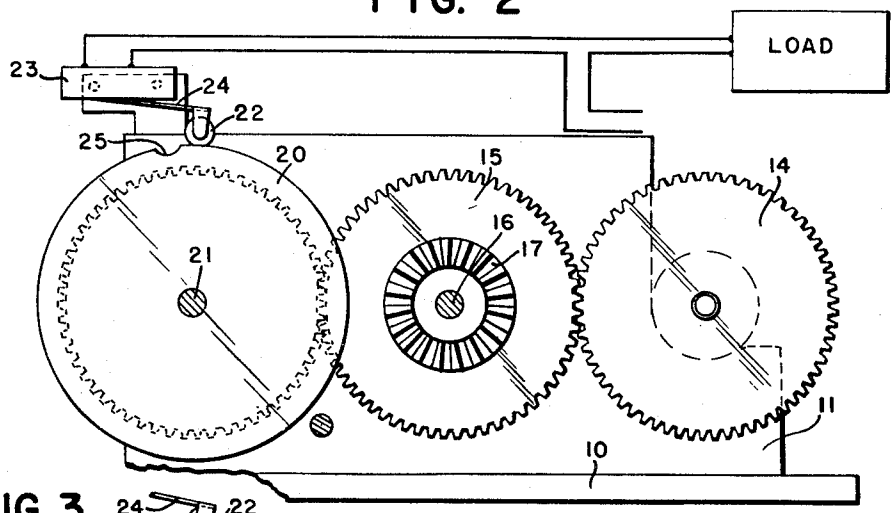
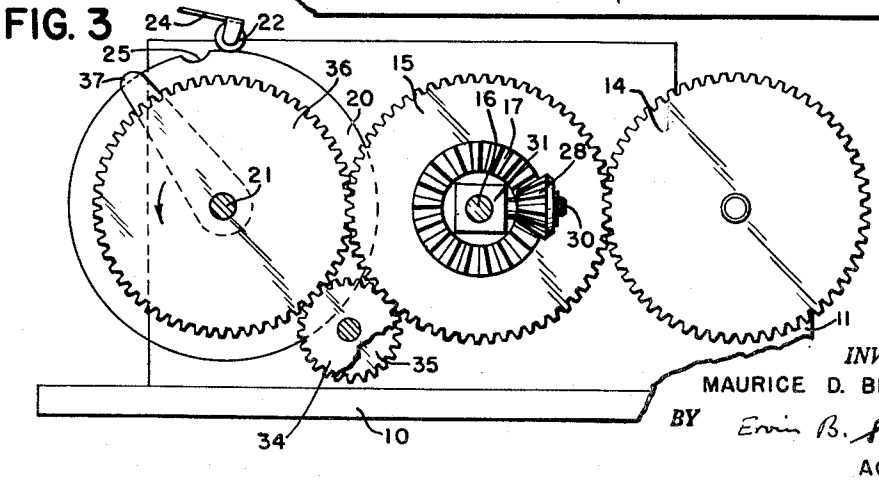


