

Feb. 24, 1942.

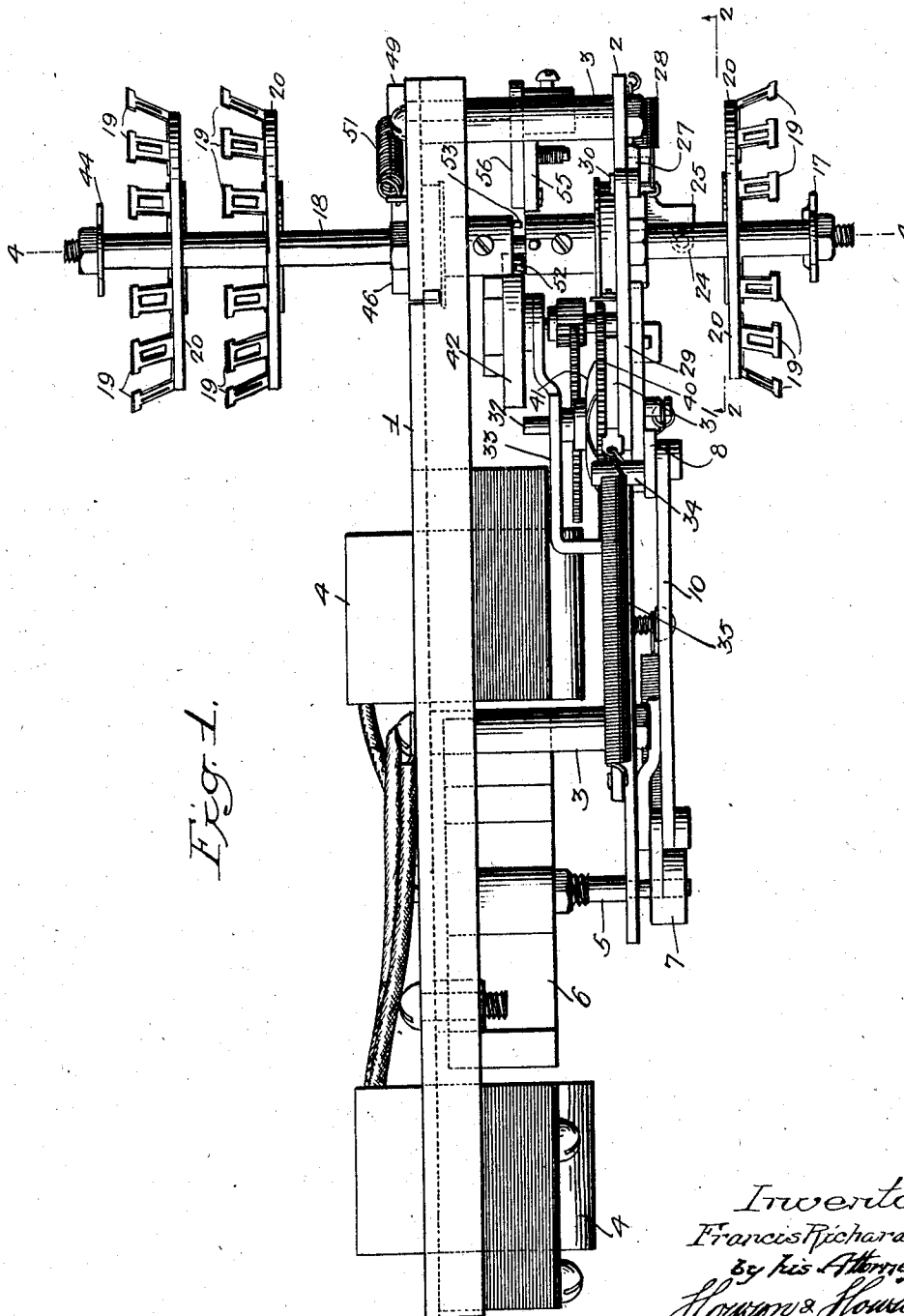
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2,274,564

STEP BY STEP POSITIONING DEVICE

Filed July 20, 1938

3 Sheets-Sheet 1



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Fig. 3.

