March 1, 1966 J. L. HARRIS 3,238,328

SWITCHING MECHANISM

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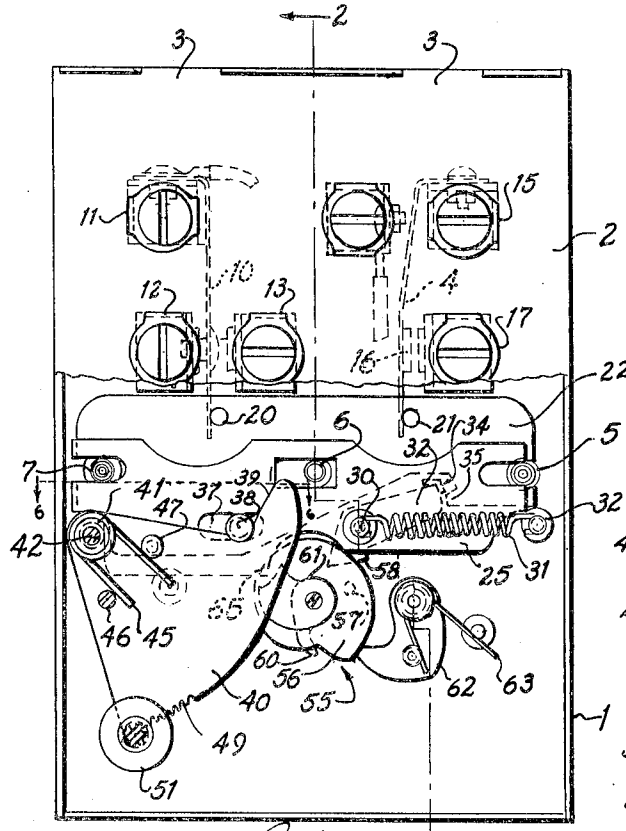


