March 25, 1958 J. L. SLONNEGER 2,828,391

DEFROST CONTROL MECHANISM

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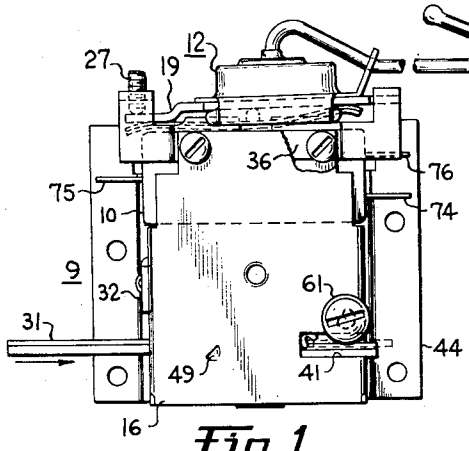


Fig. 1

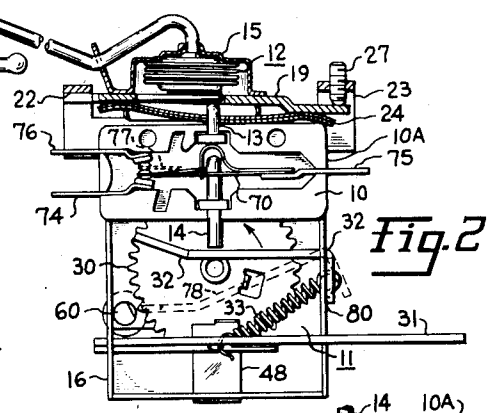


Fig. 2

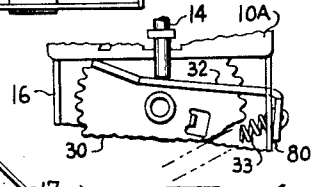


Fig 4

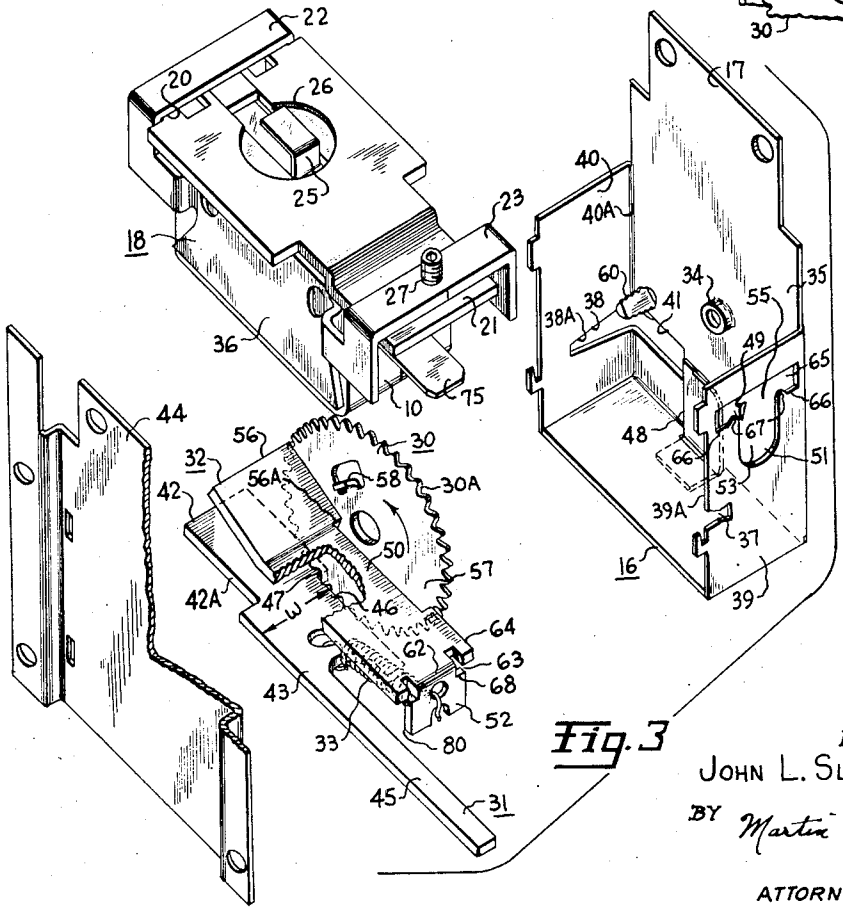


Fig. 3

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DEFROST CONTROL MECHANISM

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17 Claims. (Cl. 200—140)

My invention relates to refrigerator defrost controls adapted to be actuated automatically after the occurrence of a predetermined number of refrigerator door openings, and more particularly to switch actuating mechanisms useful in such defrost controls.