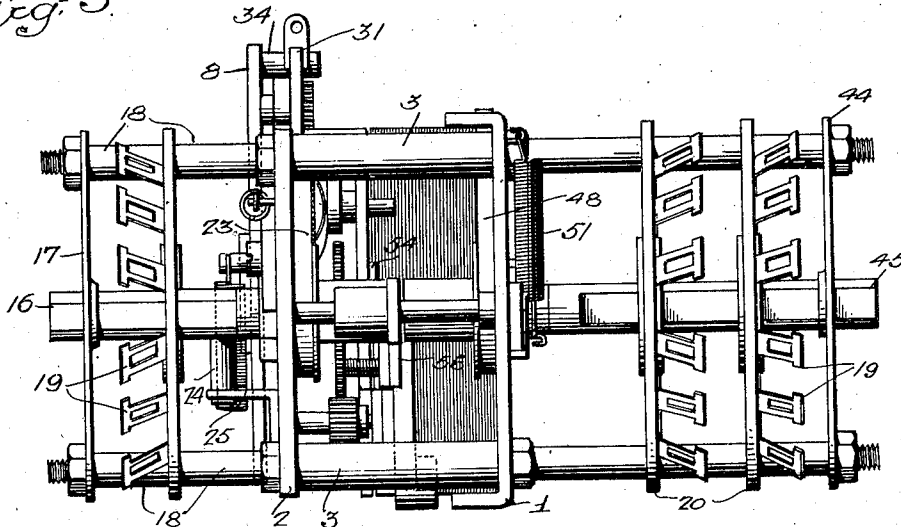


Fig. 4.

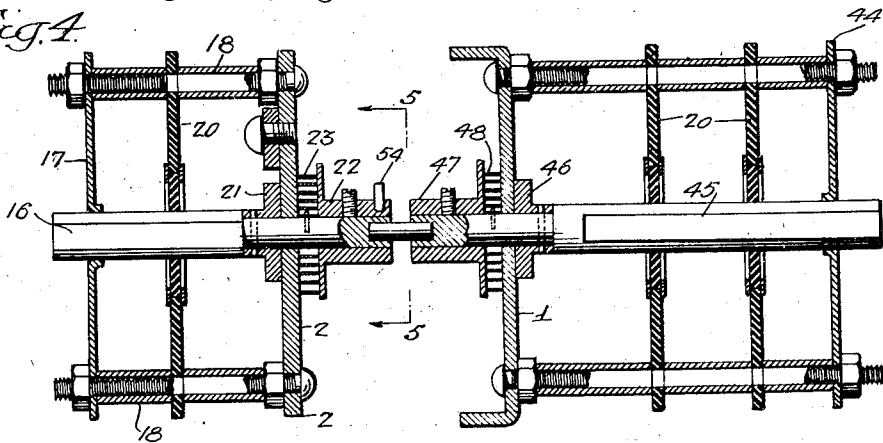


Fig. 6.

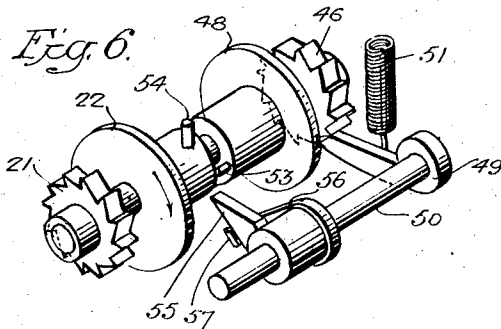
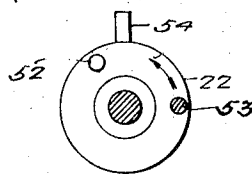


Fig. 5.



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UNITED STATES PATENT OFFICE

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STEP BY STEP POSITIONING DEVICE

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Application July 20, 1938, Serial No. 220,381

9 Claims. (Cl. 74-155)

This invention relates to positioning devices for actuating an element or elements to certain selectable positions and, more particularly, the invention relates to a novel step-by-step mechanism adapted to respond to control impulses and to position the controlled elements in a novel manner.