Fig. 1

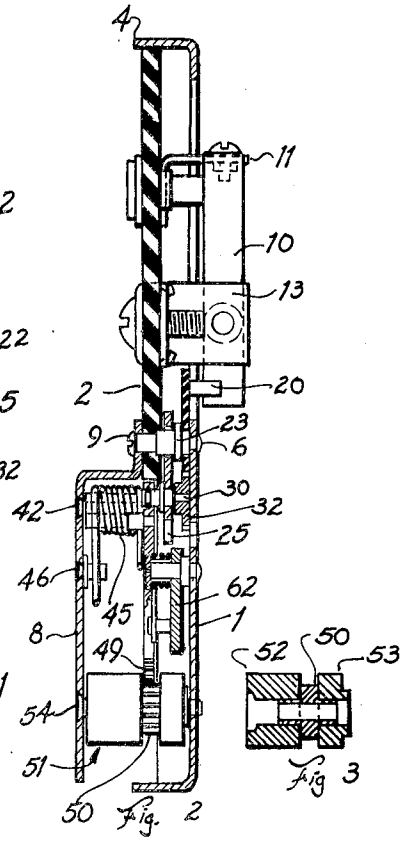


Fig. 2

Fig 3

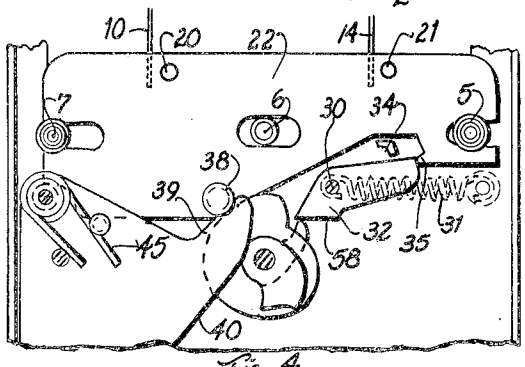


Fig. 4

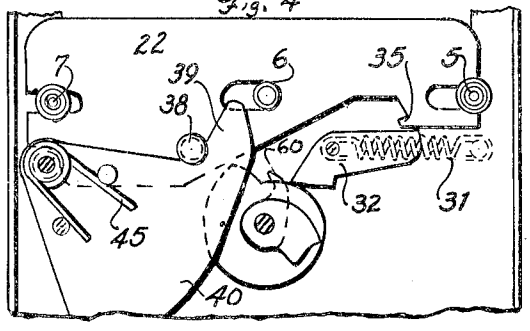


Fig. 5

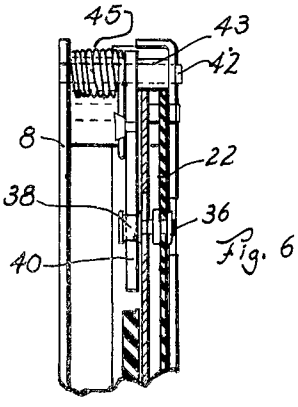


Fig. 6

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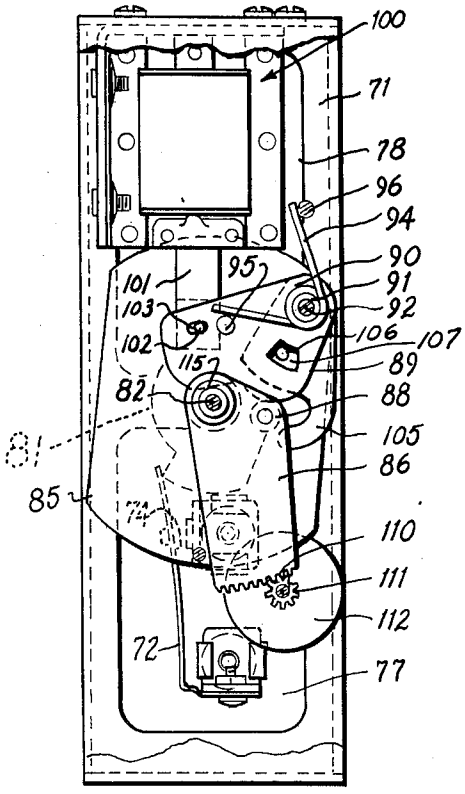


Fig. 8

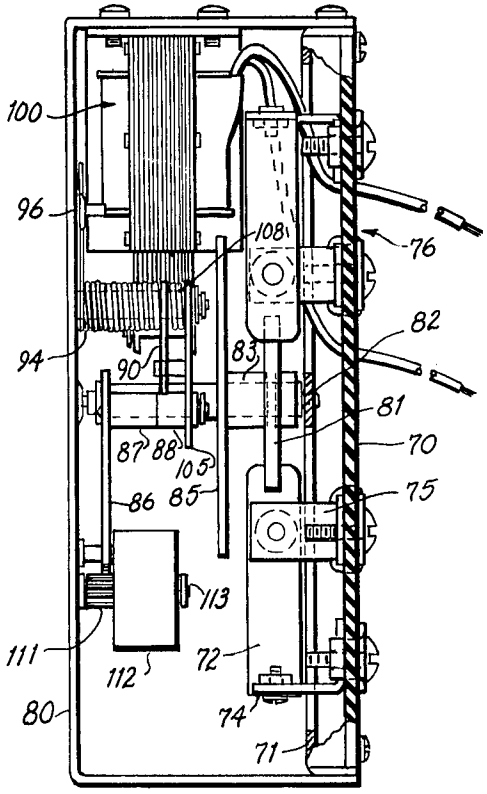


Fig. 7

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3,238,328

SWITCHING MECHANISM

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14 Claims. (Cl. 200—97)

This invention relates to switching mechanism.

The object of the invention is to provide a switch operating mechanism providing high capacity switching with a minimum of operating force required. This is accomplished in part by balancing the positive spring rate of one spring with a negative spring rate of an opposing spring. The invention also includes the provision of a flywheel which controls the make and break speeds and provides extra operating force at the point of opening the contacts.

Other objects will appear as this description proceeds.

For a full disclosure of the invention reference is made to the following detailed description and to the accompanying drawings in which:

FIG. 1 is a front view with the cover removed of a time control mechanism embodying the invention;

FIG. 2 is a side sectional view taken on line 2—2 of FIG. 1;

FIG. 3 is a sectional view of the flywheel construction;

FIG. 4 is a view similar to FIG. 1 showing the parts in another position;

FIG. 5 is a similar view to FIG. 4 showing the parts after return movement;

FIG. 6 is a sectional view taken on line 6—6 of FIG. 1;

FIG. 7 is a side view of the invention applied to an electromagnetic switch; and

FIG. 8 is a rear view of FIG. 7 taken on line 8—8 of FIG. 7.

Referring to FIG. 1, the invention is shown applied to a time control mechanism of the type shown in my copending application, Serial No. 262,471, filed March 4, 1963.

