Nov. 12, 1940. R. W. GOFF 2,221,324

CONTROL DEVICE

Filed April 29, 1939

Fig. 1.

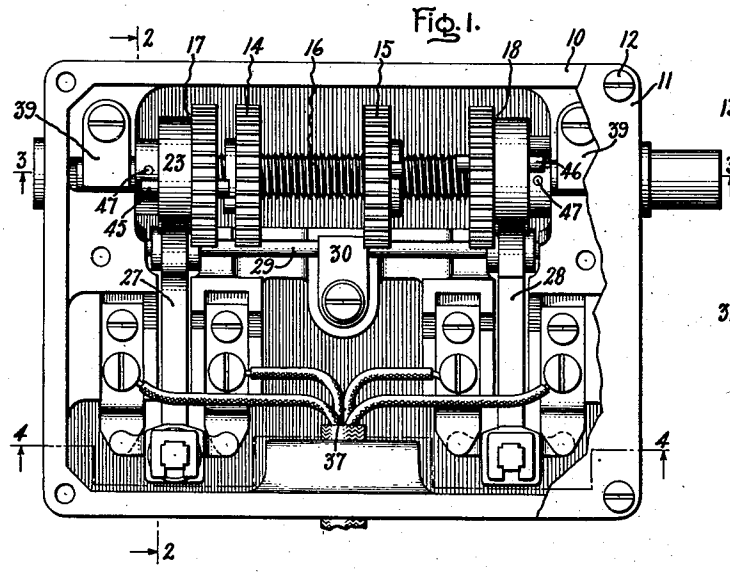


Fig. 2.

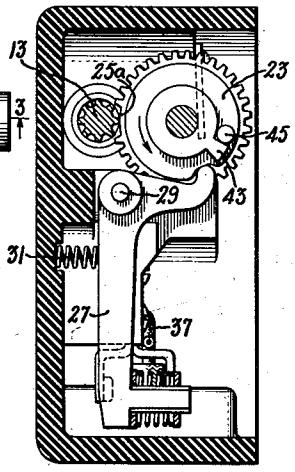


Fig. 3.

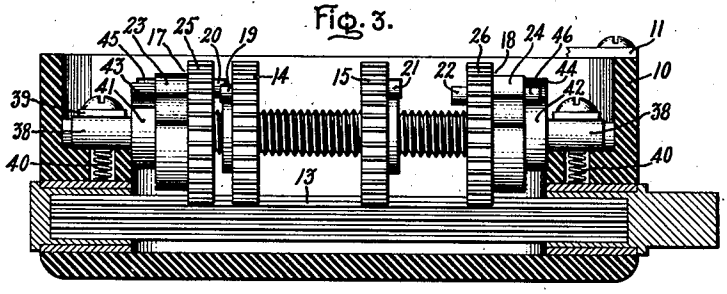


Fig. 5.

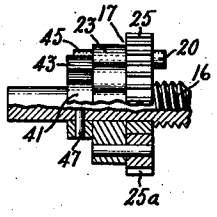
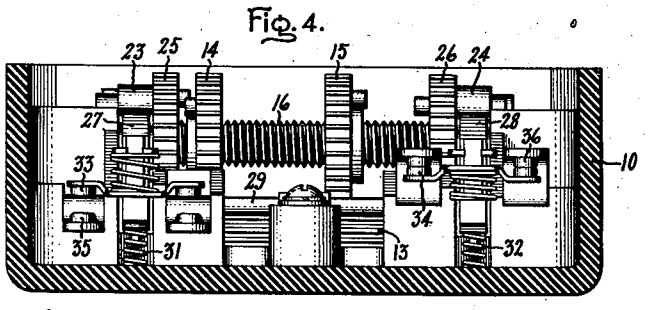


Fig. 4.