In the copending application of Milton L. Thompson, Serial No. 220,356, filed July 20, 1938, and the copending application of David Grimes and Elmer O. Thompson, Serial No. 220,366, filed July 20, 1938, there are disclosed and claimed certain remote control systems for radio receivers wherein the control of a radio receiver is effected by means of controlling impulses which actuate a stepping mechanism to effect volume control, station selection, and "off and on" actuation of the energizing switch at the receiver, as well as other desirable functions with which the present invention is not directly concerned. In those control systems, the controlling impulses are sent by means of a dial-controlled impulse generator which generates the controlling impulses under control of a finger-operated dial similar to a telephone dial. For reasons which are not important here, two of the finger positions of the dial are reserved for volume control impulses, and one of these finger positions is effective to cause generation of a pulse of fixed short duration followed by a control impulse of controllable duration, while the other of these finger positions is effective to cause generation of two pulses of fixed short duration followed by an impulse of controllable duration. One of the control impulse trains thus generated is adapted to effect a volume level change at the receiver in one direction, for example an increase in the volume level; while the other impulse train is adapted to effect a volume level change in the opposite direction, for example a decrease in the volume level. The subsequent finger positions of the dial are reserved for the control of station-selecting means at the receiver, the particular station selected in any instance being determined by the number of successive impulses of fixed short duration generated by the impulse-generating means under control of the dial. For example, if a train consisting of four successive short impulses is generated, a certain station will be selected at the radio receiver, while if a train of five impulses is generated, another station will be selected at the receiver, etc.

In the said copending Grimes and Thompson application, there is further disclosed a novel stepping mechanism comprising two shafts, one

adapted to control a step-by-step switch which effects volume control changes and also mutes or silences the receiver during station selection, while the other shaft is adapted to control station-selecting switches. The two shafts are rotatable relative to one another but are interconnected in a novel manner to effect rotation of the second shaft when the first shaft is operating through a portion of its operating range. In other words, the first shaft has a certain operating range, while the second shaft has a smaller operating range that is coextensive with a portion of the operating range of the first shaft. The first shaft is operated in a step-by-step manner by means of the controlling impulses and it rotates free of the second shaft in response to the volume control impulses above mentioned; but, when a train of station-selecting impulses is generated, the second shaft is operated in unison with the first shaft to effect station selection at the same time that the receiver is muted or silenced by the operation of the first shaft. It is further provided that the first shaft returns to its home position following the last control impulse while the second shaft is maintained in the position to which it is actuated to thus maintain the desired tuning of the receiver and when the first shaft is again actuated in response to a subsequent train of station-selecting impulses, the second shaft is returned to its home position and is again operated in unison with the first shaft.

By the present invention, there is provided a novel stepping mechanism which is adapted to control the positions of two shafts and associated switches in the manner of the above-mentioned stepping mechanism of the Grimes and Thompson application, but, in the present instance, the stepping mechanism is novelly constructed so as to be frequency selective with respect to the impulses received by it. More specifically, the present invention provides a novel mechanism wherein the homing action of the device is controlled by novel time delay means so that the homing action is effected according to the frequency of occurrence of the received impulses. It will be understood, therefore, that this invention provides a stepping mechanism which may be used in the system of the said copending Grimes and Thompson application and which is in the nature of an alternative embodiment of the stepping mechanism employed in the Grimes and Thompson system.

The principal object of the present invention, therefore, is to provide a novel stepping mechanism which is adapted to control the positioning

of two elements, such as rotatable shafts, one having a certain range of movement and the other having a range of movement coextensive with a portion of the operating range of the first element, and the two elements being operated in unison over their coextensive ranges.

Another object of the invention is to provide a device of this character embodying novel means responsive to the frequency of control impulses for governing the homing action of the device.

Still another object of the invention is to provide a novel positioning device for controlling the position of a movable element in response to received control impulse trains, which device embodies novel means for controlling the homing action thereof according to the frequency of occurrence of the successive impulses.

Other objects and features of the invention will be apparent hereinafter.

In the drawings:

Fig. 1 is a plan view of the complete mechanism;

Fig. 2 is an elevational view taken along line 2—2 of Fig. 1;

Fig. 3 is an end view of the structure of Fig. 1;

Fig. 4 is a sectional view taken along line 4—4 of Fig. 1;

Fig. 5 is a sectional detail view along line 5—5 of Fig. 4;

Fig. 6 is a perspective of a portion of the mechanism;

Figs. 7 to 9 are detail views of the assembly of Fig. 6;

Fig. 10 is a detail view of the governing mechanism;

Fig. 11 is a section on the line 11—11 of Fig. 10; and

Fig. 12 is a front face view of the switch assembly illustrating one of the switches.

