Dec. 8, 1942. F. E. SUTTON 2,304,514

MOTION REPEATING MACHINE

Filed March 19, 1941

Fig. 1

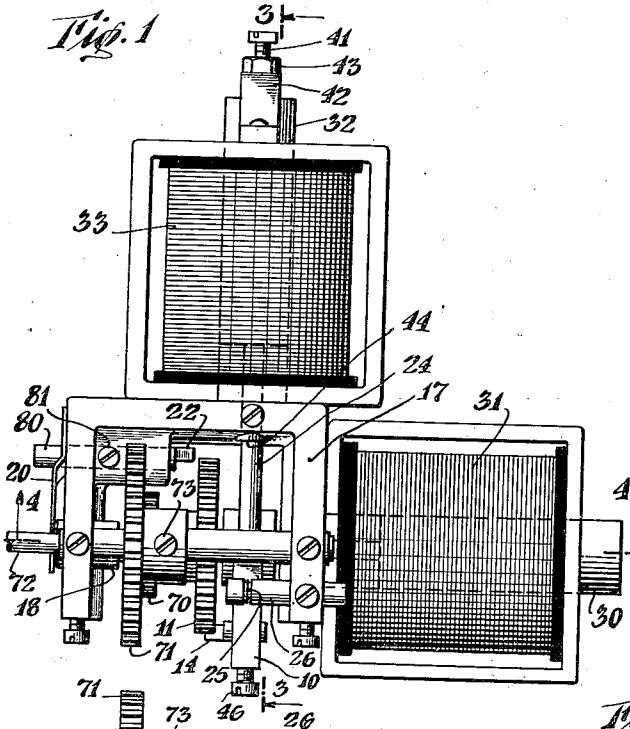


Fig. 2

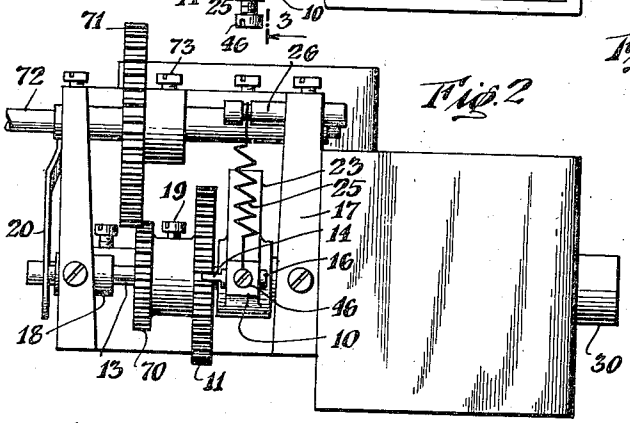


Fig. 4

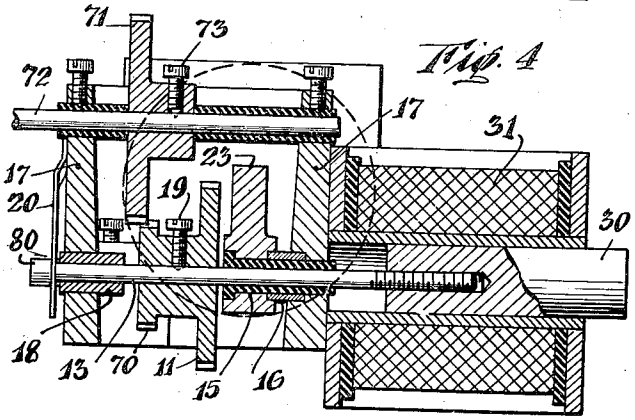


Fig. 3

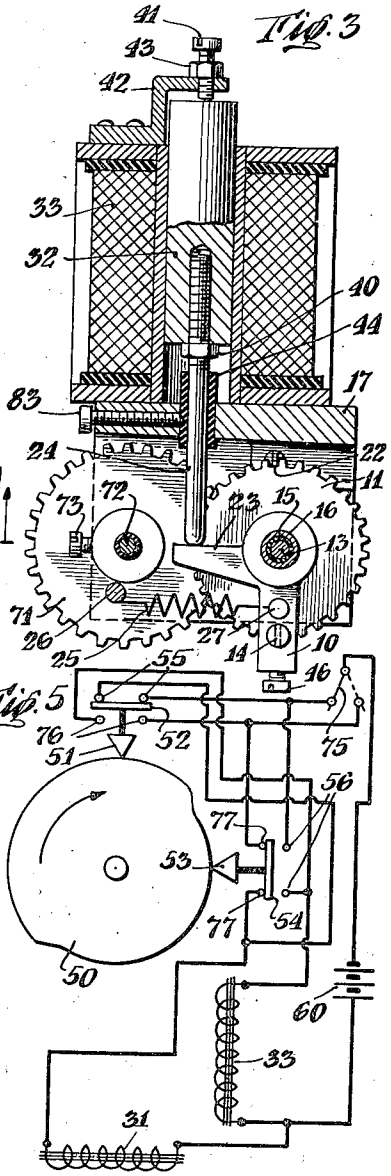
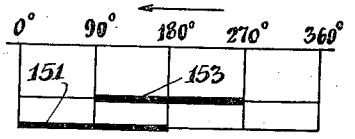


Fig. 5



INVENTOR

Frederic E. Sutton

BY

Cooper, Kerr & Dunham

ATTORNEYS

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MOTION REPEATING MACHINE

Frederic E. Sutton, Bloomfield, N. J.

Application March 19, 1941, Serial No. 384,066

9 Claims. (Cl. 74—126)

This invention relates to apparatus for translating or converting control pulses, such as pulses of electric current, hydraulic or pneumatic pressure, or the like, into accurately produced mechanical movements utilizable to operate indicators, recorders, dampers, valves, rheostats, electric switches, etc., especially where modulating or proportioning control is desired.

The invention has for objects, among others, to provide apparatus, of the class referred to, which is more reliable and accurate, comparatively inexpensive to construct and maintain and comparatively powerful with respect to previously proposed apparatus of the general class, and capable of widespread uses, some of which have been mentioned above.

