J. H. DEAN.

VOTING MACHINE.

APPLICATION FILED AUG. 11, 1910.

1,194,332.

Patented Aug. 8, 1916.

3 SHEETS—SHEET 1.

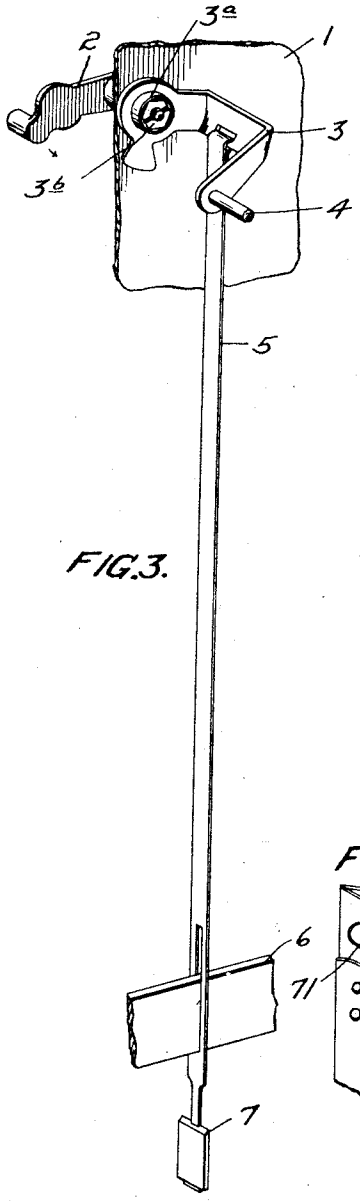


FIG. 3.

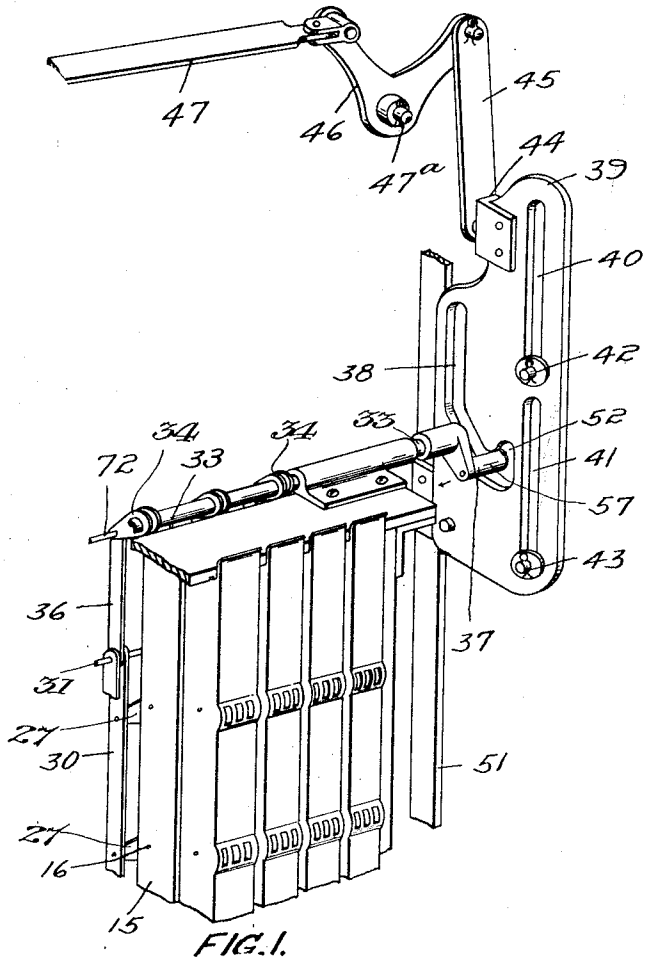


FIG. 1.

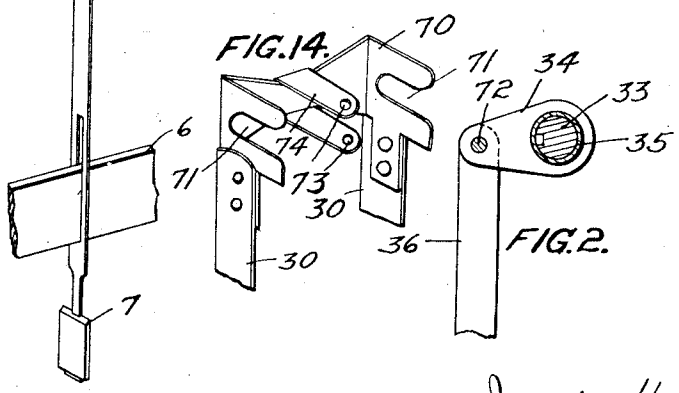


FIG. 14.