Referring principally to Figs. 1 to 3, the frame of the device comprises the side plates 1 and 2 spaced by sleeves 3. To the plate 1, two electromagnets 4 are secured as shown. Journaled in the plates 1 and 2 is the shaft 5 on which there is mounted the magnet armature 6. On the end of shaft 5, adjacent plate 2, there is secured the crank arm 7. This arm is the driving member for the assembly comprising arm 8 pivoted at 9 and operatively connected to crank 7 by the link bar 10. Pivoted on the arm 8 is the pawl 11 which is biased by the spring 12 so as to constantly bear on the stop 13. The foregoing mechanism is urged to a normal position by the spring 14 which is tensioned between a pin on plate 2 and the hub of crank 7, as shown in Fig. 2, this normal position being established by stop 15 which may be made partially of rubber to reduce noise during operation.

As is the case in most step-by-step devices, this mechanism is energized by current impulses flowing through the windings of the electromagnets 4. In the present instance when the magnets are energized, the armature 6 will be rotated clockwise until it is horizontal, at which time all forces due to the magnetic fields will be balanced. The rotation of the armature, in response to the currents, will cause the similar rotation of the arm 8 and consequently the oscillation in a horizontal plane of the pawl 11.

Thus, by means of the crank 7 and link 10, the uniform rotation of the armature 6 is translated into substantially simple harmonic motion of pawl 11. This mechanism has the advantages that it prevents overthrow of the ratchet wheel 21 mentioned hereinafter and also is devoid of

strains or noises due to sudden stoppage of moving linkages.

As in the case of the switch described in the aforementioned Grimes and Thompson application, the switches of this mechanism operate in two sections. One section, which might be called the driver or principal section, is associated with a shaft 16 which is journaled in the side plate 2 and in the end bearing plate 17, which is spaced from plate 2 by sleeves 18. The switch proper (contacts) is clearly shown in Figs. 4 and 12, and is positioned between the plates 2 and 17 by the sleeves 18. The wiring lugs and contacts 19 are riveted to an insulating wafer 20 while a rotatable contact in the center of the wafer is driven by the shaft 16. This particular type of contact assembly will be recognized as a so-called "wafer" switch now commonly used in the radio art.

A toothed ratchet wheel 21 is secured to the shaft 16 adjacent the outside of plate 2 within the operating range of the pawl 11, as shown in Fig. 2. On the inside of plate 2, a flanged collar 22 (Fig. 4) is secured to the shaft 16, and a flat coil spring 23 is positioned between said collar and plate 2. The inner and outer ends of this spring are secured respectively to the shaft 16 and the plate 2, the spring normally being tensioned so as to urge the shaft 16 to rotate counterclockwise, as viewed in Fig. 2. Such rotation is limited and a normal or home position for the shaft is provided by a pin 24 mounted on the shaft 16 and adapted to abut a right angle stop 25 secured to the plate 2.

From the above description and Fig. 2, it will readily be seen that the oscillation of the armature 6 will cause the shaft 16 to oscillate similarly, and that if said shaft is to be advanced in accordance with the current impulses supplied to the device, some means, such as a holding pawl, must be provided to prevent counterclockwise rotation of the shaft. The functioning of the novel mechanism associated with such a pawl is an important part of this invention. At this point, it will be well to consider the results to be obtained. When the series of impulses supplied to the device is a regular timed signal train, the period of which is less than some predetermined value, it is desired that the shaft 16 be advanced one step for each impulse of the train, but after the last impulse has been received the shaft must return to normal. In other words, should the interval between two impulses exceed some predetermined time, the holding pawl associated with the ratchet 21 should be rendered inoperative. In the present case, this holding pawl 26 (Fig. 2) is pivoted at 27 to the plate 2. A small spring 28 serves to urge the pawl to engage the ratchet wheel 21 but this is normally prevented by the link bar 29 whose slotted end engages pin 30 carried by the pawl. The bar 29 is secured to a tongued member 31, which is mounted on a short shaft or stud 32 journaled in plate 2 and a bracket 33 secured to plate 2. This mechanism is shown generally in Fig. 2 and is shown in detail in Figs. 10 and 11. To actuate the member 31, a pin 34 is secured to the free end of the arm 8, so that clockwise rotation of the latter will rotate the member 31 against the action of spring 35, one end of which is secured to member 31 while the other end of the spring is secured to a stationary arm 35a on plate 2. This rotation of member 31 is greater than that necessary to allow the pawl 26 to engage the ratchet 21, and consequently the pin 30 will slide in the slot in bar 29, the end of