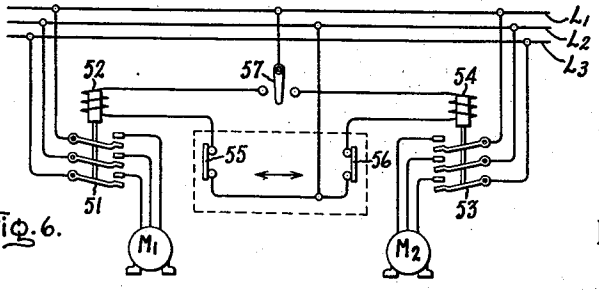


Fig. 6.

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UNITED STATES PATENT OFFICE

2,221,324

CONTROL DEVICE

Robert W. Goff, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York

Application April 29, 1939, Serial No. 270,881

10 Claims. (Cl. 200—47)

My invention relates to control devices, more particularly to mechanical limit switch devices adapted to perform an electrical switching operation after a predetermined travel of a driven member, and has for an object the provision of a device of this character which is simple, rugged and reliable, and which will not become jammed or damaged through overtravel of its driving means.

My invention is particularly adapted to limit switches and similar time interval control devices for controlling reversible motors or machines. For use in the control of metal-working machinery, such as, planers, successive switching operations may be performed after predetermined operation of the machinery. If desired, a single switching operation may be performed after the operation of the controller is initiated, and, thereafter, a second switching operation may be performed after the initiation of a second operation of the controller, and so on. This latter type of control is useful in the automatic opening and reclosing of motor-operated doors.

One of the important features of my invention is the provision of a traveling means which operates the switching means, and immediately is in position to operate again without requiring resetting or readjustment. This traveling means is readily adjustable to provide a variety of control operations, and for reliable operation, is positively associated with its driving means at all times, no reliance being placed on springs or resilient connections for either driving or resetting. The control device embodying my invention is inherently free from damage to its parts by jamming or otherwise upon overtravel of its driving means, in spite of the aforementioned positive association of the driving means and the traveling timing means for reliable operation.

In accordance with my invention, I have provided a controller having suitable driving means, such as, a driving gear, which is operated by the motor or machine to be controlled, either directly or through a suitable connecting device. Means including a pair of traveling pinions meshed with the driving gear are mounted on a threaded member for translational movement thereon, the traveling pinions being driven forward or backward along the mounting member in respectively the same direction in a definite angular and spaced relationship. Depending upon the direction of translation, the leading one of the traveling pinions engages and rotates one or the other of a pair of operating members mounted on unthreaded portions of the mounting member. Pins which engage with each other are provided for this purpose on the pinions and operating members, and are disposed in predetermined angular relationship.

Essentially, the operating members comprise a cam part for actuating a suitable control switch to control the motor and a gear part having a few gear teeth omitted. The space provided by the missing teeth is in normal registry with the driving gear so that the operating member is not rotated until engaged by its traveling pinion. Thereafter, the gear part of the operating member meshes with the driving gear for rotation thereby until the driving motor stops or reverses.

To protect the controller from damage by jamming of the traveling pinions against the operating member if the driving motor overruns, the normally stationary mounting member is rotatable by the operating members. This rotation of the mounting member is effected by co-operating projections on the operating members and mounting member engageable to rotate the mounting member after a predetermined rotation of the operating members. In this manner, simultaneous and like rotation of the mounting member and the traveling pinions prevents further translational movement of the traveling pinions, although rotation of the driving gear is continued.

In operation, the driving gear is driven by the motor to be controlled, and the motor operates until the two traveling pinions are translated along the stationary mounting member far enough for the leading one to have its pin engage the pin on the corresponding operating member. The gear part of the operating member is then meshed with the driving gear and the cam part operates its corresponding switch. Then the driving motor is stopped or reversed as the case requires. When the motor and driving gear is operated in the reverse direction, the traveling pinions move in the opposite direction retaining, of course, their predetermined angular and spaced relation, until the pin on the traveling pinion now leading engages the pin on its operating member for actuating the corresponding switch. The length of the path of travel or translational movement of the traveling pinions between their respective control positions is the determinant of the time of control. By changing the spacing between the traveling pinions so that their path of travel is increased or decreased, the control is correspondingly adjusted.