This time control mechanism includes a base bracket 1 which is of box-like configuration and carries a switch panel 2. This switch panel is formed with gears 3 which extend into suitable slots in the out-turned top section 4 of the base member. The lower end of the switch panel 2 fits over studs, 5, 6 and 7 which are staked into the base plate 1. An offset front bracket 8 mounts over the switch panel 2 and is held in place by screws 9 which are threaded into the studs 5 and 7.

The switch panel 2 carries suitable switch mechanism. In the embodiment illustrated there are two separate switches. One includes a switch blade 10 which is attached to a bracket 11 carried by the panel. This switch blade 10 extends between contact brackets 12 and 13. This mechanism thus forms a double throw switch. The second switch includes a switch blade 14 which is carried by a bracket 15 attached to the panel. This switch blade carries a contact 16 which cooperates with a stationary contact carried by a contact bracket 17 mounted on the panel 2.

The switch blade 10 is biased to the right tending to engage with the contact carried by the contact bracket 13. The switch blade 14 is also biased to the right tending to engage with the stationary contact carried by contact bracket 17. These switch blades are operated by studs 20 and 21 which are carried by a sliding switch blade operator 22. This switch blade operator 22 is formed of phenolic material and is provided with slots fitting over studs 6 and 7 carried by the base plate 1. The studs 6 and 7 are formed with shoulders 23 which maintain switch blade operator 22 in position against the base member 1.

Mounted on studs 5 and 7 and in front of the switch blade operator 22, is a sliding cam follower member 25. As shown in FIG. 2 the member 25 fits between the

shoulder 23 of the studs 5 and 7 and the switch panel 2. Both the switch blade operator 22 and the sliding cam follower 25 are free to slide over studs 5 and 7 which serve as guides.

The cam follower member 25 is provided with a stud 30 which extends both forwardly and rearwardly from member 25. The forward portion of stud 30 carries a tension spring 31 which extends to the right and is anchored to a stud 30 carried by the base member 1. The rear section of the stud 30 serves as a bearing for a latch member 32. This latch member 32 is arranged to engage either an inwardly extending projection 34 on the base member or a projection 35 forming part of the switch operator 22. This latch member 32 is biased in a counterclockwise direction by a suitable spring not shown.

As shown in FIG. 6, the switch operator 22 is provided with a stud 36 which extends forwardly through a slot 37 (FIG. 1) in the cam follower member 25. This stud 36 carries a roller 38 which rides on a cam surface 39 of a pivoted cam member 40. This member 40 is carried by a bearing 41 which fits over a stud 42 extending between the front plate 8 and the base 1. A suitable spacer 43 is provided between the cam member 40 and the base member 1 for maintaining the cam member in proper location. A torsion spring 45 is fitted over the bearing 41. One leg of the spring 45 bears against a stud 46 carried by the front plate 8. The other leg of the spring bears against a stud 47 carried by the cam member 40. The spring 45 thus biases the cam member 40 in a counterclockwise direction about its pivot 42 as seen in FIG. 1. The cam member 40 is formed with gear teeth 49 which mesh with teeth of a pinion 50 which form part of a flywheel 51. As shown in FIG. 3 this flywheel is formed of two flywheel portions 52 and 53 which are crossed over shoulders of the pinion 50. The pinion also serves as a bearing over a stud 54 which extends between the front plate 8 and the base member 1.

As described in detail in my co-pending application, the cam follower member 25 and the latch member 32 are operated by a cam shaft assembly generally indicated as 55. This cam shaft assembly includes a starting cam 56 carrying a pin 57 which is adapted to engage the lower surface 58 of the latch member 32. The cam shaft assembly also includes an off cam 60 which is also adapted to engage the surface 58 and the latch member. The cam shaft assembly also includes a reset cam 61 which engages the cam follower member 25 for camming it to the left to starting position. This cam shaft assembly 55 is driven in a counterclockwise direction by a suitable backward mechanism. The starting cam 56 is ridden by a starting cam follower 62 which is pivoted to the base member 1 and biased toward the cam by a torsion type spring 63.