Such "door counting" defrost controls generally comprise a snap acting, single or double throw electric switch, a switch actuating mechanism arranged to operate the switch to initiate a defrosting operation after a predetermined number of door openings, and a temperature sensing element arranged again to operate the switch and terminate the defrosting cycle at a predetermined elevated temperature. One of the difficulties involved in the design of such controls is that of providing sufficient reliability despite very widely differing possible conditions of use. The control must be able to function properly whether the door is opened only once every few days or over a hundred times each day. The design must, therefore, overcome problems, such as ageing and rusting of materials or sticking of parts normally associated with long periods of non-use; as well as problems, such as excessive friction, warpage of plastic parts and fatigue of resilient strip metal members, normally associated with continuing frequent use. As a consequence such door counting defrost controls have heretofore had relatively complicated and expensive precision type mechanisms with the electric switch a specialty designed integral part of the control.

Accordingly, one object of the invention is to provide a reliable switch actuating mechanism for a door counting defrost control which can utilize simple metal stampings throughout, thus avoiding problems and expense inherent in the use of plastic or resilient strip metal parts.

Another object of the invention is to provide a switch actuating mechanism capable of delivering a rebounding blow to the operating arm of an electric switch without the use of a resilient metal strip in or as the striking member.

An additional object of the invention is to provide a switch actuating mechanism for a door counting defrost control in which a single coil spring provides all of the biasing forces required in the counting and automatic switch-actuating functions of the mechanism.

A further object of the invention is to provide a simple inexpensive door counting defrost control which can utilize a conventional, independently housed, snap acting switch.

A still further specific object of the invention is to provide a simple easily accessible adjustment for doubling the number of door openings required between each defrosting cycle.

In general, in accord with the invention, a door counting defrost control is provided having a frame upon which an electric switch, a temperature sensing element and a door opening responsive switch actuating mechanism are all supported. The switch actuating mechanism includes a rotatable toothed wheel or gear and a pair of rigid arms, one serving as a pawl and the other as a hammer, extending across the face of the gear. In accord with an important feature of the invention, a single spring connected between these arms functions not only to bias

the pawl arm into advancing engagement upon reciprocation with successive teeth of the gear, but also to bias the hammer arm to a desired "at rest" position with a free end of the hammer arm in adjacent disconnected relation to an operating member of the electric switch.

In accord with further features of the invention the other end of the hammer arm is held by the spring against the frame in a manner providing a floating pivot, preferably about two different pivot points. The gear carries means for engaging, cocking and then releasing the free end of the hammer arm to swing about its floating pivot and strike the switch operating member a rebounding blow under the force of the spring. This construction enables the use of inexpensive sheet metal stampings for the frame, gear, pawl arm, and hammer arm, eliminates problems of friction and sticking of parts and permits the use of an independently housed electric switch without critical adjustment of its position on the frame.

The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however together with further objects and advantages thereof can be easily understood by referring to the following description taken in connection with the accompanying drawing in which:

Figure 1 is a front plan view of a defrost control embodying the invention;

Figure 2 is a rear view of the defrost control of Figure 1 with the rear plate removed;

Figure 3 is a perspective exploded view of the parts of the defrost control shown in Figure 2; and

Figure 4 is a detail view of the hammer arm in its switch-striking position.

Referring to the drawing, I have shown my invention in one form as comprising a defrost control **9** having a snap acting switch **10**, a switch actuating mechanism **11** for operating switch **10** to initiate a defrost period, and temperature sensing element **12** for operating switch **10** to terminate the defrost period. Switch **10** preferably constitutes a miniature, independently housed, single pole, double throw, bistable type as shown having a pair of operating buttons **13**, **14** extending from opposite sides thereof. Switches of this type are now generally available commercially.