Other objects and advantages of my invention will appear to those skilled in the art upon reading the following description of the invention and of the manner and process of making, constructing, compounding, and using it, and I shall also explain herein what I now believe to be the principle thereof, and the best mode in which I have contemplated applying that principle.

Desiring to have it understood that my invention may be carried out by other means and with other apparatus, and that it may be used in other environments and for other purposes, I shall now proceed to describe what I now consider to be a preferred form of apparatus for practicing the invention.

Referring to the drawing, which illustrates the said preferred form of my invention:

Figure 1 is a top plan view of the translating or controlling apparatus.

Fig. 2 is a front elevation of the apparatus shown in Fig. 1.

Fig. 3 is a sectional elevation taken on a vertical plane through the line 3—3 of Fig. 1.

Fig. 4 is a sectional elevation taken on a vertical plane through the line 4—4 of Fig. 1.

Fig. 5 is a somewhat diagrammatic view showing one form of control connections.

The apparatus comprises a reciprocatory actuating device 10 and an element 11 to be unidirectionally actuated thereby. While the invention may be embodied in other forms in which the actuating device and the actuated element move rectilinearly, I prefer the form shown in which the actuating device 10 is mounted for oscillation about the axis of the shaft or rod 13, and the element 11 to be actuated is mounted for movement about the same axis.