FIG. 3



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VARIABLE SWITCH OPERATED POSITIONING SYSTEM

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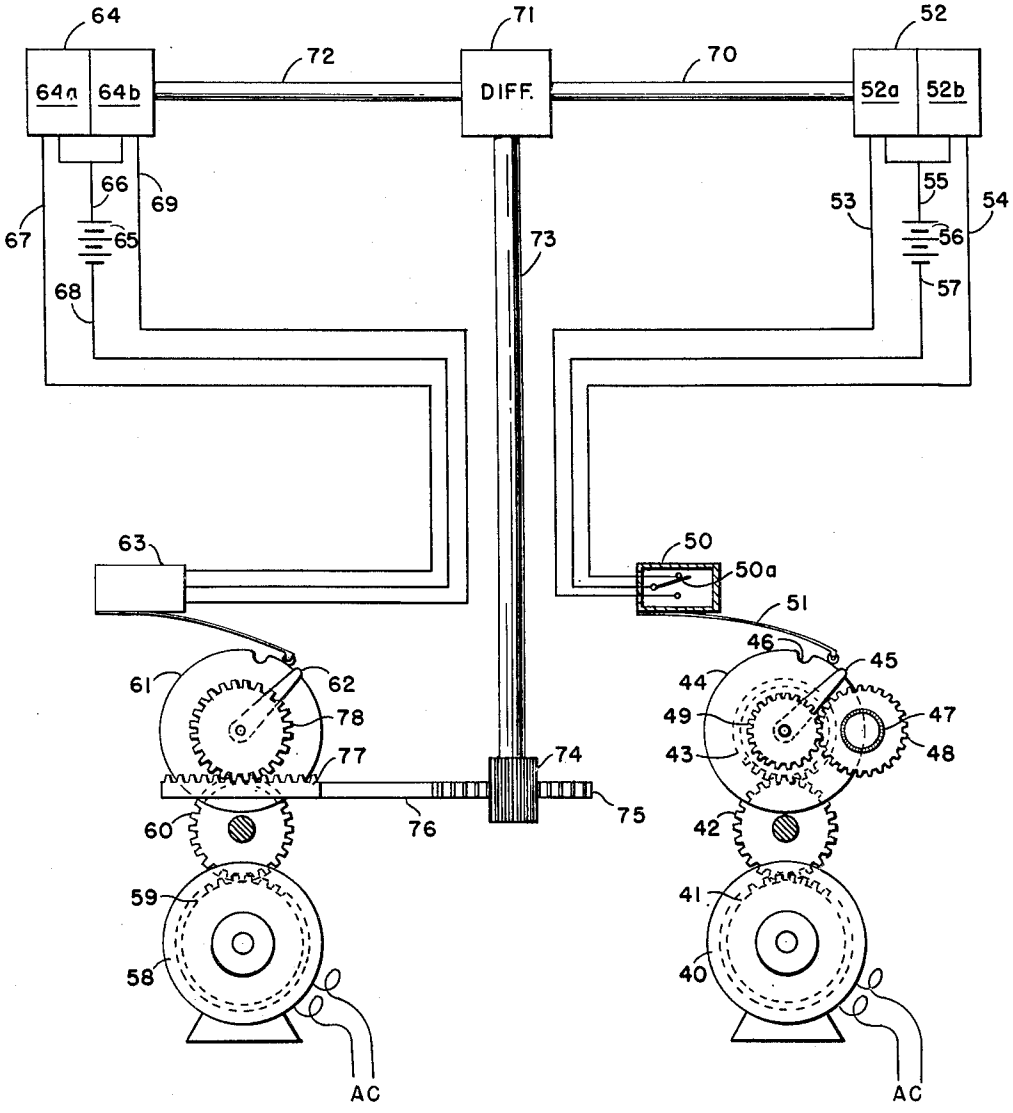


FIG. 4

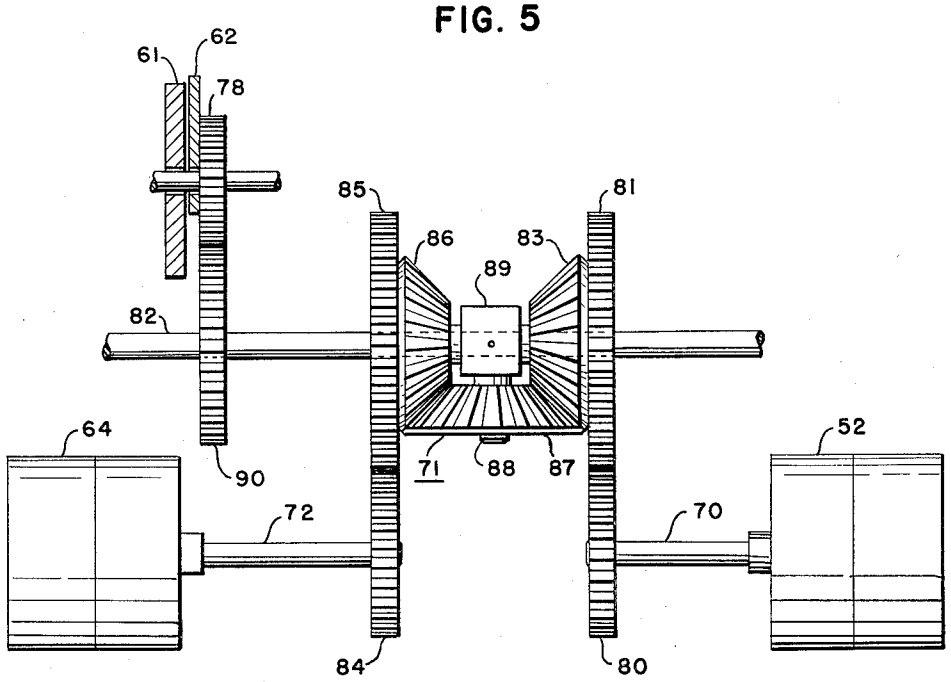
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FIG. 5