which will pass beyond the pin. When the armature 6 rotates back to normal, the pin 34 will no longer engage member 31. Consequently, the member 31 will begin to rotate under the influence of spring 35 and when the bar 29 has moved back so that pin 30 is forced to the left the ratchet 21 will be free of the pawl 26 and will be returned to normal or home position by spring 23.

Now it will be seen that if armature 6 is actuated at such a frequency that the pin 34 re-engages the member 31 before the same has drawn bar 29 against pin 30, release of the ratchet will not obtain. To make this action realizable, a novel governor mechanism is employed. This is best shown in Figs. 10 and 11. Basically, the governor consists of a train of gears, the last of which is weighted so that the system represents a body with considerable inertia. The driving member is member 31, as above noted. On the hub of member 31 is rotatably positioned the gear 40. An operative connection between member 31 and gear 40 is achieved by means of a friction clutch in the form of a cruciform spring member 41 positively secured to member 31 with its radially extending arms frictionally engaging the face of gear 40, which is the drive gear of a train which terminates in the weighted wheel 42. On the bracket 33, is secured a flat spring 43 with its free end hook-shaped to engage the teeth of one gear of the above train to prevent clockwise rotation of gear 40. The clutch above described serves to take the load of the governor off the rapidly moving driving mechanism during the power stroke, yet the load of the governor opposes the forces due to spring 35 to thus regulate the speed at which bar 29 returns to normal, thereby establishing the rate at which current impulses must be supplied to successively advance the shaft 16. That is, if the current impulses are supplied at too slow a rate, the shaft 16 will return to rest after each impulse. On the other hand, should the impulse rate be too high, the inertia of the armature and other parts will prevent rapid oscillation and the device will become stationary at a position determined by the current density in the electromagnet windings. The device, therefore, is somewhat frequency selective and is comparable to an electrical band pass filter.

Referring now to the second switch section, the wafer type switches thereof are mounted between plate 1 and the end bearing plate 44 for the operating shaft 45 of the second section. The shaft 45 is journaled in plates 1 and 44, and a ratchet 46 (Fig. 4) is secured to the shaft adjacent the outside of plate 1. The inner end of the shaft carries a flanged collar 47, and a spiral flat spring 48 is positioned between the same and the plate 1. Spring 48 is tensioned between the shaft 45 and the plate 1 so as to urge the shaft 45 to rotate in the same direction as shaft 16. To hold this shaft in the position to which it is advanced, a holding pawl 49 (Fig. 6) is mounted on a short shaft or stud 50 and urged into engagement with the ratchet at 46 by a spring 51. The means for driving the second section of the device comprises two pins 52 and 53 positioned respectively on the inner end faces of collars 22 and 47 respectively (see Figs. 5 and 6), so that when collar 22 is rotated the pin 52 will engage the pin 53 and thus drive the shaft 45. The pins also serve to limit the return rotation of shaft 45 when the pawl 49 is withdrawn.

The holding pawl 49 for the shaft 45 is released

to permit homing of the second section of the device by the cam 55 and the associated pin 54. The cam 55 (see Figs. 7 to 9) is pivotally mounted on an arm 56 carried by the stud 50. The end of arm 56 is bent or turned over at 57 to provide a stop for the cam 55 which is urged against its stop by a spring 58. The pin 54 is carried upon collar 22 and functions cooperatively with the cam 55 in the manner hereinafter set forth.

Considering the operation of the complete device, if a control signal train consisting of three or less successive pulses is received by the device, the shaft 16 will be operated in step-by-step fashion as above described, but the pin 52 will not rotate sufficiently from its home position to engage pin 53 and, therefore, the shaft 45 and associated second section of the device will not be operated. Of course, if the successive pulses are not properly timed, the first section will home itself as above described, thus discriminating between control pulses and random disturbance pulses that may be received. In the specific adaptation of the device to the control of a radio receiver, as disclosed in the said Grimes and Thompson application, the control signal trains of three or less successive pulses will be utilized to control the volume of the radio receiver and, therefore, the first three contacts of the switch first section will be connected for this purpose.