I provide means, presently to be described, for oscillating the device 10. I also provide means for positively locking the element 11 to the actuating device 10 at certain selected predetermined times in the operation of the latter. This last mentioned means, as shown, is a form of mechanical clutch comprising teeth and interposed between the device 10 and the element 11 and which when operative (in clutching position) compels the device 10 and the element 11 to move as a unit about the axis of the shaft 13, and which when inoperative (de-clutched) permits relative movement of the device 10 with respect to the element 11 about the axis of the shaft 13, thereby breaking the drive connection. While more pins or teeth could be provided, I have shown the device 10 provided with only one tooth or pin 14, having found that this will suffice for many of the uses to which the apparatus may be put. This tooth or pin 14 is adapted to engage into any one of a plurality of equi-angularly spaced openings in the element 11 which, conveniently, may be the peripheral openings between the teeth of a spur gear, as shown. When the tooth 14 is in any of the spaces between adjacent teeth of the element 11, the latter is positively clutched or locked to the device 10 so far as movement in either direction about the axis of the shaft 13 is concerned (see Figs. 1 and 2).

The device 10 and the element 11 are relatively movable axially to effect clutching and de-clutching. In the particular apparatus shown, the actuating device 10 is constrained against endwise or axial movement by being provided with annular shoulders which cooperate with annular shoulders provided by the sleeve 15—16 fixedly secured to the frame 17 of the apparatus. Thus, the actuating device is incapable of any movement except oscillatory movement about the axis of the shaft 13. The element 11 is not only rotatably mounted but also for endwise or axial movement from the clutching position shown in Figs. 1 and 2, to a position to the left in which the pin or tooth 14 is completely disengaged. To this end, the hub of the element 11 is fixedly secured, as by means of a set screw 19 to the shaft 13, mounted for rotation and endwise movement in the sleeves 15, 18, secured to the frame of the apparatus. In the particular embodiment shown, the shaft 13 is urged or biased toward the right (Figs. 1, 2 and 4), i. e. to clutch parts 10—11, by a leaf spring 20 fixed at one end to the frame 17 and engaging at its free end a projecting portion of the shaft 13 (see particularly Fig. 4).

From the description thus far it will be appre-

ciated that if the device 10 is oscillating and the element 11 is clutched to the said device 10 during front or forward strokes of the latter, and de-clutched during back or return strokes, the element 10 will be advanced step-by-step unidirectionally, i. e. in the same single direction about its axis of rotation. If the element 11 is clutched to the device 10 during back strokes of the latter and de-clutched during front strokes, the element 11 will be advanced step-by-step unidirectionally in the opposite direction.

Before proceeding further with the description of the apparatus for oscillating the device 10 and for effecting clutching and de-clutching, I shall now describe another important feature of the apparatus shown. It is desirable in many cases to insure that the element 11 shall not move angularly, or about its axis of rotation between actuating strokes of the device 10, i. e. when the parts 10—11 are de-clutched. To rely solely upon friction in some cases to prevent or impede such undesired angular movement or rotation would be unsafe and moreover such friction would be undesirable during active strokes of the device 10 in advancing the element 11. I therefore provide means for automatically locking the element 11 against any and all movement about the axis of the shaft 13 except when the said element 11 is clutched to the device 10. A simple though effective form of such means is a stationary locking pin 22 mounted in the frame of the apparatus and engageable with the space between adjacent teeth on the element 11 after the fashion of the tooth or pin 14 but when the device 10 and element 11 are de-clutched. In the embodiment shown the design and/or adjustment of parts are such that (1) the element 11 is at all times either locked against any and all angular movement by engagement with the pin 22, or locked or clutched to the device 10 and constrained to move with it as a unit (this being effected by the entry of one of the pins 14, 22 between adjacent teeth on the element 11 before the other of said pins leaves the space between adjacent teeth on the said element) and (2) whenever the element 11 has completed an increment or step of movement under propulsion by the device 10, the locking pin 22 will be in accurate alignment with respect to a space between adjacent teeth on the element 10, and (3) whenever the element 11 is moved axially to effect clutching of the parts 10—11, a space between adjacent teeth of the element 11 will be in accurate alignment with the tooth or pin 14. By these provisions all undesired angular movements of the element 11 are prevented and accuracy in operation is attained.