FIG. 2.

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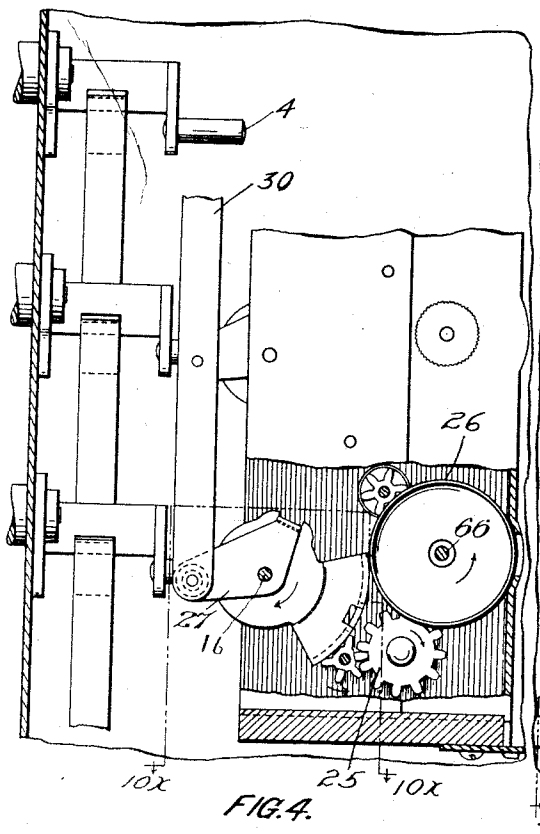


FIG. 4.

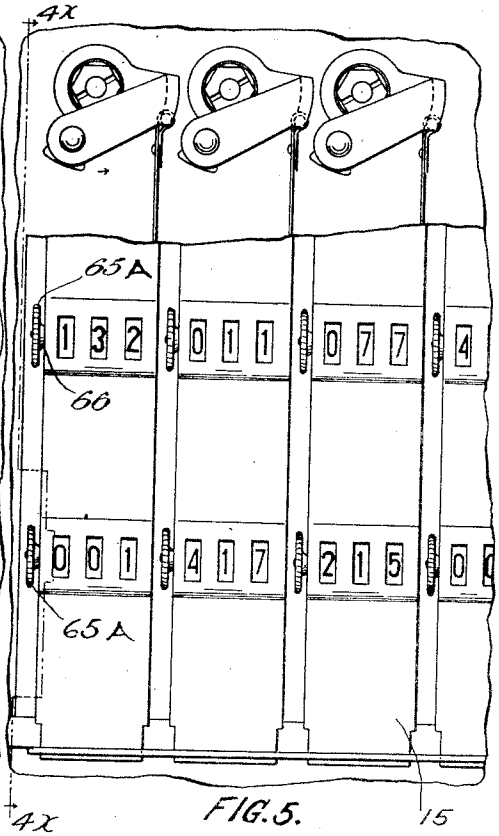


FIG. 5.

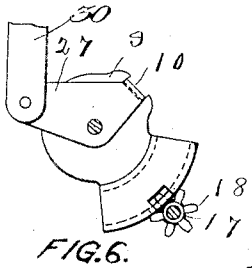


FIG. 6.

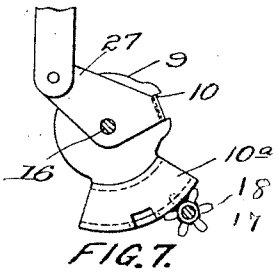


FIG. 7.

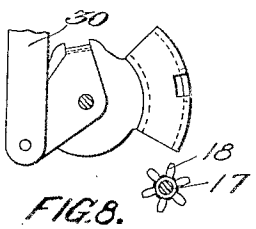


FIG. 8.

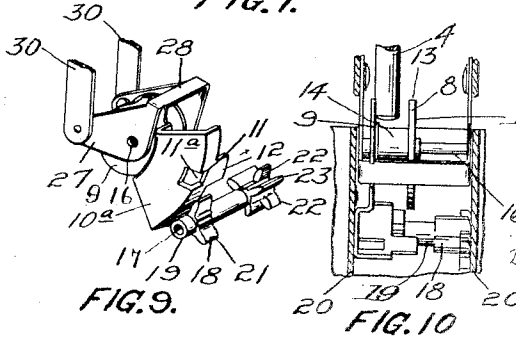


FIG. 9.

FIG. 10.