Operation

FIG. 1 shows the parts ready to begin a timing cycle. At this time the cam follower member has been cammed to the left by the reset cam 61 bearing against a cam follower surface 65 on the member 25. This reset cam 61 has already cammed the follower member 25 to the left sufficiently for the latch member 32 to get behind and engage with the projection 34 on the base member 1. This movement to the left has stretched the spring 31 which is biasing the came follower member 25 to the right. At this time the camming surface 39 of the member 40 is urging the roller 38 carried by the switch operator 22 to the left. The studs 20 and 21 carried by the switch operator 22 are thus urging the switch blades 10 and 14 to the left.

As the cam assembly 55 rotates counterclockwise the starting pin 57 carried by starting cam 56 bears against the lower edge 58 of the latch member 32. This causes clockwise rotation of the latch member 32 about its pivot

30 thus disengaging the lug 34 on the base member 1. The spring 31 now pulls the member 22 to the right. The latch member 32 now engages the lug 35 on the switch operator as shown in FIG. 4. This movement of the sliding member 25 to the right thus causes movement of the switch operator to the right. This permits corresponding movement of the switch blades 10 and 14.

When the switch operator 22 is pulled to the right by the spring 31 the roller 38 bears against the cammed surface 39 and causes clockwise rotation of the cam member 40 about its pivot 41. This same movement also causes counterclockwise rotation of the flywheel 51 about its bearing 54. As stated above, the surface 39 of cam member 40 is a camming surface. The configuration of this surface is plotted so that the angular motion of the cam member 40 progressively decreases as the switch operator 22 moves to the right. The affect of this camming surface is to characterize the spring rate of the spring 45 to compensate for the loss of tension on the spring 31 as it contracts or becomes unstressed. It will be apparent that as the spring 31 pulls the assembly to the right the force which is available from this spring reduces. This decrease in force is compensated for by the camming action of cam surface 39 which decreases the biasing affect of the spring 45 even though the actual tension of this spring is being increased.

The parts now assume the positions shown in FIG. 4. At this time the switch blades 10 and 14 have moved for closing the right hand contacts. Also, the switch operator 22 has moved beyond this point to an over travel position at which spacers exist between the switch blade and the operating studs 21 and 22.

During this motion the gear teeth 49 on the cam member cause rotation of the flywheel 51. The inertia of this flywheel slowed up the right hand motion of the mechanism for causing the switches to close slowly and positively without any contact bounce.

The next step in the cycle is the tripping of the latch 32 by means of the off cam 60 of the cam shaft assembly. This causes the latch 32 to disengage the surface 35 of the switch operator 22. The parts now assume the positions shown in FIG. 5.

When the latch 32 disengaged the switch operator, the caming surface 39 bearing on roller 38 urged the switch operator 22 to the left. This motion was initially retarded by the inertia affect of the flywheel 51. The switch operator first moved to the left taking up the over travel distance between the studs 21 and 22 and the switch blades 10 and 14. At the time of engagement with the switch blades the switch operator 22 was still moving slowly due to the inertia retarding affect of the flywheel 51. However, it was also moving with a positive driving action also due to this inertia. This caused the contacts to break slowly and positively for breaking the circuit with a minimum amount of arcing.

Also during this motion, the biasing affect of the spring 45 was being increased due to the change in "leverage" provided by the cam surface 39. In this reverse action the linear motion of the switch operator 22 progressively decreased as the cam 40 rotated about its pivot. This camming action served in effect to reverse the spring rate of the spring 45 and caused the tension on the switch operator 22 to actually increase even though the actual tension on this spring was decreasing. This affect compensates for the build up in tension on the spring switch blades 10 and 14 as they are moved against their bias.

From the foregoing description it will be apparent that the reverse spring rate affect provided by the cammed surface 39 on roller 38 reduces the tension required by the spring 31 when the switches are operated on movement to the right as seen in FIG.1. This same reversal of the spring rate also reduces the tension required on spring 45 in moving the switch blades 10 and 14 to the left on the reverse stroke. This balancing of an increasing spring rate with a decreasing spring rate thus reduces the amount of energy required to operate the switches and makes it possible to operate high capacity switches with relatively small operating forces. This balancing of positive and negative spring rates with the inertia affect of the flywheel gives controlled speed on the make and break of the contacts and further increases the capacity of the switches without requiring any additional power to operate them.

FIGURES 7 and 8

Referring to FIGS. 7 and 8, the invention is shown applied to an electro-magnetic operated switch.