Further objects and advantages of my invention will become apparent in the following specification, and for a more complete understanding

of my invention reference should be had to the accompanying drawing in which Fig. 1 is a plan view of a controller embodying my invention; Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 looking in the direction of the arrows; Fig. 3 is a sectional view taken along the line 3—3 of Fig. 1 looking in the direction of the arrows; Fig. 4 is a sectional view taken along the line 4—4 of Fig. 1 looking in the direction of the arrows; Fig. 5 is a fragmentary view partly in section of a detail of the controller embodying my invention; and Fig. 6 is a circuit diagram showing the controller connected to control a pair of electric motors.

Referring now to the drawing, I have shown my invention in one form as a limit switch for use in the control of planer motors or the like. The operating mechanism of the switch is enclosed in a suitable insulating casing 10 or, if desired, in a metal casing provided with a cover 11 secured by the screws 12. The motive force of the motor controlled is suitably applied to a driving means in the switch. This driving means comprises a long driving gear 13 which is journalled in the walls of the casing 10 and which drives means for operating a switching means in a manner described hereinbelow.

The switch operating means comprises a pair of traveling pinions 14 and 15 mounted for rotation and translational movement respectively in the same directions along the threaded portion of a mounting member or screw shaft 16. The traveling pinions 14 and 15 are meshed with the driving gear 13 and threaded back and forth along the normally stationary mounting member 16 between a pair of operating members 17 and 18 each of which is rotatable upon engagement by the leading one of the traveling pinions. At one end of the path of travel, a pin 19 on the traveling pinion 14 engages a pin 20 on the operating member 17 and at the other end of the path of travel, a pin 21 on the traveling pinion 15 engages a pin 22 on the operating member 18 for rotating these members.

The operating members 17 and 18 are rotatable on unthreaded portions of the mounting member 16. These members are identical and comprise the cams 23 and 24 and the operating pinions 25 and 26, the respective cam and operating pinion of each being integrally secured in axial relation for rotation on the mounting member 16. The pinion 25 of the operating member 17 carries the pin 20 on its inner side facing the traveling pinion 14 and its pin 19, and the pinion 26 of the operating member 18 carries the pin 22 in a similar relation to the traveling pinion 15 and its pin 21. The operating pinions 25 and 26 are preferably of the same diameter as the traveling pinions 14 and 15 and are provided with the spaces 25a on their peripheries form which a few gear teeth have been omitted. The spaces 25a formed by the missing gear teeth are in normal registry with the long driving gear 13 so that the operating pinions 25 and 26 will not be rotated thereby, the driving gear 13 extending adjacent the pinions 25 and 26 in parallel relation with the mounting member 16. When, however, either of the operating members 17 or 18 is turned slightly by its corresponding traveling pinion, the operating pinion 25 or 26 meshes with the driving gear 13 and is driven thereby. Rotation of the operating pinion 25 or 26, of course, rotates its respective cam 23 or 24 which in turn actuates the switching means.

The switching means comprises the pivoted switch arms 27 and 28 mounted on the ends of a rod 29 supported by the casing 10 and secured therein by a clamp 30 at the center. A pair of springs 31 and 32 serve to bias the switching arms 27 and 28 into respective engagement with their cams 23 and 24. The switch arms 27 and 28 are rotated respectively by the cams 23 and 24 for operating the respective movable contacts 33 and 34 carried at the forward end of the pivoted arms. As shown, the movable contacts 33 are of the spring-mounted bridging type and are normally open and operated to engage the fixed contacts 35 when the arm 27 is rotated clockwise (as viewed in Fig. 2) from its normal position. The movable bridging contacts 34 are normally closed and operated to disengage the fixed contacts 36, when the arm 28 is similarly rotated from its normal position. Connecting the fixed contacts 35 and 36 in the circuits to be controlled are the conductors 37 which are led out of a suitable opening in the front wall of the casing.

