United States Patent

Huber

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[54] INDEXING MECHANISM

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[52] **U.S. Cl.** **74/143,** 74/575, 74/577

[51] **Int. Cl.** **F16h 27/02**

[58] **Field of Search** 74/143, 575, 577; 274/4; 235/92

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[57] **ABSTRACT**

A pawl and ratchet device actuated by a solenoid for rotating the cam of a cartridge-type tape player to position the magnetic tape head adjacent different tracks on the tape includes a unitary plastic pawl element having an opening therein for receiving the ratchet wheel and further having first and second pawls integrally formed as part of the pawl element and attached to the sides of the opening thereof by a restricted portion forming a spring biasing the pawls into engagement with the ratchet. Surfaces are provided on opposite sides of the opening in the pawl element for engaging the ratchet wheel in the extreme positions of motion of the element in both directions to prevent further rotation of the ratchet at the limits of movement of the element.

10 Claims, 6 Drawing Figures

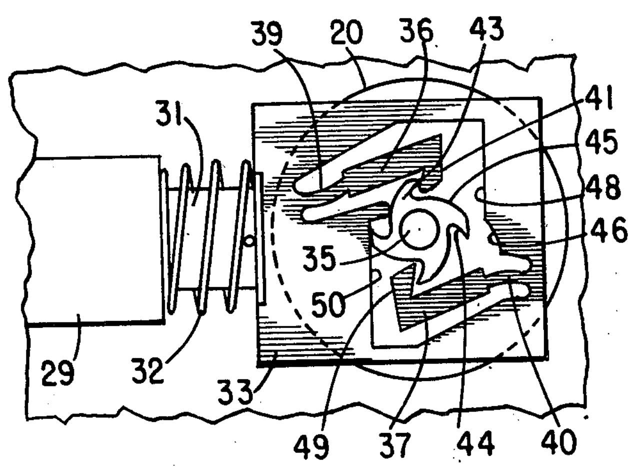

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FIG. 1

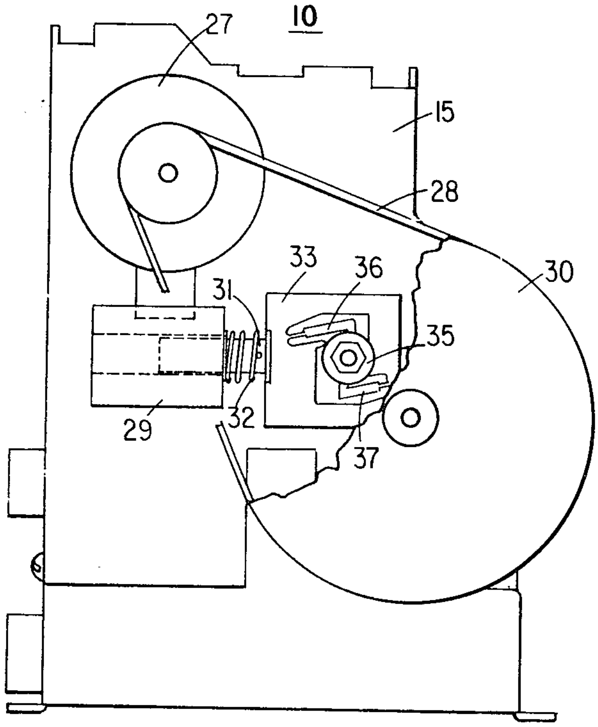


FIG. 3

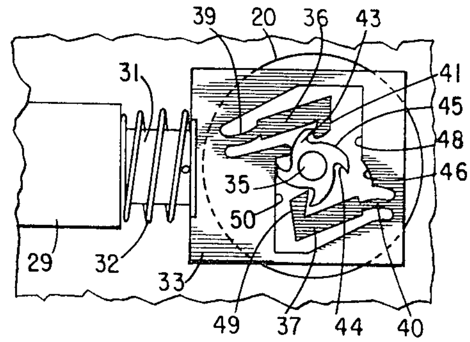


FIG. 4

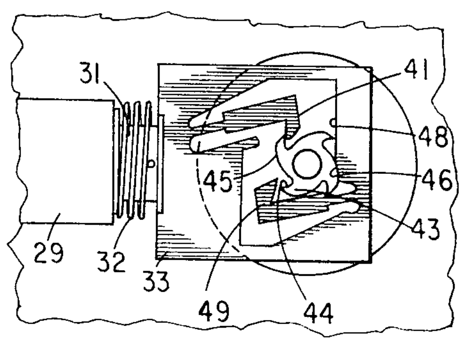


FIG. 2

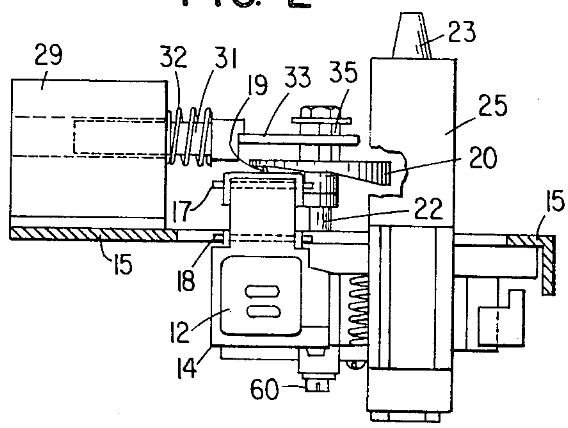


FIG. 5

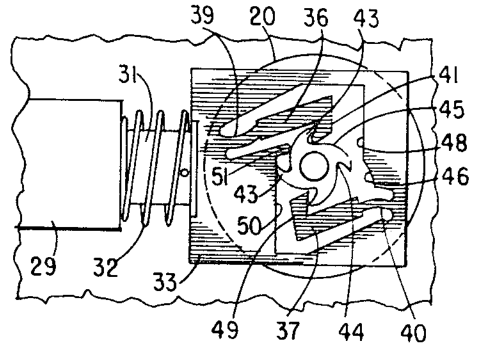
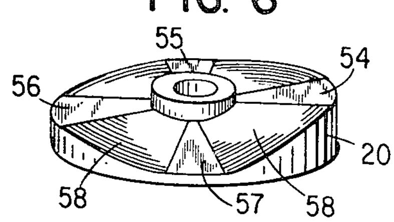


FIG. 6



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INDEXING MECHANISM

BACKGROUND OF THE INVENTION

