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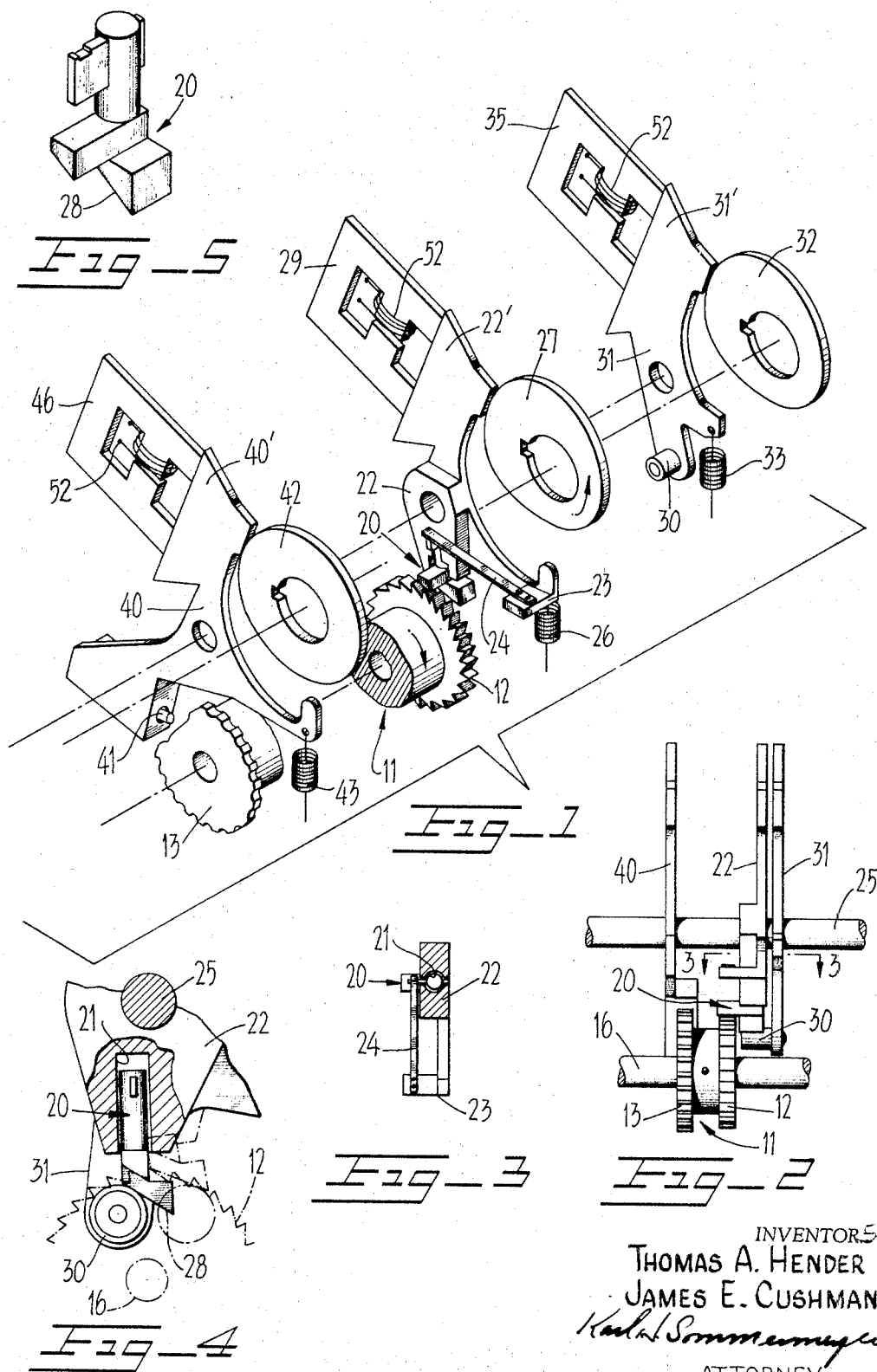
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3,434,371

SILENT RATCHET

Filed Aug. 2, 1967

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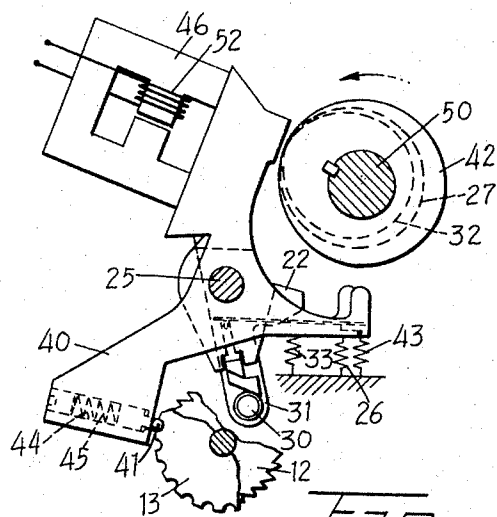