The temperature sensing element **12** is shown as a bellows assembly **15** but may alternatively conveniently be a diaphragm or a bimetal type assembly.

The switch actuating mechanism **11** is supported on and housed within a metal frame or case **16** having an extension **17** which also supports and positions the switch **10** and temperature sensing element **12**.

Means are also provided for accurately adjusting the position of the temperature sensing element **12** relative to that of the switch operating button **13** thereby to calibrate the temperature at which switch **10** will be actuated. This temperature adjusting means comprises a metal yoke **18** fastened to the housing **10A** of switch **10** as well as to frame extension **17**, a metal strap **19** carrying the bellows assembly **15** and having its opposite ends **20**, **21** underlying bridge portions **22**, **23** of yoke **18**, and a leaf spring member **24** trapped between the top of switch housing **10A** and strap **19** for biasing the strap **19** toward the yoke **18**. A resilient return bent metal ribbon **25** is fastened at one end to metal strap **19** and extends within a keyhole slot **26** of strap **19** to lie between bellows **15** and button **13**. An adjusting screw **27** threaded through bridge portion **23** of yoke **18** bears against end **21** of strap **19** and pivots the strap **19** as a lever about its opposite end thereby accurately adjusting the position of bellows **15** and ribbon **25** relative to button **13**.

The counting and switch actuating mechanism **11** of the invention is supported by and housed within the bottom portion of metal frame **16** and comprises principally a

ratchet in the form of a toothed wheel or gear 30, a reciprocating pawl arm 31, a swingable hammer arm 32, and a spring 33 connected between pawl arm 31 and hammer arm 32.

Gear 30 is journalled on a hollow cylindrical boss 34 struck inwardly from the front or base wall 35 of frame 16 and is retained against the inner surface of this base wall by a flat detent spring 48 which also biases the teeth of the gear into non-reversing engagement with a detent lug 49 also struck inwardly from the base wall 35. Gear 30 passes behind the front wall of housing 10A of switch 10 when the switch is mounted in position on frame extension 17. The yoke side portions 36 between frame extension 17 and the front wall of switch housing 10A provides the proper spacing between these two surfaces to accommodate the upper portion of gear 30 and permit the free rotation thereof.

Pawl arm 31 is a straight flat rigid plate member extending edgewise transversely across the face of an edge portion of gear 30 and out beyond the opposite sides of the control device 9 through slots 37 and 38 respectively in the side walls 39 and 40 of frame 16. Slot 37 extends from the rear edge 39A of side wall 39 while slot 38 extends with a tapered or V-shaped configuration from the front corner 40A of frame 16 and communicates with a rectangular slot 41 in the base wall 35 of frame 16 to form together with slot 38 a continuing corner opening or slot. Slot 41 extends transversely of the control a sufficient distance to overlie and expose the teeth of gear 30 and has a width sufficient to expose at least two adjacent teeth. As best seen in Figure 3, pawl arm 31 has an offset end portion 42 which extends through the corner opening formed by slots 38, 41 and has an apertured central portion 43 having a width W only slightly less than the distance from the rear plate 44 of frame 16 to the rear surface of detent spring 48. Pawl member 31 is supported for reciprocation across the lower face of gear 30 by the sliding of its rear edge 42A against the apex 38A of slot 38 and of the rear edge 45 against the under surface of rear plate 44, and by the sliding of its front edge 46 against the rear surface of detent spring 48. A screw 60 is preferably threaded through base plate 35 immediately above slot 41 with an enlarged head 61 extending down over this slot 41. Screw 60 may be withdrawn or omitted for certain purposes to be explained. Upon reciprocation of pawl arm 31, a shoulder portion 47 of its offset portion 42 extending through front slot 41 engages the teeth 30A of gear 30 in a manner to be described hereinafter and causes the incremental rotation of gear 30.