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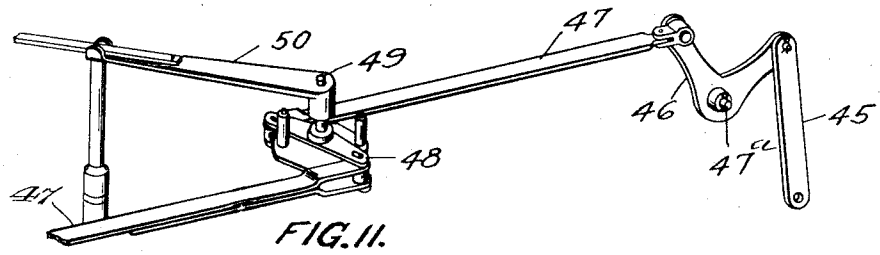


FIG. 11.

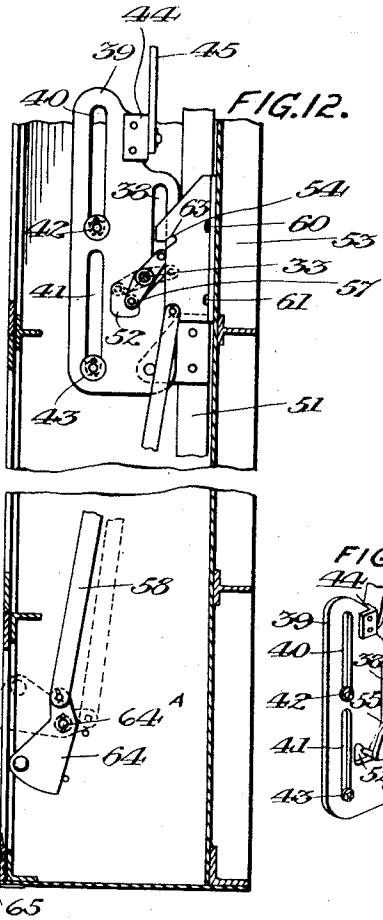


FIG. 12.

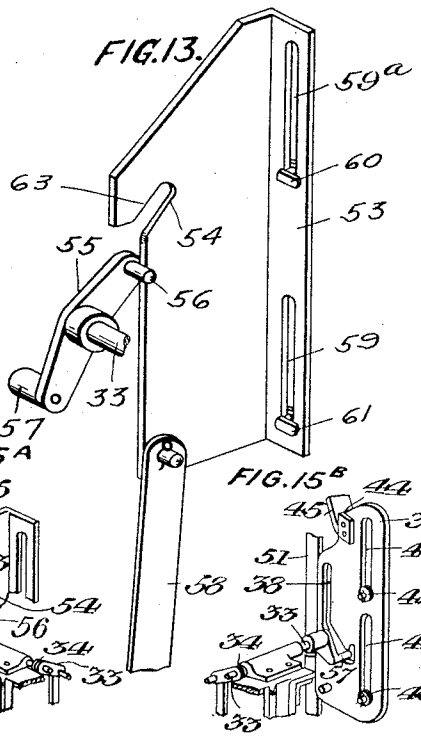


FIG. 13.

FIG. 15A

FIG. 15B

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UNITED STATES PATENT OFFICE.

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VOTING-MACHINE.

1,194,332. Specification of Letters Patent. Patented Aug. 8, 1916.

Application filed August 11, 1910. Serial No. 576,620.

To all whom it may concern:

Be it known that I, JAMES H. DEAN, a citizen of the United States, residing at Chicago, in the county of Cook, State of Illinois, have invented certain new and useful Improvements in Voting-Machines, of which the following is a specification.

The present invention consists of an improved counter applied to a machine of the type described in Patent 820,802 issued to W. J. Lausterer, and Patent 945,714.

It also consists of the mechanism driving, operating, resetting and controlling said counters.

The invention further consists of the features of construction that will be hereinafter more fully described and illustrated in the accompanying drawings and pointed out in the claims.

In the accompanying drawings, Figure 1 is a detail perspective view of the upper right hand corner of the machine as viewed from the rear, showing a portion of the counter channels and the operating mechanism of the machine. Fig. 2 is a sectional view of the rock shaft which drives the counter actuators. Fig. 3 is a perspective view of the voting key with the interlocking strap annexed. Fig. 4 is a vertical transverse section on the line 4^x, 4^x of Fig. 5. Fig. 5 is a rear elevation of a portion of the counter channels, the channels being broken away in part to expose certain of the voting keys. Figs. 6, 7 and 8 are views of the actuator and the driving pinion, showing the actuator in different positions. Fig. 9 is a perspective view of the actuator and its driving pinion. Fig. 10 is a section on the line 10^x, 10^x of Fig. 4. Fig. 11 is a detail perspective view of the curtain lever and the driving mechanism connected therewith. Fig. 12 is a side elevation of the cam for driving the counter actuator shaft shown in connection with the operating mechanism of the machine at the upper left hand corner. Fig. 13 is a perspective detail of the cam controlling the resetting of the counters. Fig. 14 is a yoke to be used for connecting the universal bars to the rock shaft. Figs. 15^A and 15^B show in perspective the rock shaft 33 and the cam plates that coöperate therewith, the figures being taken at the left and right hand corners of the machine respectively when viewed from the rear.