As shown in FIG. 7, a switch panel 70 is supported on a box like base member 71. This switch panel is shown as carrying a lower switch comprising a switch blade 72 which is carried by a terminal bracket 73. This switch blade 72 carries a contact 74 which co-operates with a corresponding stationary contact carried by a contact bracket 75 also attached to the switch panel 70. The switch panel 70 also may carry an upper switch generally indicated as 76 of the same construction as the lower switch just described.

The box like base member 71 carrying the panel 70 is formed with openings 77 and 78 which gives clearance for the upper and lower switches.

The base member 71 is mounted in a U-shaped mounting bracket 80 which serves as a base for the complete unit.

The switches are operated by means of a switch operator 81 carried by a shaft 82 which extends between the base member 71 and the bracket 80. It will be apparent that rotation of the shaft and switch operator 81 in a clockwise direction as seen in FIG. 8 opens the switches against the bias of the switch blades. Conversely rotation of the switch operator in a counterclockwise direction as seen in FIG. 8 permits the switches to close.

Preferably the shaft 82 carries tubular insulators 83 in front of and in back of the switch operator 81. It also carries a barrier 85 of insulating material for preventing arcing from the contacts to the operating mechanism to be described.

The shaft 82 at its rear end carries a lever 86. The lever 86 and the switch operator 81 are keyed to the shaft 82 in a suitable manner so that the lever and switch operator are maintained in a fixed angular relationship with each other. The lever 86 also carries a forwardly extending stud 87 which in turn carries a roller 88. This roller is engaged by the cam surface 89 of a lever 90 attached to a bearing 91 which is carried by a stud 92 attached to the base bracket 80. A torsion spring 94 fits over the bearing 91. One end of the spring 94 engages a stud 95 attached to the lever 90. The other end of the torsion spring bears against a stud 96 attached to the base bracket 80. It will be apparent that the torsion spring serves to bias the lever 90 in a counterclockwise direction as seen in FIG. 8.

The lever 90 is actuated by means of a solenoid generally indicated as 100. This solenoid 100 is of well known construction and is attached to the upper portion of the U-shaped base bracket 80. This solenoid includes a plunger 101 carrying a pin 102 which fits into a slot 103 formed in the lever 90.

Also pivotally mounted on the stud 92 is an "anti-bounce" member 105. This member is of hook-like configuration and includes a pin 106 which extends into a slot 107 formed in lever 90. This anti-bounce member 105 is biased relative to lever 90 by a torsion spring 108. As shown in FIG. 8 this spring biases member 105 in a clockwise direction causing the pin 106 to bear against the left side of the slot 107 in the lever 90.

The lower end of the lever 86 is formed with gear teeth 110 which mesh with teeth of the pinion 111. This pin-

ion 111 is attached to a flywheel 112 and is carried on a stud 113 attached to the base member 80.

Operation of FIGS. 7 and 8

The parts are shown in the positions assumed when the solenoid 100 is de-energized. At this time the spring 94 has rotated the lever 90 to its counterclockwise limit of rotation in which the lower surface of the lever 115 strikes the shaft 82. At this time the cam surface 89 has born against the roller 88 and moved the lever 86 to its clockwise limit of rotation. As the lever 86 and the switch operator 81 are in fixed relationship on the shaft the switch operator is in a position which pushes the spring switch blade 72 to the left for opening the contacts. The upper switch is open in the same manner.

When the solenoid 100 is energized its plunger 101 is pulled upwardly which rotates the lever 90 in a clockwise direction about its pivot 92. This raises the cam surface 89 from disengagement with the lever 88. The assembly including shaft 82 switch operator 81 and roller 86 are now free to rotate in a counterclockwise direction under the bias of the switch blade 72 and also the upper switch blade. The switches thus move to closed position. This movement however requires rotation of the flywheel 112 which serves to control the speed at which the switches close and thus avoids bouncing of the contacts.

When lever 90 was pulled in a clockwise direction by inward movement of the solenoid plunger 101 it also permitted the hook-like anti-bounce member 105 to approach the roller 88 on lever 86. The action of the movement of lever 90 is instantaneous by the solenoid. However, movement of the lever 86 and roller 88 is delayed by the flywheel 112. When the roller 88 catches up with the cam surface 89 of the lever 90 at the end of the stroke it tends to bounce. However, at this time the anti-bounce member 105 has come under the roller 88 which prevents this action .

When the solenoid is de-energized a spring 94 is free to rotate the lever 90 in a counterclockwise direction. At this time the cam surface 89 engages roller 88 and rotates lever 86 in a clockwise direction, thus rotating the switch operator in a manner to move the switch to open position against the spring bias affect of the spring switch blade 72.