Hammer arm 32 is also a rigid flat plate member and has a main body portion 50 which extends edgewise across the central face of gear 30 in a direction when at rest generally parallel to pawl arm 31. Hammer arm 32 extends through a T-shaped slot 51 in side wall 39 of frame 16 and has a downwardly bent end portion 52 which overlies and covers the stem portion 53 of this T-shaped slot 51. Hammer arm 32 is pivoted along the axis formed by the corner between this downwardly bent portion 52 and its main body portion against the edge of the side wall 39 defining the lower rim of the top portion 55 of slot 51 in a floating manner to be more fully described hereinafter. The other free end 56 of hammer arm 32 is preferably upwardly inclined at a slight angle as shown, and the central body portion of hammer arm 32 has a recessed or cutout portion 57 to permit free passage of an ear 58 struck up rearwardly from the gear 30. The inclined free end portion 56 of hammer arm 32 is positioned a small distance from the rear face of gear 30 and is directly in the path of ear 58 during a portion of each revolution of gear 30.

Tension spring 33 is fastened to and extends between the body portion 43 of pawl arm 31 and the downwardly bent portion 52 of hammer arm 32. This spring 33 serves many functions. Firstly, it biases the pawl arm into an at rest position from which it may be reciprocated mechanically in response to door opening and closing movements. Secondly, it biases the end portion 42 of pawl arm 31 upwardly such that a depression of pawl arm 31 to the left as viewed in Figure 2 results in a rocking motion of arm 31 within V-shaped slot 38 about its apex 38A toward the upper edge of slot 41 and into contact with a head 61 of screw 60. In this position shoulder portion 47 of pawl arm 31 is aligned with a tooth on gear 30 of more advanced angular location relative to the direction of rotation of gear 30 than that aligned with the lower edge of slot 41. Upon release of pawl arm 31 after this leftward movement, the arm picks up the advanced tooth and produces a rotation of gear 30 as it moves to the right under the force of spring 33. In the absence of screw 60, the upper surface of pawl arm 31 rocks into contact and rides upon the upper edge of slot 41 to pick up an additional tooth with each stroke.

Spring 33 also biases the end portion 52 of hammer arm 32 downward and to the left as viewed in Figure 2 such that arm 32 is mounted in a floating pivotal manner on the side 39 of frame 16. Spring 33 also maintains hammer arm 32 in its predetermined at rest position and provides the force for impelling hammer arm 32 to swing about its pivot so as to strike the operating button 14 of switch 10.

In forming the floating pivot for hammer arm 32, the corner region 62 of arm 32 is provided with two recesses resulting in the formation of ears 64 adjacent the opposite side edges of the arm 32. These ears fit within the opposite extremity portions 65 of the top portion 55 of T-shaped slot 51 and ride against the lower edges 66 of the side wall 39 defining these extremity slot portions 65. A pair of projections 67 in side wall 39 adjacent edges 66 fit within the recesses 63 of the hammer arm 32. The downwardly bent portion 52 of hammer arm 32 has upper shoulders 68 which, upon the pivoting of hammer arm 32, bear against these projections 67. This construction of the pivotal mounting of hammer arm 32 prohibits lateral shifting of the arm along the depth dimension of the control and prevents movement of the pivot axis to the left during the swinging motion of the hammer arm but does not prevent an upward or outward motion of the arm and its pivot axis during its swinging motion except against the force of spring 33.

In its normal at rest position with ear 58 of gear 30 out of engagement with hammer arm portion 56, the hammer arm is biased with its major portion in a substantially horizontal plane and its downwardly bent portion bearing flatwise against the flat outer surface of side wall 39 of frame 16. In this at rest position, hammer arm 32 is in adjacent disconnected relation to button 14 and preferably in loosely coupled relation to the actual switching mechanism of switch 10. For example, button 14 may touch or be slightly spaced, as shown in Figure 2, from the upper surface of hammer arm 32 and the end of button 14 within switch 10 may be slightly spaced from the actual switching mechanism 70 operated by button 14 when the switch is in a stable condition or position indicated by dashed lines 77 amenable to actuation by button 14.