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VARIABLE SWITCH OPERATED POSITIONING SYSTEM

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Application December 20, 1952, Serial No. 327,141

3 Claims. (Cl. 318—19)

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This invention relates to a means for transmitting information from one place to another and has particular reference to a system in which mechanical motion is transmitted electrically to be reproduced at a remote location.

Prior devices which transmit mechanical information to a remote point are either mechanical or electrical. The flexible shaft is a wholly mechanical device for transmitting such information but its application and use is limited by the practical length of the flexible cable. In the electrical field the generic name "synchro" applies to various types of electromagnetic devices which when used in the combination of a transmitter and a receiver transmit mechanical rotation electrically to a remote point.

These synchros are rather complex and are therefore expensive positioning devices which require accurate phasing of voltages and other care during manufacturing and later use in the field. The present device being an electro-mechanical system is characterized by great simplicity thereby being applicable where the use of synchros is not economically feasible.

One of the objects of this invention is to provide a positioning system which avoids one or more of the disadvantages of prior art arrangements.

Another object of this invention is to provide an electro-mechanical positioning system in which mechanical displacement is sensed and transmitted electrically to a remote point for reproduction as mechanical motion.

Another object of the invention is the use of a positioning system using revolving cams, the relative positions of which is reproduced at a remote point.

Still another object of the invention is the provision of a remote positioning system characterized by extreme simplicity and greatly reduced cost.

The invention comprises a pair of variable switching means. Each switching means is equipped with a first and a second revolving cam which rotate in the same direction and at the same speed. The second cam by means of a differential is angularly adjustable with respect to the first cam. A switch adapted to alternately open one circuit when a second circuit is closed, is associated with each of the switching means. The consecutive opening and closing of these circuits is actuated by the cyclic rotation of said first and said second cam respectively of the switching means associated therewith. Each switch is connected to a motor which is adapted

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for cyclic operation in a bidirectional manner as controlled by the relative angular positions of the pair of cams associated with each switching means. A differential is used to combine the shaft rotations of the pair of bidirectional motors and means are provided for positioning the adjustable cam of one of said switching means in accordance with the resultant output of the differential.

For a better understanding of the present invention together with other and further objects thereof reference is made to the following description taken in connection with the accompanying drawings in which:

Figure 1 is a top view of the variable switching means;

Figure 2 is a cross sectional view of the switching means taken along the line 2—2 of Figure 1;

Figure 3 is a cross sectional view taken along the line 3—3 of Figure 1;

Figure 4 is a schematic view of the positioning system employing a pair of variable switching means; and

Figure 5 is an alternate example of a gear transmission shown in Figure 4.

Explaining first the operation of the variable switching means, the basic element of the present positioning system, reference is made to Figures 1, 2 and 3 in which a base 10 supports two vertical bearing plates 11 and 12 which carry nearly all of the rotating members. A constant speed motor 13 is mounted on the base and turns a gear 14 which in turn drives a gear 15, loose on shaft 16 but secured to a first bevel gear 17 which is part of a differential gear mechanism. Gear 15 also meshes with another gear 18 which carries a cam 20 and rotates freely on shaft 21.