The cam surface 89 of lever 90 is plotted to reverse the spring rate of the spring 94. In other words, when the lever 90 rotates counterclockwise the angular clockwise travel of lever 86 progressively decreases. By properly plotting the curve of cam 89 the spring 94 is given a negative spring rate which balances the spring rate of the switch blade 72.

As in the case of the embodiment of the invention shown in FIGS. 1, 2 and 6, the switch operator 81 moves beyond the point required for closing the contacts when the solenoid 100 is energized. In other words, the contacts first close and the switch operator continues rotating counterclockwise to a predetermined overtravel position. Thus, when the solenoid is de-energized the initial movement of the switch operator in the clockwise direction first takes up the overtravel. At this time the flywheel 112 slows down the movement of the switch operator. The flywheel also stores energy which is available for opening the contacts when the switch operator 81 engages the switch blades. Thus this arrangement provides for a slow, controlled breaking action of the contacts coupled with storing of energy for breaking the contacts open in the event they should weld.

From the foregoing description it will be aparent that both embodiments of the invention provide a maximum operating force for the switches with a minimum of energy required. Also, the combination of the negative spring rate mechanism with the flywheel effect serves to provide controlled making and breaking speeds of the switches. This eliminates contact bounce on the make action and minimizes arcing on the break.

While a preferred form of the invention has been shown and described, it will be apparent that many modifications may be made without departing from the spirit and scope of the invention. It is, therefore, desired to be limited only by the scope of the appended claims.

I claim:

1. In a switching mechanism, a pair of cooperating contacts, a movable member for moving one of said contacts, said movable member being biased in one direction, operating means for moving said movable member against its bias, said operating means including a spring and motion transmitting means for transmitting motion of the spring to the movable member, said motion transmitting means being constructed and arranged to reduce progressively the amount of motion transmitted as the spring becomes unstressed.

2. In a switching mechanism, a pair of cooperating contacts, a movable member for moving one of said contacts, said movable member being biased in one direction, operating means for moving said movable member against its bias, said operating means including a spring and motion transmitting means for transmitting motion of the spring to the movable member, said motion transmitting means being constructed and arranged to reduce progressively the amount of motion transmitted as the spring becomes unstressed, a flywheel, and means for translating motion of the operating means into rotary motion of the flywheel for controlling the make and break speeds of the moving contact.

3. In a switching mechanism, a pair of cooperating contacts, movable means for moving one of said contacts, said movable means being biased in one direction, operating means for moving said movable means against its bias, said operating means including a spring and motion transmitting means for transmitting motion of the spring to the movable means, said motion transmitting means including a cam operated by the spring and a cam follower riding said cam for moving the movable means, said cam being proportioned with progressively decreasing throw when moving in the direction in which the spring is becoming unstressed.

4. In a switching mechanism, a pair of cooperating contacts, movable means for moving one of said contacts, said movable means being biased in one direction, operating means for moving said movable means against its bias, said operating means including a spring and motion transmitting means for transmitting motion of the spring to the movable means, said motion transmitting means including a cam operated by the spring and a cam follower riding the cam for moving the movable member, a flywheel, and means for translating motion of the cam into rotary motion of the flywheel for controlling the speed of said cam.

5. In a switching mechanism, a pair of cooperating contacts, movable means for moving one of said contacts, said movable means being biased in one direction, operating means for moving said movable means against its bias, said operating means including a spring and motion transmitting means for transmitting motion of the spring to the movable means, said motion transmitting means including a cam operated by the spring and a cam follower riding said cam for moving the movable means, said cam being proportioned with progressively decreasing throw when moving in the direction in which the spring is becoming unstressed, a flywheel, and means for translating motion of the cam into rotary motion of the flywheel for controlling the speed of said cam.

6. In a switching mechanism, a pair of cooperating contacts, movable means for moving one of said contacts, said movable means being biased in one direction, operating means for moving said movable means against its bias, said operating means including a spring and motion transmitting means for transmitting motion of

the spring to the movable means, said motion transmitting means comprising a cam mounted for rotation by said spring and a cam follower riding said cam for moving the movable means, said cam being proportioned with progressively decreasing throw when moving in the direction in which the spring becomes unstressed, a flywheel, a pinion for rotating said flywheel, said cam having a portion formed with gear teeth meshing with said pinion, whereby movement of the cam is controlled by said flywheel.