When a control signal train of four or more successive impulses is received, the pin 52 is rotated sufficiently to engage pin 53 and thus effect rotation of shaft 45 in unison with shaft 16. If the shaft 45 happens to be in an actuated position, as it generally will be, this shaft will be returned to its home position by the release of the holding pawl 49, which is effected when the pin 54 engages cam 55, thus rocking the stud 50. The consequent release of the holding pawl 49 permits homing of shaft 45 until pin 53 strikes pin 52. Thereafter, the stepping movement of shaft 16 effects movement of shaft 45 in unison with shaft 16. When the control impulses cease, the first section of the device is permitted to home itself as above described but the second section is maintained in the position to which it is actuated. The pivotal mounting of pawl 55 permits the pin 54 during its return movement to kick the pawl out of its way without affecting the holding pawl 49, as shown in Figs. 7 and 8. It will be understood that in the specific adaptation of the device to the control of a radio receiver, the contacts of the switches of the second section will be connected for station selection while the corresponding contacts of the first section switch will be connected to effect muting of the receiver. Since the present invention is concerned only with the specific stepping device, and not with the manner in which it may control a radio receiver, it is unnecessary to illustrate or describe further the connections of the device for such use.

Thus, it will be seen that the device comprises the two shafts 16 and 45, the shaft 16 having a certain range of movement from its home position and the shaft 45 having a range of movement from its home position coextensive with the operating range of shaft 16. Further, the first section of the device comprising shaft 16 is adapted to be operated independently of the second section comprising shaft 45, and, when the first section is operated through more than a predetermined number of steps, it functions through the mechanism provided to effect hom-

ing of the second section and then operate the second section in unison with the first section so that the two sections are operated simultaneously over their coextensive ranges. Furthermore, the homing of the first section is novelly controlled by means of the time delay mechanism which imparts frequency selective characteristics to the device.

Although a single specific form of the device has been illustrated and described for the purpose of disclosure, it will be understood that various modifications of the device are readily possible without departing from the scope of the invention.

I claim:

1. In a step-by-step positioning device, a movable element having a home position and arranged for movement to successive operating positions, an electromagnetically actuated rotatable armature, a longitudinally movable pawl, a crank and linkage connecting said armature and said pawl so as to translate uniform rotation of said armature into substantially simple harmonic motion of said pawl, for effecting step-by-step movement of said element to its successive positions, means tending to return said element to its home position, and speed controlled means actuated by said linkage for controlling said last-named means.

2. In a step-by-step positioning device, a rotatable shaft having a home position and a plurality of successive operating positions, means urging said shaft to its home position, means including a ratchet and pawl for maintaining said shaft in its operating positions, displaceable trip means normally maintaining said pawl out of engagement with said ratchet, a second pawl arranged cooperatively with said ratchet for stepping said shaft to its operating positions, an electromagnetically actuated rotary armature, a driving linkage for said second pawl including a crank arm on said armature, said linkage being constructed and arranged to translate rotary motion of said arm into substantially longitudinal motion of said second pawl and to displace said trip member, means tending to maintain said armature and linkage in a normal position and for rapidly restoring said armature and linkage to said normal position whenever actuated therefrom, and means for delaying the return of said trip member to its normal position after each displacement.

3. In a step-by-step positioning device, a rotatable shaft having a home position, means tending to maintain said shaft in its home position, a toothed wheel on said shaft, driving means adapted to engage said wheel and rotate said shaft, said driving means including an electromagnetically actuated armature arranged for rotary motion, a driving pawl arranged cooperatively with said wheel, a driving linkage including a crank arm on said armature, said linkage being constructed and arranged to translate rotary motion of said arm into substantially longitudinal motion of said driving pawl, a first spring-biased means adapted to maintain said wheel in each position to which it is moved, a second spring-biased means adapted to normally render said first spring means inoperative, said second spring-biased means including a longitudinally movable lever adapted to be displaced by said driving linkage, and a governor for controlling the return of said lever.