I shall now proceed with the description of the illustrated means for oscillating the actuating device 10. The latter, which carries the tooth or pin 14, constitutes one arm (see Fig. 3) of a bell-crank lever which, as stated, is mounted for oscillation on the sleeve 15—16, and whose other arm 23 is engaged by and operated in one direction (counter-clockwise as viewed in Fig. 3) by a plunger or reciprocatory rod 24 mounted for sliding movement in the frame of the apparatus. The said bell-crank lever is urged or biased in the opposite direction (clockwise as viewed in Fig. 3) by a tension spring 25 secured at one end to a stationary pin 26, mounted in the frame of the apparatus and, at its opposite end to a pin 27 secured to the arm or device 10.

While other means such, for example, as pneumatically or hydraulically operated suitably controlled pistons, diaphragms, or Sylphons, may be employed, at least in some cases, for operating the shaft 13 and the plunger or rod 24 in directions against the force exerted by the respective springs 20 and 25, I now prefer to use solenoids to accomplish the stated functions. Thus, the shaft 13 has secured thereto, at the end opposite the spring 20 (Fig. 4), the magnetizable core 30 of a solenoid whose stationary winding 31 is secured to and carried by the frame 17 of the apparatus. Also, the plunger rod 24 has secured thereto (Fig. 3) the magnetizable core 32 of a solenoid whose stationary winding 33 is secured to and carried by the frame 17 of the apparatus. When the coil or winding 31 is energized, the shaft 13 is thereby moved to the left (Fig. 4) to de-clutch the actuating device 10 and the element 11, and when the coil 31 is de-energized, the spring 20 moves the shaft 13 to the right to effect clutching. When the coil or winding 33 is energized, the actuating device 10 is thereby moved in a counter-clockwise direction (Fig. 3), and when the coil 33 is de-energized, the spring 25 moves the device 10 in the opposite direction, i. e. clockwise (Fig. 3).

To facilitate accurate control or adjustment of the throw or stroke of the tooth or pin 14 and accurate control or adjustment of the relative positions of the pin 22, element 11 and pin 14, I have made the following provisions. The core 32 is tapped to receive the screw-threaded end of the rod 24 whereby upon relatively rotating the core and rod, the length or distance from the outer end of the core and the outer end of the rod may be adjusted and then locked in adjusted position by the lock nut 40. The outer end of the core 32 abuts against a stationary stop to limit the stroke of the device 10 under the action of the spring 25. This stop, shown as a screw 41 which screws into a tapped hole in the bracket 42 secured to the frame of the machine, may be adjusted by turning it as desired, and then locked in adjusted position by the lock nut 43. The other limit of the stroke of the device 10 is determined by abutment of the nut 40 against the end of the adjustable sleeve 44 in which the rod 24 is slidably mounted. The pin or tooth 14 has a cylindrical shank portion (the right hand portion—Figs. 1 and 2) which seats in a cylindrical hole provided in the element 10, whereby the pin 14 may be angularly adjusted about its own axis and may be longitudinally adjusted in directions parallel to the axis of the shaft 13. The pin or tooth 14 may be locked in any of its adjusted positions by a set screw 46 which may be screwed into and out of a suitably tapped radial hole provided in the outer end of the device 10 and which intersects, at right angles, the bore in which the shank of the pin or tooth 14 is mounted. The purposes and advantages of these various adjustments should now be apparent in view of the foregoing disclosures and description herein.

Fig. 5 shows one of the more numerous systems of electrical connections which may be utilized if solenoids such as 30—31 and 32—33 are employed in the production of the desired oscillations of the device 10 and in the control of the movements of the element 11 by the device 10. Assume that the cam disc 50 is rotated manually or automatically and it is desired to reproduce its movement synchronously or proportionately by the element 11 (or by apparatus actuated thereby, as herein-

after described). To this end, the following switches and electrical connections may be satisfactorily employed.