In the accompanying drawings like reference numerals refer to like parts.

The front plate 1 has mounted thereon keys 2, 2 which are pivoted thereon and free to turn thereon. To each of the keys is connected at the rear a crank or yoke 3 having a pin 4 thereon. Connected to each of the cranks is the interlocking strap 5 which is controlled by the resetting bars 6 and the interlocking wedge 7 in the same manner as is described in the patents above referred to. Each of the pins 4 engages with an actuator 8, as shown in Fig. 10. This actuator consists in part of a plate 9 having a recess 10 stamped therein and having integral therewith the segmental portion 10^a formed by bending the plate 9 into the reëntrant shape shown in Fig. 9. This reëntrant portion has cut therein the recess 11^a, which recess extends partly into the flat side and partly into the convex surface of the reëntrant portion. The convex surface also carries a rectangular tooth 12 making of this part of the actuator a segment of a crown or face gear having a single tooth.

The plate 9 forms one of two parallel sides or disks of the actuator, between which the pin 4 is engaged. The other side 13 of the actuator is a round disk which is formed integral with the hub 14 of the actuator, on which hub the side 9 is placed. The end of the hub is spun over for the purpose of securely holding the two parts together. The hub is formed with a shoulder against which the side 9 abuts, so that the sides 9 and 13 are held positively a fixed distance apart. The voting key 2 moves through a limited arc to voted position and when moved to voted position the interlocking strap 5 is raised substantially vertically and the pin 4 moves substantially horizontally with the counter actuator with which it engages, the yoke being shaped to secure this result.

In the machine are provided the counter channels 15, one for each single office line of keys. Mounted in these channels at suitable intervals are pins 16, which pins pass through the hubs 14 of the counter actuators 8, and on which the counter actuators 8 are free to oscillate, and in which they are

free to slide sidewise. Adjacent to each of the counter actuators is also mounted a stud 17 on which is mounted the pinion 18 shown in end elevation in Figs. 6, 7 and 8 and in side elevation in Fig. 10, and in perspective in Fig. 9. This pinion is an elongated pinion and has thereon three distinct sets of teeth. It consists of a hub or barrel 19 which is substantially as long as the clearance between the sides 20, 20 of the counter channel in which it is mounted. Near one end of this hub is mounted three broad flat teeth 21, distributed around the hub at intervals of 120 degrees between centers. At the other end of the hub or barrel is a second set of three teeth 22, distributed around the barrel at intervals of 120 degrees between centers as well. These teeth 22 are comparatively short. Intermediate of these teeth 22 are three other teeth 23 which are comparatively long and which are likewise distributed around the hub or barrel at intervals of 120 degrees between centers. All three of these sets of teeth are intergral with the hub or barrel of which they form a part, the whole being made in one piece.

Between the teeth 21 and 23 the hub is left blank, coinciding in diameter with the base line of the teeth. The space between the teeth 21—23 is the same in length as the distance between the outer end of the tooth 12 and the end of the recess 11ª. The convex surface of the actuator 8 is normally in engagement with two of the teeth 21 of the mutilated pinion, as is shown in Figs. 6, 7, 9 and 10, and while occupying the position shown in Figs. 9 and 10 the mutilated pinion is locked against rotation. The actuator, however, is capable of a lateral movement along its supporting pin 16, due to the voting operation of the key, by which its rectangular tooth 12 will be thrown into engagement with the teeth 23 of the mutilated pinion. While in the position shown in Figs. 9 and 10 the oscillation of the actuator will have no effect whatever on the mutilated pinion for the purpose of moving it. When, however, the actuator is moved to the right from the position shown in Figs. 9 and 10 the tooth 12 will be placed in engagement with the teeth 23, so that the oscillation of the actuator will cause a corresponding oscillation in the mutilated pinion. While in the position shown in Figs. 9 and 10, the unbroken portion of the convex surface is kept in contact with the teeth 21. When the tooth 12 is moved into engagement with the teeth 23, this unbroken portion of the convex surface is withdrawn from the teeth 21 and the recess 11ª is placed opposite said tooth instead. When the actuator is in such position the oscillation of it will cause the tooth 12 to drive the mutilated pinion by contacting with the teeth 23 thereof, and the teeth 21 are free to move at the same time, due to the recess 11ª provided in the actuator for such purpose. The oscillation of the actuator through an angle of about 40 degrees will rotate the pinion through 120 degrees and lock it in such advance position during the further forward movement of the actuator. After the actuator and the mutilated pinion have been so rotated the actuator can be moved laterally by the resetting of the key, after which it can be rotated back to its original position without disturbing the position of the mutilated pinion. This movement of the actuator is a four-way movement and corresponds to the movement described in my prior Patent 636,730, which patent describes the counter and the counter actuator on which this is an improvement.