It often is desirable to convert the reciprocating motion of an actuating member into rotary motion by means of pawl and ratchet mechanisms. In order to most efficiently utilize the two directions of the reciprocating motion, a double-pawl arrangement cooperating with the ratchet wheel has been used, with one pawl rotating the ratchet wheel through a half-step during the movement in one direction and with the other pawl continuing the rotation of the ratchet wheel through the remainder of the step in the same direction during movement of the actuating member in the other direction.

Generally devices for accomplishing this conversion of motion utilize rigid double-lever arrangements having two lever arms with pawls arranged on opposite sides of the ratchet wheel circumference. On attraction of the magnet armature, one pawl engages the toothed rim of the ratchet wheel to rotate the wheel through a half-step; and the other pawl, at the same time, is moved out of engagement with the ratchet wheel. Upon deenergization of the magnet armature, the second pawl rotates the ratchet wheel through a further half-step in the same direction, and the first pawl is moved out of engagement with the wheel. If the pawls are provided with only straight line linear motion, it is necessary to provide the device with a relatively large armature stroke; because the pawls must be moved through the stroke corresponding to the movement of the ratchet wheel and in addition through a further path in order to cause the pawls to be moved fully out of engagement with the ratchet wheel when the other of the pawls is causing the motion to be imparted to the wheel.

Provisions have been made for utilizing rigid pawl members which are pivotally connected to the armature of a solenoid, with a spring biasing the pawl members together and into engagement with the ratchet wheel. This type of a mechanism permits more limited linear motion of the armature stroke resulting in a corresponding decrease in the current consumption of the electromagnet. In both of these arrangements, however, a number of individual parts are required for the pawl mechanism resulting in relatively high manufacturing costs.