The cam 50 has associated therewith switch operating elements 51, 53 which are movable only in reverse directions radially with respect to cam disc 50. When the high part of the cam 50 engages the switch operating element 51 it causes the conducting bridge piece 52 electrically to connect the fixed contacts 55, and when the low part of the cam 50 engages the operating element 51, the latter moves toward the cam 50 (being biased in that direction by gravity or other suitable well-known means) and the bridging connection between the contacts 55 is broken. The switch operating element 53 is similarly operated when the high part of the cam 50 reaches it to cause the bridge piece 54 electrically to connect the contacts 56 and to disconnect them while the low part of the cam 50 arrives. The solenoid winding 31 is electrically connected in series with the contacts 55—55 across a suitable source of E. M. F. 60, and the solenoid winding 33 is electrically connected in series with the contacts 56—56 across the same source 60; a common return conductor being employed between the source 60 and one end of each of the windings 31, 33. The sequence and duration of closure of the cam operated contacts is indicated in the developed cycle diagram at the bottom of Fig. 5 and included as a part thereof. There the shaded strips 151, 153 represent the intervals during each revolution of the cam 50 when the contacts 55—55 and 56—56, respectively, are bridged, i. e. electrically closed.

Assume, as stated, that the cam 50 is rotating clockwise. The contacts 55—55 have been closed by the arrival of the high part of the cam, and the winding 31 has been energized, resulting in de-clutching device 10 from element 11. Continued rotation of the cam 50 causes the high part thereof to arrive at the switch-operating element 53, thereby closing the contacts 56—56 and energizing the solenoid winding 33. Thereupon the actuating device 10 is operated one stroke in a counter-clockwise direction (as viewed in Fig. 3, or clockwise as viewed from the left looking toward the right in Fig. 1) but the element 11, being at this time de-clutched from the actuating device 10, does not move with it through that stroke, but remains stationary, being locked against angular movement in either direction by the pin 22. Continued rotation of the cam 50 causes the low part thereof to arrive at the switch-operating element 51, whereupon the contacts 55—55 are opened, the winding 31 de-energized, and the device 10 and element 11 become clutched. Continued rotation of the cam 50 causes its low part to arrive at the switch-operating element 53 thereby opening the contacts 56—56 and de-energizing the winding 33. Thereupon the actuating element is returned by the spring 25 to the position shown in Fig. 3. During this stroke the parts 10, 11 stand clutched so that angular movement of the element 11 is produced, the element 11 moving in unison with the device 10. This cycle is repeated as long as the cam continues to rotate in the direction assumed and indicated.

If and when the cam 50 reverses its direction of rotation, the direction of angular movement of the element 11 is also reversed and automatically. Now the element 11 will be actuated by movement of the actuating device 10 by its solenoid 32—33; the parts 10—11 being de-clutched during the stroke produced by the spring 25.

Thus the angular movement of the element 11 will be at all times proportionate to that of the cam 50 and in the same direction as that of the cam. If it is desired to produce or equal angular displacement of an element adjacent the element 11, with respect to the cam 50, this may be achieved by suitable gearing driven by the element 11. In other cases it may be desirable to produce proportionate angular movement at a lower ratio. This may be achieved in various ways among which is that illustrated, embodying a spur gear 70 secured to the same hub as the element 11 and continuously in mesh with a larger spur gear 71 (regardless of endwise movements of the element 11) secured as by means of a set screw 73 to a suitably journaled shaft 72. The shaft 72 may be employed to operate any of a variety of desired instrumentalities such as an indicator, recorder, damper, etc.

The repeating apparatus shown in Figs. 1 to 4 may be located remotely with respect to the controlling cam 50, there being but three line wires, or two line wires and a ground return, required to achieve the results thus far described.

In some cases it may be desirable to reverse the direction of angular movement of the element 11 with respect to that of the controlling cam 50. While this could be effected by reversing certain of the leads or conductors, it may be more conveniently and quickly accomplished by means illustrated and which I shall now proceed to describe.