In a typical installation, the cold control device 9 is mounted within a refrigerator in a manner such that pawl arm 31 is reciprocated in response to door openings and closings. Terminals 74, 75 of switch 10 are connected in a circuit for heating the evaporator to accelerate the defrosting process while terminals 75, 76 of switch 10 are connected in a circuit for controlling the compressor motor. Usually, a refrigerator box temperature control device (not shown) is also connected in this compressor motor control circuit.

In the operation of the control device 9, presume switch 10 in one of its two stable conditions in which the circuit is completed between terminals 75 and 76 and the compressor motor is operating under the influ-

ence of a conventional temperature control device connected in series with these terminals **75, 76**. In this position of switch **10** the expansion or contraction of temperature sensing element **12** will have no effect upon the switch **10**. As pawl arm **31** is reciprocated in response to the opening and closing of the refrigerator door, gear **30** is incrementally rotated and its angular position represents a count of the number of door openings. If screw **60** is withdrawn or removed, pawl arm **31** will rock sufficiently during reciprocation to pick up two teeth of gear **30** but if screw **60** is tightened down against the base wall **35** of frame **16**, the pawl arm will rock only slightly hitting against the head **61** of screw **60** and pick up only one tooth with each stroke of the pawl arm **31**. The continued rotation of gear **30** eventually brings its ear **58** into engagement with the inclined upper surface of the free end portion **56** of hammer arm **32** and then carries the arm downwardly during a portion of its revolution to the position shown by dashed line 78 thus cocking the hammer arm **32**. Upon further rotation of gear **30**, the ear **58** drops off the shoulder **56A** of arm **32** and passes through the recess **57** thereby releasing hammer arm **32** to swing about its floating pivot and strike the operating button **14** of switch **10** a rebounding blow. Switch **10** thereupon snaps to its other bistable condition opening the circuit to the compressor motor and energizing the heating circuit to the heater.

In performing this striking operation, hammer arm **32** first swings about its rectangular corner **62** until it reaches its at rest position but then, because of its momentum, continues to move beyond this at rest position to the striking position shown in Figure 4; this further movement being permitted by the floating manner of its pivotal support. The pivot axis of arm **32** then shifts from the rectangular corner portion **62** of the hammer arm to the lower inner edge **80** of the hammer arm where it bears against the side wall **39** of frame **16**. During this further movement the rectangular corner **62** moves slightly upward and to the right away from this side wall **39** thereby permitting the body portion **50** of hammer arm **32** to move slightly upwardly beyond its normal at rest position and thereby to strike the operating button **14**. This additional upward movement however is accomplished against the force of spring **33** which quickly returns the hammer arm to its at rest position in which its downwardly bent end portion **52** is flat against the side wall **39**. This construction has been found to be unusually effective in eliminating any further rebound or restriking. The overtravel of the the hammer arm **32** beyond its at rest position compensates for any minor variations in the location of operating button **14** or in the looseness of the coupling between the operating button and the actual switch mechanism.

As the refrigerator defrosts, the temperature thereof increases causing bellows **15** to expand and eventually, at a predetermined temperature depending upon the adjustment of screw **27**, to move upper operating button **13** sufficiently to snap switch **10** to its initial stable condition again completing the compressor motor circuit.

It will thus be seen that I have provided a door counting control **9** capable of unusually long life and reliability despite its comparatively low cost of manufacture and assembly. The loose fit of the pawl arm **31** within its supporting slots **37, 38, 41** and the floating pivot of the hammer arm **32** reduces friction and eliminate any sticking of these moving parts. In addition the use of rigid metal stampings for these moving parts not only reduces their cost but also reduces problems of ageing and fatigue such as associated with resilient metal strips. Moreover, the metal frame **16** and spring **33** each serve multiple functions as desired thereby further reducing the size and cost of the control **9**.

While I have described above a specific embodiment of the invention many modifications may be made. I intend therefore by the appended claims to cover all such modifications as wall within the true spirit and scope of the invention.