Pawl and ratchet mechanisms of the type described above are used in many cartridge-type tape players capable of reproducing multitrack tape. Such players use a cam and a cam follower arrangement for positioning the magnetic tape head, with the ratchet wheel being utilized to rotate the cam. It has been discovered in the use of this type of mechanism in a cartridge-type tape player that some cam surfaces, when in contact with the cam follower, cause autorotation of the cam, thereby misaligning the tape head with the track. In order to prevent such misalignment, additional locking devices for positively locking the cam into position after it has been moved from one set of tracks to another, have been provided. Such additional locking devices, however, also result in an increased cost of the positioning mechanism in such tape players.

Because of the high acceleration imparted to the ratchet by the operation of the electromagnet, it is possible for the ratchet and cam to rotate past a single step and to double or triple index. Thus, it is desirable to prevent such additional rotation to insure single step indexing for each operation of the electromagnetic.

SUMMARY OF THE INVENTION

Accordingly, it is an object of this invention to provide an improved pawl and ratchet device for transforming reciprocating linear motion into rotary motion.

It is an additional object of this invention to form a double pawl element of a pawl and ratchet device from a single piece of resilient material.

It is still another object of this invention to form a double-pawl element for a pawl and ratchet mechanism from a single piece of resilient material in the form of a frame having an opening therein for receiving a ratchet, with the pawl members attached to and formed with the frame and further providing locking surfaces on the frame for engaging the ratchet in extreme positions of linear movement of the frame.

In accordance with a preferred embodiment of this invention, a pawl and ratchet mechanism uses a double-pawl element made from a single piece of resilient material, with the element comprising a frame portion and with the pawl elements formed with and attached to the frame portion by resilient connecting webs which bias the pawl elements into engagement with the ratchet wheel. Locking surfaces are provided on the frame portion on opposite sides of the ratchet wheel; so that when the pawl element is moved to either of its extreme positions, one or the other of the locking surfaces engages the ratchet wheel to prevent further rotation due to momentum of the ratchet wheel or due to autorotation of the member driven by the ratchet wheel.

An additional feature is to utilize the pawl and ratchet mechanism in a push-pull pawl arrangement to position the cam in the head-positioning mechanism of an eight-track recorder having four head positions, the cam having only four cam surfaces, each corresponding to a different one of the four positions to which the head is to be located. As a result, each push-pull action of the pawl driving mechanism causes rotation of the cam over an arc of 90° for each cycle of operation.

Another feature is to provide the ratchet teeth with a concave surface for engagement by the actuation portions of the pawl elements to improve the operation of the mechanism.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a top view of a tape player utilizing a push-pull double-pawl and ratchet mechanism in accordance with a preferred embodiment of this invention;

FIG. 2 is a side elevation view of the mechanism shown in FIG. 1;

FIGS. 3, 4 and 5 are bottom views illustrating the operation of the pawl and ratchet mechanism shown in FIGS. 1 and 2; and

FIG. 6 is a perspective view of a cam used in the tape player shown in FIGS. 1 and 2.

DETAILED DESCRIPTION

Referring now to the drawings, in which like reference numbers are used in the different figures to designate the same or similar components, there is shown a portion 10 of a cartridge-type tape player adapted to receive and play tape cartridges having multitrack tapes therein. The tape player 10 includes a magnetic tape head 12 which is mounted in a head bracket 14. In order to provide for vertical adjustment of the tape head 12 (as viewed in FIG. 2) to reproduce the different tracks on the magnetic tape used with the tape player, the bracket 14 is movably mounted on a tape deck 15 by a pantograph, a portion of which includes a pair of pivot rods 17 and 18.

Integrally mounted with the head bracket 14 is a cam follower 19, and a spring, which is not shown, biases the pantograph and therefore the head bracket 14 and the cam follower 19 into contact with a cam 20. The cam 20 has four different cam surfaces, each of which is associated with the four different sets of tracks on the magnetic tape (assuming that a standard eight-track stereo tape cartridge is to be played by the tape player 10). The cam 20 in turn is mounted on a shaft 22 which is rotatably mounted on the tape deck 15. Upon rotation of the cam 20 at the end of one set of tracks on the tape, the cam follower 19 moves the magnetic tape head assembly 14, and thus the head 12, against the spring bias of the pantograph to position the magnetic tape head to a different set of tracks on the tape.