The teeth 22 and 23 form a gear of six teeth, which engages with the pinion 25 shown in side elevation in Fig. 4, which pinion in turn engages with the units wheel 26 of the counter, which wheel has a gear of twenty teeth thereon. As each oscillation of the actuator when in voted position advances the mutilated pinion two teeth, it is obvious that the units wheel will be advanced two teeth thereby, or one-tenth of a revolution.

Each of the counters is provided with units, tens and hundreds wheels, which are geared together by the ordinary transfer pinions, such as are shown, for example, in my prior Patent 938,412, forming a decimal counter in which all of the counter wheels are positively driven, and in each of which counters the locking of the units wheel will lock the tens and hundreds wheels as well.

The counter actuators are oscillated by the yokes 27 formed of the bell cranks pivoted on the pin 16. As shown in Fig. 9, the bell cranks are united by a bridge 28, which bridge is integral therewith, the bell cranks and bridge being formed from a single piece of sheet metal. The yoke engages with the recess 10 of the counter actuator, so that the oscillation of the yoke will cause the oscillation of the actuator. By this recess, the counter actuator has a sliding engagement with the yoke by which the actuator is enabled to move laterally with the key and still maintain its oscillating engagement with the yoke.

For each office line two universal bars 30 are provided, to each of which the yokes 27, are connected, one of these universal bars connecting to the bell cranks forming the part of the yoke on one side of the office line and the other universal bar connecting to the bell cranks on the other side of the office line. At the top these universal bars are connected by the rod 31, through which rod the universal bars are driven up and down to cause the oscillation of the actuators. To this rod are connected the links 36, which links in turn are connected to the cranks 34

by the rod 72. The cranks 34 are keyed on the shaft 33 and are spaced apart thereon by the collars 35. By the rocking of the shaft 33 the universal bars are moved up and down.

The mechanism for oscillating the rock shaft 33 I am now about to describe: On the end of this shaft at the right as shown in Fig. 1, is carried a crank 57. This crank engages with the cam slot 38 of the cam plate 39, which is shown in Figs. 1 and 12. This cam plate has the slots 40 and 41 cut therein, which slots engage with the studs 42 and 43, by which engagement the cam plates are held to a longitudinal movement. On the upper end of the cam plate 39 is secured a bracket 44 to which is pivoted a link 45, which in turn is connected to the bell crank 46 pivoted on the stud 47ª fastened in the front plate of the machine. The bell crank 46 has connected thereto the link 47, which link in turn is connected to and is operated by the crank 48 keyed to the shaft 49, to which shaft is also keyed the lever 50, as is described in the Patent 820,802.

The foregoing describes the mechanism at one end of the machine and at the other end of the machine similar mechanism is also placed connected by a link 47 to the crank 48. The machine is thus equipped with two links 47, two bell cranks 46, two links 45 and two cam plates 39 which operate upon the opposite ends of the rock shaft 33 to rock it.

The oscillation of the curtain lever will cause the cam plates 39 to rise and fall. The cam slots 38 therein will cause the cranks 57 to turn in one direction as the plate 39 moves up and in the reverse direction as the plate 39 moves down, imparting thereby the reciprocating motion to the universal bars 30 and the oscillating motion to the counter actuators connected thereto. The cam plate 39 shown in Fig. 12 is at the left hand end of the machine and the cam plate 39 shown in Fig. 1 is at the right hand end of the machine. The counter channels in Fig. 1 expose the counters at the rear of the machine and in Fig. 12 the rear of the machine is at the left hand side.