A cam follower roller 22 is resiliently pressed against the edge of cam 20 and is coupled to a switch mechanism 23, commonly termed microswitch. This switch is constructed with a toggle action and its characteristics are such that operating arm 24 must be moved a definite distance to one side of a central position to operate the switch arm in one direction, and a similar definite distance to the other side of the central position to operate the switch in the other direction. This means that when the switch arm 24 is held in the central position the switch contacts may be either open or closed, depending upon the previous arm movement.

The cam face of cam 20 is a circle except for one depression 25 and the switch mechanism 23 is adjusted so that this cam face holds the arm 24 in the central position. When, during an

operation, the roller 22 drops into depression 25 the switch is opened if it had previously been closed and after being opened the switch is held in that condition until operated upon by some other force which will move the arm 24 in a direction away from cam face 26.

Shaft 16 is journalled in plates 11 and 12 and supports gears 15, 17 near one plate and a pair of similar gears 26, 27 near the other plate. These gears rotate freely on shaft 16. A bevel gear 28 meshes with bevel gears 26 and 17 and turns on a stub shaft 30 which is part of block 31 secured to shaft 16. Shaft 16 also is secured to a manually operable dial 32 which may extend beyond the base and which is engaged by a friction pad 33.

Gear 27, which is secured to bevel gear 26, meshes with an idler gear 34 which turns a second idler gear 35 meshing with a larger gear 36 mounted for free turning on shaft 21. Gear 36 is the same size as gear 18, and, since the idler gears 34 and 35 are the same size and gear combinations 15—17 and 26—27 are identical, gears 36 and 18 turn at the same speed and in the same direction as long as shaft 16 remains stationary.

A second cam 37 is secured to bar 38 and has a cam face which engages roller 22 to move arm 24 and close the contacts in switch 23. After the contacts have been closed, the return of arm 24 to its central position does not open the contacts until the roller moves into depression 25.

The operation of this device is as follows: With the motor 13 running at or near constant speed, gears 18 and 36 revolve in the same direction and at the same speed and carry cams 20 and 37 around their common axis in an unchanged relative position. If the cams are in the positions shown in Figure 3 and if they are turning in the direction indicated, the switch contacts will be made when roller 22 is engaged by cam 37 and then opened by depression 25, thereby being in a closed position for a short fraction of the time cycle represented by the complete revolution of gears 18 and 36.

In order to increase the time interval during which the contacts are closed, dial 32 is turned manually in counterclockwise direction, turning shaft 30 and bevel gear 28. This momentarily increases the speed of gears 26 and 27 and advances gears 34, 35, and 36 together with cam 37 to set a new angular position between depression 25 and the end of cam 37. The new arrangement supplies the load with an electrical power pulse of longer duration than previously and results in a longer duty cycle for the controlled load.

The time interval may be shortened by turning dial 32 in a clockwise direction, reversing the above described operation.

Toggle switches are generally supplied with two stationary contact points and arranged so that one circuit is made when a second circuit is opened. This type of switch may be used with a reversing motor which can be connected to run in one direction when one set of contacts is closed and to run in the opposite direction when the second set of contacts is closed. Such an arrangement comprises an integration system, the final result being controlled by the relative setting of the two cams.

It is not necessary to connect the constant speed motor 13 to a driving gear 14 as shown in Figure 1. The motor may be coupled to shaft 21, in which case gear 18 must be secured to the shaft and gear 36 must be free to rotate on it

as described above. The device may be made with a cage type differential instead of the bevel type and any type of toggle switch can be used with the device as long as its characteristics include a central position where the switch may be open or closed, depending upon its previous actuation.