To prevent jamming of the controller after a predetermined overtravel or overrunning of the driving gear 13, means are provided for rotating the normally stationary mounting member 16. Frictional bearings 38 support the mounting member 16 at each end, the mounting member being secured by the clamps 39 and the springs 40 against normal rotation. Near the ends of the mounting member 16, the hubs 41 and 42 are provided having the projections 43 and 44 which are engaged by the pins 45 and 46 extending respectively from the outer faces of the cams 23 and 24. After a predetermined rotation of one of the cams 23 and 24, the pin 45 or 46 engages its hub 41 or 42 and the mounting member 16 is rotated in accordance with the angular movement of the driving gear 13, the hubs 41 and 42 being secured to the mounting member 16 by the pins 47. Rotation of the mounting member 16 by the driving gear 13 at a predetermined rate prevents further translational movement of the traveling pinions 14 and 15, and as will be more fully described hereinafter, damage to the controller by overtravel of the driving gear 13 cannot occur.

In operation of the controller, the length of the path of travel of the traveling pinions 14 and 15 may be adjusted by loosening the clamps 39 on the mounting member 16. The springs 40 then cause the mounting member 16 to rise in the casing 10 for enabling manual rotation of the traveling pinions 14 and 15 independently of the driving gear 13. One or both of the traveling pinions 14 and 15 is threaded on the mounting member 16 to the desired position. Then the traveling pinions are re-engaged or meshed with the driving gear 13, but in a predetermined angular relation, so that the pins 19 and 21 carried by each will register respectively with the pins 20 and 22 on the operating members 17 and 18 when the traveling pinions are driven to their operating positions.

From a starting position, preferably with the pin 21 of the traveling pinion 15 in engagement with the pin 22 of the operating member 18, the driving motor is operated to drive the driving gear 13 in a counter-clockwise direction as viewed from the right hand end in Fig. 1. The traveling pinions 14 and 15 are rotated clockwise on the mounting member 16 and translated from right to left thereon. After a predetermined travel, the pin 19 engages the pin 20 and the operating

member 17 is rotated in a counter-clockwise direction as viewed in Fig. 2 or as viewed in Fig. 1 in a clockwise direction as indicated by the arrow. Immediately, the operating pinion 25 is moved into mesh with the driving gear 13, the space 25a from which the gear teeth are omitted being moved out of registry with the driving gear. Rotation of the operating pinion 25, of course, causes like rotation of the cam 23 which forms a part of the operating member 17. As viewed in Fig. 2, counter-clockwise rotation of the cam 23 causes clockwise rotation of the switch arm 27 on its rod 29, and the normally-open contacts 33 and 35 are engaged.

Engagement of the contacts 33 and 35 may cause immediate reversal of the driving motor so that the driving gear 13 is rotated in the opposite direction, namely, clockwise as viewed from the right hand end in Fig. 1. Thereupon, the operating member 17 and the traveling pinions 14 and 15 are rotated counter-clockwise, the driving gear 13 positively driving the operating pinion 25 until the space 25a registers with the driving gear and rotation of the operating member 17 ceases. The cam 23 again enables the switch arm 27 to place the contacts 33 and 35 in the normally-open position, the spring 31 appropriately biasing the switch arm 27.

Continued rotation of the driving gear 13 clockwise causes the traveling pinions 14 and 15 to thread from left to right along the mounting member 16 until the pin 21 on the traveling pinion 15 engages the pin 22 on the operating member 18. Operation of the normally-closed contacts 34 and 36 to the open position occurs in a manner similar to that described in connection with the operation of the contacts 33 and 35. Thus, the driving motor may be stopped until it is again desired to initiate the control by operating the motor in the reverse direction. It will be understood, of course, that the motor may be made to operate and reverse continuously or may be made to operate only for one cycle of operation. Therefore, I do not wish to be limited to the particular forward and reverse operation described herein.