Connected to the plates 39 are the driving bars 51 which engage with and drive the resetting bar 6 by which the keys are reset and locked. It will be understood of course, that there are two bars 51 in the machine, one at each end of the machine and that these bars engage with and drive the resetting bar 6. The arrangement of the driving bars and resetting bar is more fully shown in Fig. 4 of Patent No. 945,714, Gillespie, and Fig. 5 of Patent No. 995,424, Gillespie. As the plates 39 move downward from the position shown in Fig. 1, it is apparent that the shaft 33 will be rocked to a certain position and then held idly in that position during the further downward movement of the plate 39, during which movement the bar 51 operates on the bar 6 to reset and lock the keys. It is apparent that the oscillating movement of the actuators is completed before the bars 51 have moved far enough to engage the resetting bar for the purpose of locking the keys. It will be understood that at the end of each link 47 is connected a bell crank 46, each of which is pivoted on a stud 47ª and to each of which is connected a link 45 to which in turn is connected the cam plate 39, the one shown in Fig. 1 being at the right of the machine and the one in Fig. 12 being at the left of the machine. The shaft 33 extends the full length of the machine and is driven at each end by a cam plate 39. This shaft has the crank 57 at each end thereof that engages with and is driven by the plate 39 and at the left end it has the crank 56 which engages with and is operated by the cam plate 53.

While the plate 39 is in the position shown in Fig. 1 the cranks 57 may be turned upward to the right so as to enter the recesses 52, in which position the counter actuators will be thrown to the position shown in Fig. 8 with reference to their mutilated pinions. In this position the mutilated pinions are released from the control of the counter actuators, so that the counters can be turned forward or back at will. This construction is provided for the purpose of permitting the resetting of the counters.

To prevent the improper turning of the shaft 33 to the position just described I provide the cam plate 53 mounted to slide on the casing of the machine and having therein a cam slot 54. Mounted on one end of the shaft 32 I provide the crank 55 having a stud 56 thereon which bears against the cam 54. This crank 55 is formed as a part of the crank 57 which engages with the cam slot 38 in the cam plate 39 at its end of the machine, so that the rock shaft 33 is positively driven by cam plates 39 at both ends of the machine. The rotation of it, however, is limited by the cam plate 53 which is located only at one end of the machine. This cam plate has the slots 59 and 59ª cut therein, with which engage the studs 60, 61 mounted on the front plate of the machine and on which the cam plate 53 is free to travel with a limited movement. Connected to the cam plate 53 is the link 58, which link in turn connects to the bell crank 64 pivoted in the bottom of the machine at 64ª.

Pivoted at the bottom of the machine at 65 is provided a bottom door 62 which is shown closed in full line position in Fig. 12 and opened in dotted line position in Fig. 12. When the door has been opened as far as shown by the dotted lines in Fig. 12, the bell crank 64 can be rocked to the dotted line position, drawing down the cam plate

53 through the link 58. This will cause a hook 63 on the plate to engage with the stud 56, drawing the stud forward into the cam slot as the cam plate 53 moves down, rocking the shaft 33, so that the cranks 57 at each end enter the recesses 52 in the cam plates 39 and place all of the counter actuators in the position shown in Fig. 8.

Each of the units wheels of the counters is tightly mounted on the shaft 66 which carries the counter wheels, so as to rotate therewith. The knurled wheel 65^A is also tightly mounted on this shaft 66, so that the knurled wheel, shaft and units wheel all revolve in unison. After the counters have been unlocked by placing the actuators in the position shown in Fig. 8, the knurled wheels can be rotated, causing the rotation of the units wheels and through the transfer pinions, the rotation of the tens and hundreds wheels as well. By rotating the knurled wheels the counter wheels can be rotated in either direction until they stand at 000. The counters may be provided with the stops for automatically stopping the wheels at 000, such as are shown in Fig. 7 of the Patent 761,218, and in such case I prefer to have the wheels stop with the wheels exposed through the sight openings half way between 000 and 999. This positions the mutilated pinion 18 so that the teeth 21 therein cannot be dead centered with the actuator. When the bell crank 64 is moved to the full line position shown in Fig. 12, the actuators will be moved into engagement with the mutilated pinions, rotating them slightly so as to throw all of the counter wheels to the position to expose 000 through the sight openings of the channel.

In Fig. 14 I have shown a modification of the connection between the shaft 32 and the universal bars 30 which comprises a yoke 70 to which may be connected the pair of universal bars used to operate the counters in an office line. This yoke is formed of a single piece of sheet metal cut and bent to the shape shown in Fig. 14. The recesses 71, 71 embrace the rod 72 supported by the outer ends of the cranks 34. This rod extends continuously the full length of the rock shaft 33 and rocks in unison with it, being supported at regular intervals by the cranks 34 heretofore mentioned.

When the yoke 70 is engaged with the rod 72 it can be locked in engagement therewith by passing a cotter pin through the holes 73 formed in the fingers 74. By this arrangement the universal bars 30 can be readily connected to and disconnected from the rock shaft by which they are operated.