Having now described in detail the operation of the variable switching means, reference is made to Figure 4 which shows schematically the positioning system making use of a pair of variable switching means. A driving motor 40 running at or near constant speed, drives via gears 41, 42 and 43 a first variable switching means which includes the two revolving cams 44 and 45 described in Figures 1, 2 and 3. Cam 45 is angularly adjustable with respect to the depression 46 of cam 44 by means of dial 47 secured to gear 48 and acting upon gear 49. Dial 47 in Figure 4 occupies the same position and performs the same function as dial 32 in Figure 1. A toggle switch 50 adapted to open alternately one circuit when a second circuit is closed, is operated by cams 44 and 45 by virtue of its operating arm 51 contacting these cams. A reversing or bidirectional motor 52 which may consist of a synchronous clock motor having two field windings 52*a* and 52*b*, and the rotation of which is determined by the respective field winding energized, is connected to switch 50 by conductors 53, 54, 55, a source of electrical energy 56, and conductor 57. With the switch position being as shown in Figure 4, field winding 52*b* of motor 52 is energized. Assuming that cams 44 and 45 rotate in counterclockwise fashion, then, when operating arm 51 is contacted by cam 45 the contact making element 50*a* of switch 50 will close the other circuit so as to disconnect field winding 52*b* and energize field winding 52*a* thereby reversing the motor. It can be seen therefore that during each complete revolution of the cams 44 and 45, motor 52 will cyclically operate in forward and reverse rotation. The relative amount of forward and reverse rotation of the motor is determined by the position of cam 45 and the depression 46 in cam 44 with respect to one another.

In a similar manner as described above, a second motor 58 drives via gears 59 and 60 a second variable switching means which includes cam 61 and adjustable cam 62. A second toggle switch 63 is actuated by rotation of cams 61 and 62. This switch 63 is connected to a bidirectional motor 64 having two field windings 64*a* and 64*b* respectively. The motor in the same manner as described above is operated alternately in forward and reverse direction by the switching action of toggle switch 63 via a source of electrical energy 65 conductors 66, 67, 68 and 69 respectively.

Shaft 70 of motor 52 is connected to one input side of a differential 71 and the shaft 72 of motor 64 is connected to the other input side of the differential. The output shaft 73 of the differential is equipped with a pinion 74 acting upon rack 75 connected to bar 76. Bar 76 on its other end has attached thereto a rack 77 which engages gear 78. Gear 78 positions adjustable cam 62 with respect to cam 61 in the same manner as gear 36 of Figure 3 positions the adjustable cam 37.

The operation of this positioning system may be visualized as follows: Motor 40 drives the first variable switching means which results in a bidirectional rotation of shaft 70. Motor 58 drives

the secondary variable switching means resulting in a bidirectional rotation of shaft 72. If cams 61 and 62 occupy the same angular displacement with respect to one another as cams 44 and 45, and if the field windings of motor 52 and 64 respectively are connected such that the rotations of shafts 70 and 72 are opposed, then shaft 73 constituting the output of the differential 71 will stand still. When changing the angular position of cam 45, a resultant shaft rotation is obtained on shaft 73 which in turn is transmitted via pinion 74, rack 75, rack 77 and gear 78 upon adjustable cam 62 in such a manner as to cause cam 62 to occupy the same angular displacement with respect to cam 61 as occupied by cam 45 with respect to cam 46. In such a way when considering motor 40 at the transmitting end and motor 58 at the receiving end, a remote positioning system or follow-up system is obtained, because any change of angular position of cam 45 initiated by setting of dial 47 is reproduced on cam 62. The combination of cams 61 and 62 may be brought to a stationary dial (not shown) in the very same manner as described and shown in connection with Figures 1 through 3. Although cams 44 and 61 are shown with their depressions being at approximately the same angle, the system will operate if these cams are angularly shifted with respect to one another as long as the same rotational speed is maintained between both variable switching means. Synchronous clock motors for instance have been found to be very suitable driving means to occupy the positions of motors 40 and 58. If the depressions of cams 44 and 61 do not occupy the same angle with respect to one another the inherent mechanical inertia, gear backlash as well as the average resultant incremental motion of shaft 73 attained at the end of the cycle will assure that the relative position of cam 45 with respect to the depression 46 of cam 44 is reproduced on cams 61 and 62 respectively.

Figure 5 illustrates an alternate gear transmission which may be employed if adjustable cam 45 is rotated through an angle which is greater than that permissible by the limited length of racks 75 or 77.