The tape player 10 also includes a capstan shaft 23 mounted within a capstan housing 25 that is supported by the tape deck 15. In order to rotate the capstan 23, a motor 27 is coupled by a drive belt 28 to a flywheel 30 which is connected to the capstan shaft 23 and drives the shaft 23 to move the magnetic tape through the cartridge and past the magnetic tape head 12.

In tape player mechanisms of the type generally described above, upon completion of one pair of tracks in the tape player, a solenoid is actuated to operate a linkage for rotating the cam 20 to position the tape head 12 to a new set of tracks on the magnetic tape. In the device shown in FIGS. 1 and 2, this is accomplished by the operation of a solenoid 29 which is momentarily energized in a known manner upon completion of the reproduction of a pair of tracks in the player to momentarily attract and then release an armature 31 against the action of a biasing spring 32, imparting a reciprocating linear motion to the armature. When the solenoid 29 is deenergized, the spring 32 returns the armature 31 to the position shown in FIGS. 1 and 2.

A double-pawl element or mechanism 33 is attached to the end of the armature 31 and operates upon a four-toothed ratchet wheel 35, with the ratchet wheel 35 being rigidly attached to the cam 20. The pawl element 33 is made of a thin piece of resilient plastic or metal material of substantially rectangular or square shape. A pair of pawls 36 and 37 are integrally formed with the pawl element 33 in an opening in the center of the pawl element 33. The ratchet wheel 35 then extends into the opening and is engaged by the actuating portions of the pawls 36 and 37 which are resiliently spring-biased into contact with the ratchet wheel 35 by connecting webs 39 and 40, respectively.

It should be noted that the entire pawl element 33, including the pawls 36 and 37 and the connecting webs 39 and 40, is formed out of a single piece of resilient plastic material and may be formed by molding the structure in the shape most clearly seen in FIGS. 3, 4 and 5, or by cutting out the central portion of the pawl element 33 to form the pawls 36, 37 and connecting webs 39 and 40 from a solid piece of resilient plastic stock. The material used to form the pawl element 33 may be of any suitable type which is relatively rigid in the hardened state with good fatigue characteristics and possessing sufficient elasticity so that the pawls 36 and 37 bear against the ratchet wheel 35.

Operation of the device may best be understood by reference to FIGS. 3 to 5. When the solenoid 29 is energized, the armature 31 is pulled into the coil of the armature 29 toward the left as viewed in FIGS. 3 to 5, causing the actuating portion or projection 41 on the pawl 36 to engage a first tooth 43 on the ratchet 35.

The ratchet 35 carries four teeth 43, each of the teeth having a generally radially extending concave surface which is engaged by the actuating portions 41 and 49 of the respective pawl members 36 and 37 to cause rotation of the ratchet wheel 35. It should be noted that the actuating portions 41 and 49 of the pawl members 36 and 37 are angled from the body portions of the pawl members 36 and 37 to extend the tips of the actuating portions 41 and 49 respectively into the "-pocket" formed by the concave surfaces 44 on the teeth 43 of the ratchet wheel 35 in order to provide a positive engagement between the teeth 43 and the actuating portions 41 and 49 of the pawls.

By utilizing this configuration, it is possible to use a weaker spring bias of the pawls into engagement with the ratchet wheel, while still retaining a positive engagement or self-energization between the actuating portions 41 and 49 and the teeth 43 of the ratchet wheel 35 upon movement of the respective pawls. If the surface 44 of the teeth 43 of the ratchet wheel 35 were straight, a stronger spring bias would need to be imparted to the pawls 36 and 37 by the webs 39 and 40 to prevent the pawl actuating portions 41 and 49 from slipping out of engagement with the respective teeth 43 of the ratchet wheel 35 by movement of the pawls 36 and 37. The concave pawl engaging surface 44 of the teeth 43 permits positive engagement between the actuating portions 41 and 49 of the pawls with the teeth of the ratchet wheel without increasing the spring bias imparted by the webs 39 and 40 to a point where a stronger electromagnet 29 would have to be employed.