A switch 75, which may be manually operable, when moved from the full line to the dotted line position, removes the control from the back contacts 55—55, 56—56, and causes front contacts 76—76 and 77—77 of the switch-operating elements 51, 53 to assume control. It will be seen that the winding 31 will now be controlled by the front contacts 77—77, and the winding 33 by the front contacts 76—76. These front contacts are opened when the high part of the cam 50 arrives at the corresponding switch-operating element 51, 53, and are closed, i. e. conductively bridged, when the low part of the cam arrives.

Among other advantages which will now be apparent, it will be appreciated that the apparatus shown in Figs. 1 to 4 may be duplicated or any number thereof may be operated in exact synchronism with each other from a single cam control. The particular system shown may be supplied either A. C. or D. C., the source 60 being merely diagrammatic.

It will be noted that when the parts 10 and 11 are de-clutched, there is no tendency for the latter to move angularly, by friction or otherwise, with the former, i. e. with the actuating device 10. Furthermore, when the parts 10 and 11 are clutched, i. e. locked together, the entire torque is transmitted mechanically and not magnetically in any sense. In fact, when the winding 31 is de-energized, the parts 10 and 11 are clutched or locked together. I wish also to emphasize that during the entire operation, and even when the line is dead and both solenoids 31, 33, deenergized, the element 11 is in engagement with at least one of the pins 14 and 22. Moreover, the shapes of the pin or tooth 14 and the teeth on the element 11, with which the tooth 14 cooperates, are such that when the parts 10 and 11 are clutched, the same torque would

continue to be transmitted by the device 10 to the element 11 even though the spring 20 were not present. In short, when angular movement is being transmitted by the device 10 to the element 11, there is no tendency of the tooth 14 to push the element 11 away or in any direction parallel to the axis of the shaft 13.

I have described above an adjustable mounting of the pin or tooth 14 in the device 10 and how that pin may be held in desired positions of adjustment by means of a set screw 46. The stop pin 22 is shown similarly adjustable in the frame of the machine by virtue of its cylindrical shank portion 89, and the set screw 81 similar to the set screw 46 serves as a means for locking the pin 22 in any of its desired positions of adjustment.

The sleeve 44 (Fig. 3) whose upper end limits, by the nut 40 abutting it, the extent of downward stroke of the rod 24, is shown adjustably mounted in the frame of the machine so as to be movable vertically up or down in the frame and then held in the desired position of adjustment by means of a set screw 83 which extends into a tapped opening provided in the frame at right angles to the sleeve.

In accordance with the provisions of the patent statutes, I have herein described the principle of operation of my invention, together with the apparatus which I now consider to represent the best embodiments thereof, but I desire to have it understood that the apparatus disclosed is only illustrative and that the invention can be carried out by other means. Also, while it is designed to use the various features and elements in the combinations and relations described, some of these may be altered and others omitted, without interfering with the more general results outlined, and the invention extends to such use within the scope of the appended claims.

What I claim is:

1. In apparatus of the class described, in combination, an actuating device mounted for reverse movements about an axis, an element to be actuated thereby and mounted for reverse movements about the same axis, a mechanical clutch interposed between said device and element and including teeth for preventing all relative movement between said device and element about said axis when said clutch is in clutching position, means for operating said actuating device, means for operating said clutch from clutching to de-clutched position and vice versa, and means controlling the sequence of operation of said first and second named means for causing successive movements of said device in either direction about said axis to actuate said element about said axis unidirectionally in the selected direction.

2. In apparatus of the class described, in combination, an actuating device mounted for reverse movements about an axis, an element to be actuated thereby and mounted for reverse movements about the same axis, a mechanical clutch interposed between said device and element and including teeth for preventing all relative movement between said device and element about said axis when said clutch is in clutching position, means for operating said actuating device, means for operating said clutch from clutching to de-clutched position and vice versa, means controlling the sequence of operation of said first and second named means for causing successive movements of said device in either direction about said axis to actuate said element about said axis unidirectionally in the selected direction, and means positively locking said element against movement except when said clutch means is in operative condition.