The connection between the key 2 and its yoke 3 is as follows: The key is formed with a stem projecting through the plate 1. The pin has a rectangular oblong cross section at the place where it engages the yoke 3 and the yoke 3 is recessed to positively engage with the pin at this point so as to be positively turned thereby. Beyond this the pin is threaded. A cup shaped washer 3^a is placed over the pin and a nut 3^b is screwed on the pin to hold all the parts together. As indicated in Fig. 3, the nut has a slotted head permitting the use of a screw driver thereon.

Having thus described my invention, what I claim as new and patentable is as follows:

1. The combination of a voting machine, of a series of decimal counters, each having a plurality of wheels, a gear in each counter idly meshing with the units wheel thereof, a mutilated pinion for each counter meshing with said gear, an actuator for driving and locking each of said mutilated pinions, a lever on each of said actuators, and a universal bar connected to a plurality of said levers to simultaneously operate said actuators.

2. The combination in a voting machine of a plurality of oscillating actuators, a lever attached to each of said actuators, and a universal bar pivotally connected to a plurality of said levers to communicate simultaneous movement back and forth to a plurality of said actuators.

3. The combination in a voting machine of an oscillating counter actuator having a cylindrical segment having a driving tooth extending from its periphery perpendicular to the plane of motion of its oscillation and having a recess in its periphery, said recess being in line with said tooth.

4. The combination in a voting machine of a mutilated pinion comprising a hub, and two sets of teeth thereon separated by an open space, the teeth of one set being staggered with reference to the teeth of the other set.

5. The combination in a voting machine of a mutilated pinion comprising a hub, two sets of teeth thereon separated by an open space, the teeth of one set being staggered with reference to the teeth of the other set, one set of said teeth being used for driving said pinion, the other set being used for locking and driving said pinion.

6. The combination in a voting machine of a mutilated pinion comprising a hub, and two sets of teeth thereon separated by an open space, the teeth of one set being staggered with reference to the teeth of the other set, one set of said teeth being used for driving said pinion, the other set being used for locking and driving said pinion, an actuator having a tooth for intermittently engaging with the teeth of the one set for driving said pinion, and a recess the sides of which intermittently engage with and drive the teeth of the other set.

7. The combination in a voting machine of a mutilated pinion comprising a hub, two sets of teeth thereon separated by an open space, the teeth of one set being staggered with reference to the teeth of the other set,

one set of said teeth being used for driving said pinion, the other set being used for locking and driving said pinion, and an actuator having a segmental surface engaging with the teeth of one set to lock the pinion against rotation.

8. The combination in a voting machine of a decimal counter, a mutilated pinion connected thereto and rotated therewith, and means for stopping said counter in its backward rotation in an abnormal position.

9. The combination in a voting machine of a decimal counter, a mutilated pinion for driving said counter, an actuator for driving said pinion, said actuator being capable of disengagement from said pinion, and means for stopping said counter in its backward rotation in an abnormal position to expose the interval between consecutive teeth of said pinion to the edge of said actuator, permitting said actuator to be moved back into engagement with said pinion without dead centering therewith.

10. The combination in a voting machine of a face plate, a voting key pivoted thereon extending through said plate, a yoke keyed to said key behind said face plate, a pin mounted on said yoke eccentric to the bearing of said key, and an interlocking strap attached to said yoke between said pin and said key, said pin traveling a shorter distance than the said interlocking strap.

11. The combination in a voting machine of a counter actuator formed of a hub having a flange integral therewith, and a plate fastened to said hub, said plate having a segmental cylindrical surface formed thereon.

12. The combination in a voting machine of a counter actuator formed of a hub having a flange integral therewith, and a plate fastened on said hub, and having a recess therein.

13. The combination in a voting machine of a counter actuator formed of a hub having a flange integral therewith, and a plate fastened on said hub and having a recess therein, an annular groove being left between said flange and said plate.

14. The combination in a voting machine of a counter actuator formed of a hub having a flange integral therewith, a plate fastened on said hub, and having a recess therein, an annular groove being left between said flange and said plate, a face plate, a key pivoted thereon, and a pin connected to said key and engaging with said groove.

15. The combination in a voting machine of a key, a pin connected thereto, and a counter actuator having a groove therein, said counter actuator being mounted to permit lateral and oscillating movement, said pin engaging with said groove to produce lateral movement in the counter actuator by the movement of the key.

16. The combination in a voting machine of a channel, a pin mounted in said channel, a counter actuator mounted to slide and oscillate on said pin, and a yoke mounted to oscillate on said pin, said actuator maintaining a sliding engagement with said yoke, by which said counter actuator oscillates with said yoke but moves laterally independent thereof.