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

1. A defrost control comprising a frame, a switch mounted on said frame and having an operating member, a toothed wheel journalled on said frame, a rigid pawl arm supported for reciprocating motion on said frame, a rigid hammer arm supported for swinging motion on said frame, spring means connected between said pawl arm and said hammer arm for biasing said pawl arm into engagement with the teeth of said wheel and for biasing said hammer arm into an at rest position disconnected from and adjacent to said switch operating member, and means responsive to the rotation of said wheel for cocking and releasing said hammer arm to strike said operating member under the force of said spring means.

2. A defrost control comprising a frame, an independently housed electric switch mounted on said frame having switch operating buttons extending from opposite sides thereof, a temperature sensing element mounted on said frame on one side of said switch for moving one of said operating buttons in response to temperature variations, means for adjusting the location of said temperature sensing element relative to said one operating button, a rigid hammer arm pivotally mounted on said frame on the opposite side of said switch, spring means biasing said rigid arm toward an at rest position disconnected from and adjacent to said other operating button, and means responsive to repeated mechanical motion for cocking and releasing said spring arm to swing about its pivot to strike said other button under the force of said spring means.

3. A defrost control comprising a frame, a switch mounted on said frame and having an operating member, a pivotal bearing surface on said frame, a rigid hammer arm, spring means connected to said hammer arm for supporting one end portion of said arm in a floating manner against said bearing surface with the other end portion of said arm in an at rest position slightly spaced from said operating member, and a counting mechanism supported on said frame for cocking and releasing said arm to strike said operating member under the force of said spring means in response to successive mechanical operations of said counting mechanism.

4. The defrost control of claim 3 wherein said bearing surface comprises a flat wall, and said arm has a flat L-shaped configuration with one flat end portion biased by said spring means against said flat wall in said at rest position.

5. A defrost control comprosing a frame, a switch mounted on said frame and having an operating member, a wheel journalled on said frame, a rigid hammer arm having one free end portion extending across a face of said wheel, a pivotal bearing surface on said frame, spring means connected to said arm for biasing its other end portion in a floating manner against said bearing surface with said free end portion in an at rest position overlying but disconnected from said operating member, and means carried by said wheel for engaging, cocking and releasing said arm to strike said member under the force of said spring means upon rotation of said wheel in one direction.

6. A switch actuating mechanism comprising a frame having an apertured wall, a flat rigid L-shaped hammer arm having one flat end portion extending as a loose fit through said aperture, spring means biasing said flat end portion against said apertured wall of said frame, and means for cocking and releasing the other end portion of said arm to swing and strike an operating member of a switch under the force of said spring means.

7. A counting and switch actuating mechanism comprising a frame having two walls at right angles to one another, a toothed wheel journalled parallel to one wall, an ear projecting from said wheel, a movable pawl for actuating said wheel, a hammer member pivoted on the other wall and extending in generally parallel relation with said pawl, and a spring connected between said pawl and said hammer member for biasing said pawl into engagement with the teeth of said wheel and for biasing said hammer member in a predetermined position in the path of said ear.

8. A counting mechanism comprising a frame having two walls at right angles to one another, a toothed wheel journalled on and parallel with one wall, a pawl arm extending across a lower edge portion of said wheel and through said other wall, a support member on said other wall above said pawl, and a spring connected between said support member and a portion of said pawl overlying said wheel to bias said pawl arm upwardly and against said teeth thereby to advance said wheel upon reciprocation of said pawl.

9. A switch actuating mechanism comprising a frame having a pair of walls at right angles to one another, a toothed wheel having an ear projecting therefrom and being journalled parallel to one wall, a hammer member having a bend therein forming a pivot axis with one portion thereof on one side of said pivot axis overlying said wheel in the path of said ear and with the other portion thereof on the other side of said pivot axis extending through and beyond said other wall, spring means connected to said other portion of said member for biasing said member with its pivot axis floating against an edge of said other wall through which it extends, and means for rotating said wheel in one direction in response to repetitive mechanical motion, said ear engaging, cocking and then releasing said member to swing about its floating pivot upon rotation of said wheel.