3. Apparatus for converting reciprocatory motion into unidirectional motion comprising, in combination, a reciprocatory device, an element to be actuated thereby, clutch means for positively locking said element to said device to drive said element, means including a solenoid having a stationary winding for operating said clutch means from operative to released condition and vice versa, means including a second solenoid having a stationary winding for operating said reciprocatory device and correlated to said last mentioned means for causing said element to be driven by said device only on forward strokes of the latter, or only on backward strokes thereof, and means controlling the sequence of energization of said translating instruments.

4. Apparatus for converting reciprocatory motion into unidirectional motion comprising, in combination, a reciprocatory device, an element to be actuated thereby, clutch means for positively locking said element to said device to drive said element, means including an energy-converting translating instrument for operating said clutch means for operative to released condition and vice versa, means including a second energy-converting translating instrument for operating said reciprocatory device and correlated to said last mentioned means for causing said element to be driven by said device only on forward strokes of the latter, or only on backward strokes thereof, means positively locking said element against movement except when said clutch means is in operative condition, and means controlling the sequence of energization of said translating instruments.

5. Apparatus for converting oscillatory motion into unidirectional rotational motion comprising, in combination, an oscillatory device, a rotatably mounted element to be actuated thereby, clutch means for positively locking said element to said device to drive said element, means including a solenoid having a stationary winding for operating said clutch means from operative to released condition and vice versa, means including a second solenoid having a stationary winding for operating said oscillatory device and correlated to said last mentioned means for causing said element to be driven by said device only on forward strokes of the latter, or only on backward strokes thereof, and means controlling the sequence of energization of said translating instruments.

6. Apparatus for converting oscillatory motion into unidirectional rotational motion comprising, in combination, an oscillatory device, a rotatably mounted element to be actuated thereby, clutch means for positively locking said element to said device to drive said element, means including an energy-converting translating instrument for operating said clutch means from operative to released condition and vice versa, means including a second energy-converting translating instrument for operating said oscillatory device and correlated to said last mentioned means for causing said element to be driven by said device only on forward strokes of the latter, or only on backward strokes thereof, means positively locking said element against movement except when said clutch means is in operative condition, and means controlling the sequence of energization of said translating instruments.

7. In apparatus of the class described the combination with a reciprocatory device and an element to be actuated thereby, of means including an energy-converting translating instrument for causing relative movement of said device and element for positively locking them together during actuating movement of said device in one direction and for releasing said element from said device upon idle reverse movement of the latter, and additional locking means relatively movable with respect to said element for preventing undesired movement of said element whenever the latter is not locked to said device.

8. In apparatus of the class described, in combination, a reciprocatory actuating device, an element to be actuated thereby, means including a solenoid having a stationary winding for causing relative movement of said device and element for positively locking them together, means including another solenoid having a stationary winding for reciprocating said device, and means controlling the sequence of operation of said first and second named means for causing successive strokes of said device in either direction to actuate said element unidirectionally in the selected direction.

9. In apparatus of the class described, in combination, a reciprocatory actuating device, an element to be actuated thereby, means including an energy-converting translating instrument for causing relative movement of said device and element for positively locking them together, means including a second energy-converting translating instrument for reciprocating said device, means controlling the sequence of operation of said first and second named means for causing successive strokes of said device in either direction to actuate said element unidirectionally in the selected direction, and means positively locking said element against movement except when said element is being actuated by said device.

FREDERIC E. SUTTON.

CERTIFICATE OF CORRECTION.

Patent No.2,304,514. December 8, 1942.

FREDERIC E. SUTTON.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 3, first column, line 19, for "while" read --when--; page 4, second column, line 29, claim 4, for the words "means for" read --means from--; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 9th day of February, A. D. 1943.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)