Referring now to Fig. 2, the manner in which jamming or damage to the controller is prevented may be described as follows. If the driving motor fails to stop or reverse in response to the operation of the controlling contacts 33, 35 or 34, 36 or if the control is effective but the motor overtravels due to its momentum, the driving gear 13 will continue to drive the operating member 17 or 18 and the traveling pinions 14 and 15. Considering the left hand end of the controller, as seen in Fig. 1 and Fig. 2, it appears that upon overtravel the traveling pinion 14 soon would ride into the operating member 17 and jam against it. To avoid such an occurrence, sufficient spacing is allowed between the traveling pinion 14 and the operating pinion 25 to permit at least one full revolution of the traveling pinion 14 after its pin 19 engages the pin 20 on the operating pinion. In this manner, because of a four to one gear ratio between the traveling pinions and driving gear 13, the driving gear safely may make substantially three revolutions without causing damage to the controller. Also, since the operating pinions 25 and 26 and traveling pinions 14 and 15 are of the same diameter, the operating member 17 will make one revolution during four revolutions of the driving gear.

As seen in Fig. 2, when the operating member 17 is turned counter-clockwise through slightly less than one revolution by rotation of the driving gear 13 approximately three revolutions, its pin 45 engages the projection 43 on the hub 41 which is secured to the mounting member 16. Immediately the mounting member 16 is rotated in the same direction and at the same speed as the traveling pinions 14 and 15. Since, both the mounting member 16 and the traveling pinions 14 and 15 now are rotating as a unit, further translational movement of the traveling pinions 14 and 15 cannot occur. Thereafter, the driving gear 13 may rotate indefinitely without damaging the controller, the contacts 33 and 35, however, being opened and closed during each revolution of the operating member 17. In this manner, a predetermined factor of safety, in this instance, three revolutions, is provided through which the driving gear 13 may turn without affecting contact operation, and thereafter the whole operating mechanism operates, but without damage to itself.

After overtravel, when the driving motor is finally stopped and reversed, the driving gear 13 drives the operating member 17 and through it the hub 41 and mounting member 16 to their respective normal positions, shown in Fig. 1 and Fig. 2. The space 25a in the operating pinion 25 again registers with the driving gear 13 to prevent further rotation of the operating member 17, and the controller is ready for operation without further resetting or manipulation. That is, the traveling pinions 14 and 15 may now be driven from left to right to operate the operating member 18 and the contacts 34 and 36.

To illustrate the use of a controller embodying my invention in a simple circuit, I have shown in Fig. 6 a pair of driving motors M_1 and M_2 for driving a planer bed back and forth, each motor operating the planer in one of the directions. If desired, a single reversing motor may be used instead, but that involves a reversing switch and additional contactors which, for the present purposes, would unduly complicate the circuit. As shown, the motors M_1 and M_2 are supplied from suitable three phase power lines L_1, L_2 and L_3. The motor M_1 is switched by the contactor 51 having the magnetic operating coil 52, and the motor M_2 is switched by the contactor 53 having the magnetic operating coil 54. Each contactor is normally open when its respective magnetic coil is de-energized.

The controller or limit switch contacts 55 and 56 serve to de-energize the magnetic coils 52 and 54 respectively at the end of the predetermined working stroke of the planer bed, the contacts 55 and the coil 52 being series connected to line L_2, and the contacts 56 and the coil 54 also being series connected to line L_2. In normal operation in this particular circuit, both sets of controller contacts 55 and 56 are normally closed, each set being opened when the traveling pinions have moved toward and operated it as hereinbefore described. In the present instance, the driving gear 13 is suitably connected to each of the motors M_1 and M_2 for operation thereby when the particular motor is energized.