10. A counting mechanism comprising a frame having a base wall and two side walls at right angles to said base wall, a toothed wheel journalled on and parallel with said base wall, a pawl arm supported for reciprocation on said side walls and extending across a lower face of said wheel, said base wall having a slot underlying a portion of said pawl arm and extending to underlie the teeth of said wheel, said pawl arm having a shoulder portion extending into said slot and being guided thereby to engage said teeth upon reciprocation of said pawl arm, said slot having a width greater than said pawl arm shoulder portion and sufficient to expose at least two adjacent teeth of said wheel, and spring means connected to said pawl arm for biasing said pawl arm to rock toward the upper edge of said slot during its reciprocation.

11. The counting mechanism of claim 10 comprising a screw threaded into said base wall above said slot and having an enlarged head extending down into said slot to limit the amount of rocking movement of said pawl arm shoulder toward the upper edge of said slot thereby to reduce the number of teeth picked up by the pawl arm during each reciprocation.

12. A counting mechanism comprising a frame having a base wall and two spaced side walls at right angles to said base wall, a gear journalled on and parallel to said base wall, said side walls having aligned slots and said base wall having a slot underlying the teeth of said gear and communicating with one of said side wall slots to form a corner slot opening, a flat rigid pawl arm extending across the face of said gear through said side wall slots as a loose fit therein and having a shoulder portion extending into said base wall slot, the edges of said side wall defining said corner slot being tapered to permit rocking of said pawl arm during a reciprocation thereof, and a spring connected to said pawl arm to bias said shoulder portion toward the upper edge of said base slot and into engagement with said gear teeth.

13. A switch actuating mechanism comprising a frame having a base wall and a side wall at right angles to said base wall, said side wall having a slot lying in a plane at right angles to both said walls, a gear having an ear projecting from a face thereof and being journalled on and parallel to said base wall, a rigid flat hammer arm bent to form two flat portions at substantially right angles to one another, said arm extending as a loose fit through said slot with said flat portions on opposite sides of said side wall, spring means biasing one flat portion against said side wall with the bend of said arm against an edge of said slot and with the other flat portion overlying said gear in the path of said ear whereby said arm is engaged by said ear and pivoted about its bend upon rotation of said gear, said arm having a recess to release said ear after being engaged and pivoted thereby.

14. The switch actuating mechanism of claim 13 wherein said spring means comprises a tension spring connected to said one flat portion of said arm and extending through said side wall of said frame.

15. A counting and switch actuating mechanism comprising a frame having two walls at right angles to one another, one wall having an aperture therein, a gear journalled parallel to the other wall, an ear projecting from said gear, a flat rigid hammer arm bent to form two angularly disposed flat portions and extending as a loose fit through said aperture with one flat portion overlying said gear in the path of said ear, a pawl arm, and a spring connected between said pawl arm and the other flat portion of said hammer arm, said spring biasing said pawl arm toward engagement with the teeth of said gear and biasing said other flat portion against said apertured wall to determine the at rest position of said arm and biasing the bend of said hammer arm against an edge defining said aperture to provide a floating pivot for said arm.

16. A counting and switch actuating mechanism comprising a frame having a base wall and two spaced side walls extending at right angles to said base wall, one side wall having two spaced slots therein and the other side wall having one slot aligned with a slot in said one side wall, a gear journalled on and parallel to said base wall, an ear projecting from said gear, a pawl arm overlying said gear and extending as a loose fit through said aligned slots for reciprocation therein, a flat rigid hammer arm bent to form two angularly disposed flat portions and extending as a loose fit through the other slot of said one side wall with one flat portion overlying said gear in the path of said ear, and a spring extending through said one side wall and connected between said pawl arm and the other flat portion of said hammer arm, said spring biasing said pawl arm toward engagement with said gear and biasing said other flat portion against said one side wall and biasing the bent region of said hammer arm into engagement with an edge of said side wall defining said other slot.

17. The counting and switch actuating mechanism of claim 16 wherein said base wall has a slot underlying said pawl arm and the teeth of said gear, and said pawl arm has a shoulder portion for engaging said teeth extending within said base wall slot, said spring also biasing said shoulder portion toward the edge of said base wall slot which is leading relative to the direction of rotation of said gear whereby said shoulder portion rocks to pick up teeth and advance said gear under the force of said spring upon reciprocation of said pawl arm.

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