As the actuating projection 41 on the pawl 36 engages and moves or pulls to the left a first tooth 43 on the ratchet wheel 35, the ratchet wheel 35 and cam 20 rotate approximately 45° in a counterclockwise direction to the position shown in FIG. 4. With the armature 31 pulled into the coil of the solenoid 29 as shown in FIG. 4, a locking surface 46 on the pawl element 33 is moved into engagement with the back surface of a different tooth 50 on the ratchet wheel 35 to engage the ratchet wheel 35 in order to prevent the ratchet wheel 35 from being rotated through more than one-half tooth gradation (45°) owing to the momentum imparted to the ratchet wheel and cam 20 by the energization of the solenoid 29. At the same time, the rear surface 48 of the pawl element 33 operates to prevent clockwise or counterrotation of the ratchet wheel 35 since the surface 48 is in abutting relationship with the tip of the next adjacent tooth 43 on the ratchet wheel 35. If for any reason, the ratchet wheel 35 is not completely rotated through a one-half tooth gradation by the operation of the pawl 36, engagement of the rear surface 48 with the tip of the next adjacent tooth 43 tends to complete the rotation.

When the solenoid 29 is deenergized, the solenoid spring 32 returns the pawl element 33 to the rest position shown in FIG. 5. During this return movement, the actuating projection 49 of the pawl 37 engages the concave surface of a different tooth 43 on the ratchet wheel 35 to move or pull the ratchet wheel 35, and thus the cam 20, through another approximately 45° rotation in the counterclockwise direction, thereby completing the desired 90° of rotation of the ratchet wheel 35 and cam 20.

When the pawl 36 is moved to the left as viewed in FIGS. 3 to 5, the actuating portion 49 of the nondriving pawl 37 rides on the rear convex curved surface 45 of the respective tooth 43 of the ratchet 35 until the ratchet 35 is rotated to a position to enable the pawl 37 and extension 49 to drop into the position shown in FIG. 4 under the spring bias urging of the web 40 connecting the pawl 37 to the pawl element 33. Similarly, when the solenoid 29 is released, enabling a rightward movement of the pawl element 33 under the urging of the spring 32, the actuating portion 41 of the pawl 36 rides in a sliding relationship on the convex rear surface of the respective tooth 43 as the pawl element 33 is moved toward the position shown in FIG. 5 until the actuating portion 41 drops over the edge of the tooth when the pawl element 33 reaches the position shown in FIG. 5.

When the armature 31 has been returned to the rest position shown in FIG. 5 upon deenergization of the solenoid 29, the actuating projections 41 and 49 of the pawls 36 and 37 respectively engage corresponding teeth 43 of the ratchet wheel 35 to lock the ratchet wheel into position to prevent any counterrotation of the ratchet wheel in a clockwise direction. At the same time, when the pawl element 33 moves to the rightmost extreme position shown in FIG. 5, a front locking surface 50 in the opening in the pawl element 33 engages a tooth of the ratchet wheel 35 to prevent additional rotation in a counterclockwise direction due to the momentum imparted to the ratchet wheel 35 by the return action of the armature 31. In addition, when the pawl element 33 is in the position shown in FIG. 5, a projection 51 provided on the front surface 50 of the pawl element 33 extends into the path of the next adjacent tooth of the rachet wheel 35 to further provide, or lock against, counterrotation of the ratchet wheel in a clockwise direction, since the projection 51 is located directly in the path of rotation of the next adjacent tooth 43 of the ratchet wheel 35. In the event movement of the pawl 37 causes a slight overtravel of the ratchet wheel 35, the projection 51 pushes on the back surface of the adjacent tooth 43 to rotate the wheel 35 to the position shown in FIG. 5.

Each energization and subsequent deenergization of the solenoid 29 causes the pawl mechanism to operate in the manner described previously to rotate the ratchet wheel 35 and thus the cam 20 an additional 90°.