7. In a switch, a pair of cooperating contacts, a switch operator for moving one of said contacts for opening and closing the switch, said switch operator being arranged with more travel than required to operate the switch so that on movement in one direction it moves the switch to one of its positions and then overtravels to a predetermined position, means including a spring for biasing the switch opeartor in the opposite direction, a flywheel arranged to rotate with movement of the switch operator, said flywheel retarding the speed of the switch operator and storing kinetic energy during return movement of the switch operator through its overtravel to provide force for operating the switch.

8. In a switch mechanism, a movably mounted switch operator, a first spring, motion transmitting means between the first spring and the switch operator for biasing the switch operator in one direction, a second spring opposing the first spring for biasing the switch operator in the opposite direction, said second spring having greater force than the first spring so that when released it moves the switch operator in its direction and applies tension to the first spring, control means for first releasing the second spring to effect movement of the switch operator in one direction and then releasing the switch operator from the second spring so the first spring moves the switch operator in the opposite direction, said motion transmitting means between the first spring and said switch operator being constructed and arranged to decrease progressively the amount of motion transmitted from the switch operator to the first spring when the switch operator is moved by the second spring.

9. In a switch mechanism, a movably mounted switch operator, a first spring, motion transmitting means between the first spring and the switch operator by biasing the switch operator in one direction, a second spring opposing the first spring for biasing the switching operator in the opposite direction, said second spring having greater force than the first spring so that when released it moves the switch operator in its direction and applies tension to the first spring, control means for first releasing the second spring to effect movement of the switch operator in one direction and then releasing the switch operator from the second spring so the first spring moves the switch operator in the opposite direction, said motion transmitting means between the first spring and said switch operator being constructed and arranged to decrease progressively the amount of motion transmitted from the switch operator to the first spring when the switch operator is moved by the second spring, a flywheel, and means for translating motion of the switch operator into rotary motion of the flywheel for controlling the speed of said switch operator.

10. In a switching mechanism, a pair of cooperating contacts, movable means for moving one of said contacts, said movable means being biased in one direction, operating means having a spring which when released overcomes the bias of said movable member for moving the same in the opposite direction, said operating means including motion transmitting means between the spring and movable means constructed and arranged to reduce progressively the amount of motion transmitted as the spring becomes unstressed, and an electro-magnet for selectively holding or releasing said spring.

11. In a switching mechanism, a pair of cooperating contacts, movable means for moving one of said contacts, said movable means being biased in one direction, operating means having a spring which when released overcomes the bias of said movable member for moving the same in the opposite direction, said operating means including motion transmitting means between the spring and movable means constructed and arranged to reduce progressively the amount of motion transmitted as the spring becomes unstressed, a flywheel, means for translating motion of the operating means into rotary motion of the flywheel for controlling the make and break speeds of the moving contact, and an electro-magnet for selectively holding or releasing said spring.

12. In a switching mechanism, a stationary contact, a flexible leaf spring type switch blade having one end fixed and one end movable, a movable contact carried by said switch blade cooperating with said stationary contact, said switch blade being biased in one direction, operating means for moving said switch blade against its bias, said operating means including a spring and motion transmitting means for transmitting motion of said spring to said switch blade, said motion transmitting means being constructed and arranged to reduce progressively the amount of motion transmitted as the spring becomes unstressed.

13. In a switching mechanism, a stationary contact, a flexible leaf spring type switch blade having one end fixed and one end movable, a movable contact carried by said switch blade cooperating with said stationary contact, said switch blade being biased in one direction, operating means for moving said switch blade against its bias, said operating means including a spring and motion transmitting means for transmitting motion of said spring to said switch blade, said motion transmitting means including a camming surface arranged to reduce progressively the amount of motion transmitted as the spring becomes unstressed.

14. In a switching mechanism, a stationary contact, a flexible leaf spring type switch blade having one end fixed and one end movable, a movable contact carried by said switch blade cooperating with said stationary contact, said switch blade being biased in one direction, operating means for moving said switch blade against its bias, said operating means including a spring and motion transmitting means for transmitting motion of said spring to said switch blade, said motion transmitting means including a cam operated by the spring and a cam follower riding the cam for moving said switch blade, said cam being porportioned with progressively decreasing throw when moving in the direction in which the spring is becoming unstressed.

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