Motor 52 with shaft 70 and gear 80 fast thereon drives the input gear 81 which turns freely on shaft 82 but transmits its rotation to a first bevel gear 83 of the differential identified in general by numeral 71. In a similar manner motor 64 with shaft 72 and gear 84 fast thereon drives the input gear 85 which turns freely on shaft 82 but transmits its rotation to the other input bevel gear 86 of the differential. Bevel gear 87 meshes with bevel gears 83 and 86 and turns on a stub shaft 88 which is part of block 89 secured to shaft 82. Bevel gear 87 causing shaft 82 to rotate as the algebraic mean of the rotations of input bevel gears 83 and 86 drives gear 90 secured to shaft 82 and meshing with gear 78. Gear 78 in turn is used to position the adjustable cam 62 in Figure 4. In this manner dial 47 which adjusts cam 45 may be rotated continuously through any angle without being limited by linear motions on the receiving end of the system. It is obvious to those skilled in the art that various other means may be used to transmit mechanical rotation between the differential 71 and adjustable cam 62 without departing from the spirit of the invention.

While there have been described and illustrated specific embodments of the invention, it will be obvious that various changes and modifications may be made therein without departing from the field of the invention which should be limited only by the scope of the appended claims. Other features of the invention disclosed are claimed in my co-pending application for Letters Patent Serial Number 316,741 with filing date of October 24, 1952.

What is claimed is:

1. A positioning system comprising a pair of variable switching means, each of said switching means equipped with a first and a second revolving cam rotating in the same direction and at the same speed and said second cam by means of a differential being angularly adjustable with respect to said first cam, a switch adapted to alternately open one circuit when a second circuit is closed associated with each of said switching means, the consecutive opening and closing of said circuits actuated by the cyclic rotation of said first and said second cam respectively of the switching means associated therewith, a pair of motors each being adapted for bidirectional rotation and connected to one of said switches respectively, each motor operating cyclically in a bidirectional manner as controlled by the relative angular positions of the pair of cams associated with each switching means, a differential combining the shaft rotations of said bidirectional motors and means for positioning the adjustable cam of one of said switching means in accordance with the resultant output of said differential.

2. A positioning system comprising a primary and a secondary variable switching means, each of said switching means equipped with a first and a second revolving cam rotating in the same direction and at the same speed and said second cam by means of a differential being angularly adjustable with respect to said first cam, a toggle switch adapted to alternately open one circuit when a second circuit is closed associated with each of said switching means, the consecutive opening and closing of said circuits actuated by the cyclic rotation of said first and said second cam respectively of the switching means associated therewith, a pair of motors each being adapted for bidirectional rotation and connected to one of said toggle switches respectively, each motor operating cyclically in a bidirectional manner as controlled by the relative angular positions of the pair of cams associated with each switching means, a differential subtracting the shaft rotations of said bidirectional motors and gear means for connecting the resultant shaft rotation of said differential with the adjustable cam of said secondary switching means to cause this adjustable cam to follow the angular displacement imparted upon the adjustable cam of the primary switching means.

3. A positioning system comprising a primary and a secondary rotating variable switching means driven at substantially the same speed, each of said switching means equipped with a first and a second revolving cam rotating in the same direction and at the same speed and said second cam by means of a differential being angularly adjustable with respect to said first cam, a toggle switch adapted to alternately open one circuit when a second circuit is closed associated with each of said switching means, the consecutive opening and closing of said circuits actuated by the cyclic rotation of said first and said second cam respectively of the switching means associated therewith, a pair of motors each being adapted for bidirectional rotation and connected

to one of said toggle switches respectively, each motor operating cyclically in a bidirectional manner as controlled by the relative angular positions of the pair of cams associated with each switching means, a differential connected to said bidirectional motors to substract their shaft rotations, gear means between said differential and the adjustable cam of said secondary switching means to impart upon this cam an angular displacement proportional to the difference of said

shaft rotations to cause the adjustable cam of said secondary switching means to assume the same angular displacement with respect to its first cam as the angular displacement selected between the cams of said primary switching means.

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No references cited.