The coils 52 and 54 are respectively energized from line L_1 through a suitable three position switch 57 which may be hand-operated to a neutral position as shown to de-energize the coils. If operated counter-clockwise, the switch 57 closes the circuit from L_1 through the coil 54 and the limit switch contacts 56 to line L_2. If operated clockwise, the switch 57 closes the cir-

cuit from line L_1 through the coil **52** and the limit switch contacts **55** to line L_2.

In operation, with the bed of the planer in some intermediate position ready to be moved, out to either end of its stroke, the switch **57** is moved to one or the other of its circuit closing positions. If, for instance, it is desired to operate the planer in one direction, the switch **57** may be moved clockwise from its neutral position shown. Immediately the contactor coil **52** is energized, the contactor **51** picks up and the motor M_1 operates. The motor M_1 drives the planer in the desired direction and simultaneously drives the operating mechanism of the controller to open the contacts **55** at the end of the predetermined stroke. When the contacts **55** open, the coil **52** is deenergized and the motor M_1 is disconnected.

The switch **57** may then be moved counterclockwise to energize the coil **54** and thereby close the circuit to the motor M_2 through the contactor **53**. The motor M_2 then drives the planer and operating mechanism in the opposite direction until the contacts **56** are finally opened and operation discontinued. Although for simplicity I have shown the switch **57** as a manually operated switching means, obviously automatic starting means for the motors may be used if continuous automatic operation is desired.

While I have shown a particular embodiment of my invention, it will be understood, of course, 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 any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The combination in a controller of a travelling member mounted for translational movement, a driving member connected to said travelling member to give said travelling member translational movement, an operating member mounted in the path of translational movement of said travelling member arranged to be driven by said driving member but normally in disengaged relation with said driving member, said operating member being engaged by said travelling member and moved thereby into engagement with said driving member for movement by said driving member, and control means operated by said operating member.

2. The combination in a controller operable to perform a control function after a predetermined time interval of driving means including a rotatable member, timing means including a pair of traveling members driven by said rotatable member, means mounting said traveling members for translational movement respectively in the same direction said traveling members being movable on said mounting means in one or the other of two predetermined translational directions depending upon the direction of rotation of said rotatable member means including a first and a second operating member operable by said traveling members, the first of said operating members being operated by one of said traveling members after a predetermined movement of said traveling members in one of said predetermined translational directions, the second of said operating members being operated by the other of said traveling members after a predetermined movement of said traveling members in the other of said predetermined translational directions, and adjustable supporting means for said mounting means whereby said mounting means is movable to move said travelling members out of driving relation with said rotatable member thereby to provide for adjustment of said travelling members on said mounting means for regulation of said translational movements of said travelling members.

3. The combination in a controller operable to perform a control function after a predetermined time interval of driving means including a rotatable member, timing means including a pair of traveling members driven by said rotatable member, means mounting said traveling members for translational movement respectively in the same direction, said traveling members being movable on said mounting means in one or the other of two predetermined translational directions depending upon the direction of rotation of said rotatable member, means including a first and a second operating member normally disengaged from said rotatable member, but movable by said traveling members into engaged driving relation with said rotatable member, the first of said operating members being moved into driving relation with said rotatable member by one of said traveling members after a predetermined movement of said traveling members in one of said translational directions, the second of said operating members being moved into driving relation with said rotatable member by the other of said traveling members after a predetermined movement of said traveling members in the other of said translational directions, and switching means operable by said operating members.

4. The combination in a controller operable to perform a control function of driving means including a driving gear, actuating means including a traveling pinion driven by said driving gear, a member having a threaded portion mounting said traveling pinion for rotational and translational movement thereon, an operating member provided with gear teeth and with a portion from which gear teeth are omitted said operating member being moved after a predetermined translational movement of said traveling pinion by said traveling pinion into operating relation with said driving gear, said gear teeth on said operating member meshing with said driving gear for movement of said operating member independent of said traveling pinion, and switching means operable by said operating member.