Fig. 6

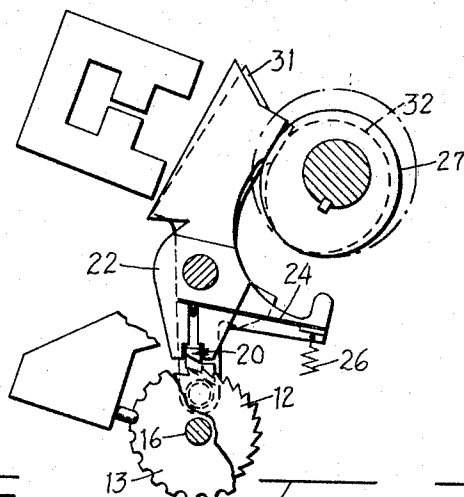


Fig. 7

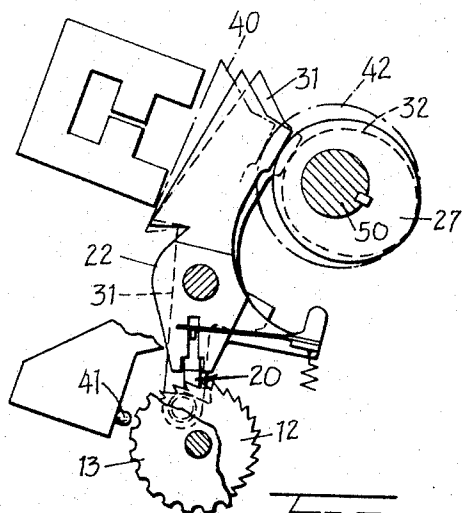


Fig. 8

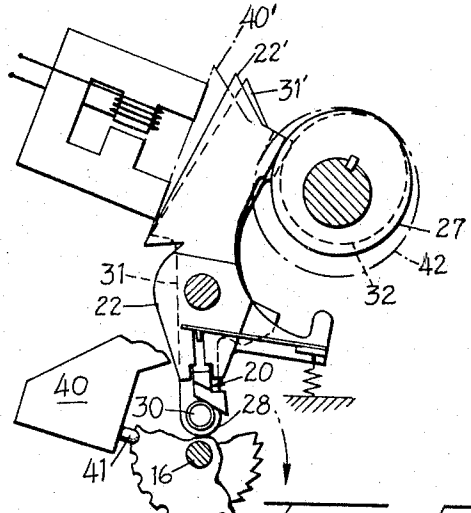


Fig. 9

Followers 22, 31 & 40

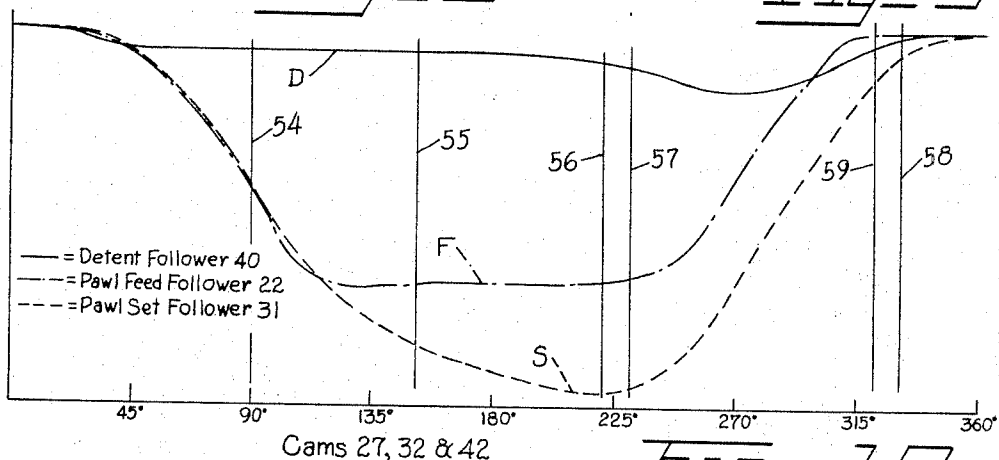


Fig. 10

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SILENT RATCHET

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6 Claims

ABSTRACT OF THE DISCLOSURE

In a silent ratchet for driving paper tape in a tape punch mechanism, one cam oscillates a pawl carrier and a second cam operates a camming lifter for retracting and setting the pawl. A third cam disengages a detent during pushing operation of the pawl. The followers of all three cams are normally held on high, inactive, position by permanent magnets and are released by timed pulses in a shunting coil.

Background

Field of invention.—This invention relates to an intermittent drive mechanism and more particularly to an electrically controlled cam operated silent ratchet mechanism.

Prior art.—In one prior silent-operating ratchet mechanism, an L-shaped pawl is pivoted on an arm which is pivoted on the same shaft that carries the ratchet gear. A connecting rod is pivoted to a radial arm of the pawl. On the idle stroke, the connecting rod will first rock the pawl off the ratchet wheel and against a stop, and then swing the pawl and arm together. On the drive stroke, the pawl will first rock into engagement with the ratchet teeth, and the whole mechanism will then turn as one piece, including the ratchet wheel and the shaft.