A perspective view of the cam 20 is shown in FIG. 6, and the cam includes four cam surfaces 54 to 57 located at different elevations at 90° angles from one another. Separating the cam surfaces 54 to 57 are sloped surfaces 58 for providing a relatively gradual slope for adjusting the position of the cam follower 19 from one of the surfaces 54 to 57 to another of the surfaces, upon each 90° rotation of the cam 20 by the pawl and ratchet mechanism shown in FIGS. 3 to 5.

The cam surfaces 54 to 57 are located at different vertical positions within relatively close tolerances. In order to provide for an initial adjustment of the position of the head 12 within each individual tape player, an adjusting screw 60 is provided for adjusting the vertical direction of the shaft 22, as best shown in FIG. 2, after the tape player is assembled. This adjustment moves the cam 20, and the ratchet 35 attached thereto, a small amount in the vertical direction as viewed in FIG. 2 so that proper alignment of the tape head 12 with a given track on the tape may be provided as an initial adjustment for the tape player.

The pawl element 33 is made relatively thin compared to the axial length of the ratchet wheel 35 so that adjustment of the ratchet wheel 35 in the vertical direction under the action of the screw 60 may be effected while the webs 39 and 40 maintain the actuating portions of the pawls 41 and 49 in engagement with the ratchet wheel 35 in a plane substantially normal to the axis of rotation of the ratchet wheel 35 and cam 20. Because the pawls 36 and 37 and the actuating portions 41 and 49 thereof are relatively thin in comparison to the axial length of the ratchet wheel 35, substantial adjustments in the vertical direction of the ratchet wheel 35 may be effected with the pawls remaining in engagement with the ratchet wheel 35.

Since the pawls 36, 37 and the actuating portions 41 and 49 are spring biased by the connecting webs 39 and 40 to engage the ratchet wheel 35, slight misadjustments of the longitudinal centerline of the shaft 22 which locates the ratchet wheel 35 within the opening in the pawl element 33 can be tolerated. The operation of the device is not affected by such misadjustments. If the armature and pawls were rigid, it would be necessary to provide accurate alignment of the shaft 22 with the armature and pawl assembly in order to prevent binding of the pawls.

By providing for a 90° rotation, with each operation of the solenoid 29, only four cam surfaces are necessary on the cam 20 to provide each of the four head different positions which normally are utilized in the conventional eight-track stereo tape players currently being manufactured. If a 90° rotation for each operation of the solenoid 29 were not provided, it would be necessary to provide more than one cam surface on the cam 20 for each of the different locations of the tape head 12, thereby requiring critical manufacturing tolerances to be maintained for a relatively large number of cam surfaces used to locate the tape head 12 to the vertical positions. By providing only one surface for each of the different positions to which the head 12 is to be located, a cam 20 having only four cam surfaces, resulting in reduced manufacturing costs, can be utilized in the tape player apparatus 10.

The pawl and ratchet mechanism which has been described transforms reciprocating linear motion into rotary motion by use of a double-pawl member in which the pawl elements and locking or braking surfaces all are integrally formed from a single piece of resilient plastic material. The alignment of the pawl mechanism with the center of rotation of the ratchet is not critical, permitting considerable tolerance in assembling the respective components of the tape player with which the pawl mechanism is used. When the pawl and ratchet mechanism is used with a cartridge-type tape player, the pawl and ratchet cooperate to lock the cam for positioning the tape head in place once the cam has been rotated to position the tape head to a different set of tracks. In addition, the pawl mechanism permits adjustment of the cam in elevation along its axis of rotation without interfering with the engagement of the pawl-actuating portions with the ratchet wheel.

I claim:

1. In a device for transforming reciprocating linear motion to rotary motion through a double-pawl mechanism operating on a ratchet wheel, wherein the double-pawl mechanism comprises a unitary pawl element made of resilient material, said element including a frame portion, a pair of lever arms integrally and flexibly connected to the frame portion with each of the lever arms terminating in an integral pawl member resiliently biased into engagement with the ratchet wheel; and at least one locking surface on the frame portion for engaging the ratchet wheel with the pawl element being moved to a predetermined position in at least one linear direction.