5. The combination in a controller operable to perform a control function of driving means including a driving gear, actuating means including a traveling pinion driven by said driving gear, a member having a threaded portion mounting said traveling pinion for rotational and translational movement thereon, an operating member provided with gear teeth and with a portion from which gear teeth are omitted, said operating member being mounted for rotation on said mounting member and after a predetermined translational movement of said traveling pinion being movable by said traveling pinion into operating relationship with said driving gear for rotation thereby, said gear teeth on said operating member meshing with said driving gear for rotating said operating member independent of said traveling pinion, and switching means operable by said operating member.

6. The combination in a controller operable to perform a control function of driving means, actuating means including a traveling member, means mounting said traveling member for rotational and translational movement thereon by

said driving means, an operating member on said mounting means movable by said traveling member into operating relation with said driving means for rotation thereby after a predetermined translation of said traveling member, said operating relation of said operating member and said driving means being independent of said traveling member, switching means operable by said operating member, and means including said operating members for rotating said mounting means thereby to prevent jamming of said controller upon overtravel of said driving means.

7. The combination in a controller operable to perform a control function of driving means including a rotatable member, actuating means including a pair of traveling members driven by said rotatable member means mounting said traveling members for rotational and translational movement respectively in the same direction, said traveling members being movable on said mounting means in one or the other of two predetermined translational directions depending upon the direction of rotation of said rotatable member, means including a first and a second operating member operable by said traveling members, the first of said operating members being movable into operating relation with said rotatable member by one of said traveling members after a predetermined movement thereof in one of said translational directions, the second of said operating members being movable into operating relation with said rotatable member by the other of said traveling members after a predetermined movement thereof in the other of said translational directions, said operating relations of said operating members and said rotatable member being independent of said traveling members, switching means operable by said operating members, and means including said operating members for rotating said mounting means to avoid further translational movement of said traveling members upon overtravel of said rotatable member, said mounting means and said traveling members rotating as a unit thereby to prevent jamming of said controller.

8. The combination in a controller operable to perform a control function of driving means including a driving gear, actuating means including a traveling pinion driven by said gear, a member having a threaded portion mounting said traveling pinion for rotational and translational movement thereon, an operating member provided with gear teeth and with a portion from which gear teeth are omitted, said operating member being moved after a predetermined translational movement of said traveling pinion by said traveling pinion into operating relationship with said driving gear, said gear teeth on said operating member meshing with said driving gear for moving said operating member independent of said traveling pinion, switching means operable by said operating member, and means including said operating member and a projection on said mounting member for moving said mounting member after a predetermined movement of said operating member by said driving gear, whereby further translational movement of said traveling pinion is prevented to avoid jamming of the controller upon overtravel of said driving means.

9. The combination in a controller operable to perform a control function of driving means including a driving gear, actuating means including a traveling pinion driven by said driving gear, a member having a threaded portion mounting said traveling pinion for rotational and translational movement thereon, an operating member provided with gear teeth and with a portion from which gear teeth are omitted, said operating member being mounted for rotation on said mounting member and after a predetermined translational movement of said traveling pinion being movable by said traveling pinion into operating relation with said driving gear for rotation thereby, said gear teeth on said operating member meshing with said driving gear for rotating said operating member independent of said traveling pinion, switching means operable by said operating member, and means including said operating member and a projection on said mounting member for rotating said mounting member after a predetermined rotation of said operating member by said driving gear, whereby further translational movement of said traveling pinion is prevented to avoid jamming of the controller upon overtravel of said driving means.

10. The combination in a controller of a normally fixed threaded member, a travelling gear mounted on said threaded member for rotational and translational movement thereon, a driving gear meshing with said travelling gear, an operating gear normally disengaged from said driving gear mounted to be engaged by said travelling gear after a predetermined translational movement of said travelling gear and moved thereby into engagement with said driving gear for rotation thereby, and control means actuated by said operating gear.

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