4. In a step-by-step device, an oscillable shaft, means for effecting oscillatory movement of said

shaft, a pivoted arm, a crank and connecting rod interconnecting said shaft and said arm, thereby to oscillate said arm, a pawl carried by said arm, a ratchet wheel engageable by said pawl, a rotatable shaft adapted to be driven by said ratchet wheel, means urging said driven shaft to its normal position, a holding pawl arranged to engage said ratchet wheel to hold said driven shaft in the positions to which it is rotated, spring means urging said holding pawl into engagement with said ratchet wheel, spring-biased means normally maintaining said holding pawl out of engagement with said ratchet wheel and operable by said arm to release said holding pawl, and means for delaying the return of said last means to normal position.

5. In a step-by-step device, an oscillable shaft, means for effecting oscillatory movement of said shaft, a pivoted arm, a crank and connecting rod interconnecting said shaft and said arm, thereby to oscillate said arm, a pawl carried by said arm, a ratchet wheel engageable by said pawl, a rotatable shaft adapted to be driven by said ratchet wheel, means urging said driven shaft to its normal position, a holding pawl arranged to engage said ratchet wheel to hold said driven shaft in the positions to which it is rotated, spring means urging said holding pawl into engagement with said ratchet wheel, a spring-biased linkage including a slotted bar connected to said holding pawl, for normally maintaining said holding pawl out of engagement with said ratchet wheel, cooperating means on said arm and an element of said linkage whereby said arm operates said linkage to release said holding pawl, said slotted bar permitting the holding pawl to remain effective during the return motion of said linkage, and means for delaying the return of said linkage to normal position.

6. In a step-by-step device, a rotatable shaft having a home position and a plurality of successive operating positions, a ratchet wheel on said shaft, a stepping pawl for actuating said ratchet wheel, means for driving said pawl through forward and return movements thereof, a holding pawl for said ratchet wheel, spring means urging said holding pawl into holding position, means normally maintaining said holding pawl in non-holding position, means actuated by said driving means simultaneously with the forward movement of said stepping pawl to render said last-named means ineffective, thereby permitting said holding pawl to move to holding position, and means for returning said maintaining means to normal position at a relatively slow rate.

7. In a step-by-step positioning device, a ratchet wheel, a reciprocating pawl for driving said ratchet wheel and adapted upon one or more of a predetermined number of actuations for rotating said wheel in step-by-step adjustment, electromagnetic means adapted to be energized at periodic intervals of time and having an armature operably connected to said driving pawl, a spring-pressed check pawl for said ratchet wheel, spring means for resetting said ratchet wheel to starting position upon disengagement of the check pawl, and gear and pinion type timing mechanism for controlling said check pawl for precluding resetting of said ratchet wheel to starting position during the time that said driving pawl is being successively actuated by said electromagnetic means within periodic intervals of time, said timing mechanism including an element actuated by the armature of said electro-

magnetic means for energizing said timing mechanism upon actuation of the driving pawl.

8. In a step-by-step positioning device, a rotatable ratchet wheel, a stepping means including a pawl adapted to engage and step said ratchet wheel, a pivoted holding pawl arranged cooperatively with said ratchet wheel, a spring arranged to urge said holding pawl into engagement with said ratchet, a pivoted member engaging said holding pawl and adapted to disengage the holding pawl from the ratchet wheel, a second spring connected to said member and adapted to move the same to its effective pawl-disengaging position, an actuator on said member engageable by said stepping means to move said member to ineffective position against the action of said second spring, thereby permitting said holding pawl to engage said ratchet wheel under the influence of said first spring, and means for delaying the return of said member to its effective position under the influence of said second spring following the release of said actuator by said stepping means.

9. In a step-by-step positioning device, a rotatable ratchet wheel, a stepping means including a pawl adapted to engage and step said ratchet wheel, a pivoted holding pawl arranged cooperatively with said ratchet wheel, a spring arranged to urge said holding pawl into engagement with said ratchet, means including a pivoted member for disengaging the holding pawl from the ratchet wheel, a second spring connected to said member and adapted to move the same to its effective pawl-disengaging position, an actuator on said member engageable by said stepping means to move said member to ineffective position against the action of said second spring, thereby permitting said holding pawl to engage said ratchet wheel under the influence of said first spring, and means for delaying the return of said member to its effective position under the influence of said second spring following the release of said actuator by said stepping means.

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