2. The device according to claim 1 wherein movement of the pawl element in one linear direction causes the pawl member on a first one of the lever arms to be in driving engagement with the ratchet wheel and the pawl member on the other one of the lever arms to be in sliding relation to the ratchet wheel for rotating the ratchet wheel through a portion of the desired rotation, and with movement of the pawl element in a linear direction opposite to said one direction causing the pawl member on said other one of the lever arms to be in driving engagement with the ratchet wheel and the pawl member on said first one of the lever arms to be in sliding relation thereto for completing the desired rotation of the ratchet wheel.

3. The device according to claim 1 wherein the frame portion of the pawl element substantially surrounds the ratchet wheel, the frame portion including a first locking surface for engaging the ratchet wheel upon movement of the pawl element to a limit in said one linear direction and a second locking surface for engaging the ratchet wheel upon movement of the pawl element to a limit in said opposite linear direction.

4. The combination according to claim 3 wherein the frame portion is formed of plastic material with an opening therein for receiving the ratchet wheel, with the lever arms terminating in the pawl members being integrally formed with the frame portion within the opening and being connected to the frame portion by an integral flexible connecting web for engaging a ratchet wheel placed within the opening, and wherein the first and second locking surfaces are formed on diametrically opposite sides of the opening in the frame portion.

5. The combination according to claim 1 wherein the reciprocating linear motion is imparted to the pawl means by an electromechanical means including a solenoid and an armature, the armature being coupled to the pawl member for imparting linear motion thereto.

6. A device for transforming reciprocating linear motion to rotary motion including in combination:

- a ratchet wheel having a plurality of teeth, each including a convex upper surface and a concave engaging surface;
- a pawl element made of resilient material including a frame portion and at least one pawl member integrally formed therewith and carrying an actuating portion, the actuating portion of the pawl member being resiliently biased into engagement with the ratchet wheel teeth; and
- means for reciprocating the pawl element to cause the actuating portion of the pawl member to engage the concave surface of a tooth on the ratchet wheel upon movement of the pawl element in a first predetermined linear direction.

7. The combination according to claim 6 wherein the pawl element includes first and second pawl members integrally formed therewith and each carrying an actuating portion, with the first and second pawl members being resiliently biased into engagement with the ratchet wheel on substantially opposite sides thereof, movement of the pawl element in said first linear direction causing the actuating portion of the first pawl element to engage the concave surface of a first one of the teeth on the ratchet wheel to rotate the ratchet wheel a predetermined amount, and movement of the pawl element in a diametrically opposite direction causing the actuating portion of the second pawl element to engage the concave surface of a second one of the teeth on the ratchet wheel to move the ratchet wheel in the same direction an additional predetermined amount.

8. A double-pawl mechanism for transforming reciprocating linear motion to rotary motion of a ratchet wheel wherein the double-pawl mechanism comprises a unitary pawl element made of resilient material, said element including a frame portion, first and second connecting means, a pair of lever arms integrally and flexibly connected to the frame portion through said first and second connecting means, respectively, with each of the lever arms terminating in an integral pawl member resiliently biased toward an opening for receiving a ratchet wheel, the pawl members being located so that movement of the pawl element in one linear direction causes the pawl member on a first one of the lever arms to be located for a pulling driving engagement with said ratchet wheel through said first connecting means and the pawl member on the other one of the lever arms to be in sliding relation to said ratchet wheel for pulling of said ratchet wheel through a portion of the desired rotation, and with movement of the pawl element in a linear direction opposite to said one direction causing the pawl member on said other one of the lever arms to be located for driving engagement with said ratchet wheel and the pawl member on said first one of the lever arms to be in sliding relation thereto for enabling completion of the desired rotation of said ratchet wheel.

9. The combination in accordance to claim 8 further including a ratchet wheel located in said opening for actuation by the double pawl mechanism between the pawl members on said lever arms.

10. The combination according to claim 8 wherein said frame portion substantially surrounds the opening for receiving said ratchet wheel and said first and second connecting means are located on diametrically opposite sides of the opening, so that the pawl member on said other one of the lever arms is located for pulling driving engagement with said ratchet wheel through said second connecting means with movement of said pawl element in said linear direction opposite to said one direction.

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