17. The combination in a voting machine of a channel, a pin mounted in said channel, a counter actuator mounted to slide and oscillate on said pin, a yoke mounted to oscillate on said pin, said actuator maintaining a sliding engagement with said yoke by which said counter actuator oscillates with said yoke but moves laterally independent thereof, and a crank on said yoke.

18. The combination in a voting machine of a channel, pins mounted in said channel, a counter actuator mounted to oscillate and slide on each of said pins, and a yoke mounted to oscillate on each of said pins, each of said actuators maintaining a sliding engagement with its yoke, by which said counter actuators oscillate with their yokes but move laterally independent thereof.

19. The combination in a voting machine of a channel, pins mounted in said channel, a counter actuator mounted to oscillate and slide on each of said pins, a yoke mounted to oscillate on each of said pins, each of said actuators maintaining a sliding engagement with its yoke, by which said counter actuators oscillate with their yokes but move laterally independent thereof, and means to oscillate all the yokes of said channel simultaneously.

20. The combination in a voting machine of an operating lever therefor, a cam plate connected to and reciprocated by said lever, a rock shaft having a crank engaging with said cam plate, and universal bars connected to said rock shaft, whereby the oscillation of the operating lever causes the reciprocation of said universal bars.

21. The combination in a voting machine of an operating lever therefor, a cam plate connected to and reciprocated by said lever, a rock shaft having a crank engaging with said cam plate, and universal bars connected to said rock shaft, whereby the oscillation of the operating lever causes the reciprocation of said universal bars, said cam plate having a recess therein which in one position permits an abnormal oscillation of said rock shaft.

22. The combination in a voting machine of an operating lever therefor, a cam plate connected to and reciprocated by said lever, a rock shaft having a crank engaging with said cam plate, universal bars connected to said rock shaft, whereby the oscillation of the operating lever causes the reciprocation of said universal bars, said cam plate having a recess therein which in one position

permits an abnormal oscillation of said rock shaft, and an auxiliary cam plate which normally prevents the abnormal oscillation of said rock shaft.

23. The combination in a voting machine of an operating lever therefor, a cam plate connected to and reciprocated by said lever, a rock shaft having a crank engaging with said cam plate, universal bars connected to said rock shaft, whereby the oscillation of the operating lever causes the reciprocation of said universal bars, said cam plate having a recess therein which in one position permits an abnormal oscillation of said rock shaft, an auxiliary cam plate which normally prevents the abnormal oscillation of said rock shaft, and a door on the voting machine, connections between said door and said auxiliary cam plate whereby upon the opening of said door said cam plate can be advanced to rock said rock shaft to its abnormal position.

24. The combination in a voting machine of a rock shaft, a cam for oscillating said rock shaft, a recess in said cam permitting the abnormal rocking of said shaft, an auxiliary cam plate preventing said abnormal rocking of said shaft, and means for moving said auxiliary cam plate to rock said shaft to its abnormal position.

25. The combination in a voting machine of a rock shaft, a cam for oscillating said rock shaft, a recess in said cam permitting the abnormal rocking of said shaft, an auxiliary cam plate preventing said abnormal rocking of said shaft, means for moving said auxiliary cam plate to rock said shaft to its abnormal position, a door on the voting machine, and a crank connected to said auxiliary cam plate preventing the closing of said door when said rock shaft is in its abnormal position.

26. The combination in a voting machine of a plurality of counters, actuators for driving and locking said counters, said actuators being capable of movement to a position to release said counters for resetting operation, a door on the voting machine and a connection between said counter actuators and said door which prevents the closing of said door while the counter actuators are in unlocking position.

27. In a voting machine, the combination of a counter actuator having a web, and a cylindrical surface integral therewith, said web and said cylindrical surface being bent up out of a single piece of sheet metal, said cylindrical surface being cut away to form the teeth of a face gear therein.

28. In a voting machine, the combination of registers, actuators normally locking said registers against operation, means for connecting said actuators to said registers to move the latter, actuator operating means normally holding said actuators in engagement with said registers, and means allowing movement of said actuator operating means to disconnect said actuators from said registers.

29. In a voting machine, the combination of registers, actuators movable into position to operate said registers and normally locking said registers against operation, actuator operating means normally holding said actuators in engagement with said registers, and means allowing movement of said actuator operating means to disconnect said actuators from said registers.

30. The combination in a voting machine, of an oscillating counter actuator having a driving tooth extending from its periphery perpendicular to the plane of motion of its oscillation, and having a recess in its periphery, a mutilated pinion meshing with and being driven by said actuator, said pinion having a hub and two sets of teeth thereon separated by an open space, the distance between the end of the driving tooth and the recess on the actuator being the same as the length of the open space between the teeth on the pinion.

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Witnesses:
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