The pawl-carrying arm may be restrained by friction to insure that the pawl rocks before the arm swings. However, such devices still produce impact noise each time the pawl rocks against its stop or the ratchet wheel.

Summary of invention

The present invention provides separate means for driving the pawl in its pushing and retracting motions. Further, the separate retracting means cams the pawl away from the ratchet, as by means of a roller acting against a ramp surface on the pawl. A cam controlled detent is disengaged during the pushing stroke of the pawl, and the whole mechanism is normally held inactive magnetically.

A primary object of this invention is to provide a new and improved intermittent feed mechanism that is extremely quiet in operation and that is capable of instant on-command operation.

Another object of this invention is to provide a stepping mechanism having holding magnets that are responsive to a short current pulse for momentarily changing the flux path of the magnets so that the cam followers are released for control by their respective cams.

The features of this invention include low power requirements, fast response to command signals, no mechanical backlash, low torque requirements when starting up and when idling.

Brief description of the drawings

FIG. 1 is an exploded pictorial view of the present invention showing the general arrangements of the parts and their relationship to one another;

FIG. 2 is a partial elevational view of the mechanism shown in FIG. 1;

FIG. 3 is a partial cross-sectional view of the pawl control lever as indicated by the line 3—3 of FIG. 2;

FIG. 4 is an enlarged partial elevational view showing the pawl and its lifter;

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FIG. 5 is an enlarged detail view of the pawl;

FIGS. 6, 7, 8 and 9 are partial elevational views showing the mechanism of FIG. 1 in several stages of a cycle of operation; and

FIG. 10 is a graph showing the relative motions of the cam followers during a cycle of operation.

Description of the preferred embodiment

Referring now to the drawings, there is illustrated a preferred embodiment of the present invention which includes a toothed member 11 having ratchet teeth 12 and detent teeth 13. The toothed member 12 is mounted on an output shaft 16 which drives the tape feed mechanism of a paper tape punch not otherwise shown. The toothed member 11 is intermittently rotated by a pawl 20 slidably mounted for up and down movement in a channel 21 (FIG. 4) provided in a cam follower lever 22 which is pivotally mounted on a shaft 25. A leaf spring 24 carried on a forwardly extending arm 23 of the cam follower 22 normally urges the pawl 20 downward into engagement with the ratchet teeth 12.

Cam follower lever, or pawl carrier, 22 is urged clockwise in FIG. 1 by spring 26 into engagement with a pawl feed cam 27. Operation of feed cam 27 is effective to oscillate the pawl carrier 22 back and forth for cyclically driving the pawl 20 in a pushing stroke and an idle return stroke for driving the toothed member 11 forward one tooth space for each cyclic oscillation of the pawl carrier.

A pawl-set, cam follower 31, journaled on shaft 25, carries a roller, or slider, 30 which rides under a ramp 28 of the pawl 20 (FIGS. 1, 4 and 5) for lifting and lowering the pawl in the channel 21 for respectively disengaging and setting the pawl against the ratchet teeth 12. Cam follower 31 is biased by a spring 33 against pawl-set cam 32 which controls the position of follower 31 relative to pawl-feed follower 22 for moving roller, or slider, 30 along the ramp 28 for effecting the desired up and down motion of pawl 20.

The motions of the cam followers are shown by the graph of FIG. 10. The horizontal scale represents the rotation of cams 27, 32 and 42 through one cycle of 360° beginning and ending at the angular position shown in FIG. 6 in which the followers are arrested at their high position by magnets 29, 35 and 46, as will be described. The vertical scale represents rotation of the cam followers 22, 31 and 40 about the shaft 25 under control of those cams. In the start, or home, position, feed-cam follower 22 is at the extreme end of its pushing stroke, that is, to the right as seen in FIG. 6, and pawl 20 is retracted and disengaged from the ratchet. During the first portion of the cycle, to about ninety degree position (vertical line 54 in FIG. 10), the graphs F and S for two cam followers 22 and 31 slope down and coincide. This coincidence of the graphs shows that the two cam followers move together (clockwise in FIG. 7) to hold the pawl 20 retracted and clear of the ratchet teeth. Then, during the 150° to 220° interval, indicated by vertical lines 55 and 56, the graph F for the feed-cam follower 22 is horizontal, showing no motion, while the graph S for set-cam follower 31 continues to descend, showing continued motion. This separation of these curves shows relative motion between these two cam followers. This relative motion moves roller 30 (to the left in FIG. 8) along ramp 28 for lowering the pawl 20.

FIG. 8 shows the parts in the 180° position at which the two curves F and S (FIG. 10) have almost reached their greatest separation. In this position the roller 30 has moved to the left end of ramp 28 as seen in FIG. 8, and has lowered, or set, the pawl 20 into engagement with the ratchet teeth 12.

Then in the 230° to 300° interval (indicated by vertical lines 57 and 58 in FIG. 10), the two curves move up

together, remaining separated. The upward slope of the curve F shows that the pawl-feed cam follower 22 is carrying the pawl 20 in the pushing stroke, to the right in FIGS. 8 and 9. The upward slope of the curve S shows that the roller 30 is also moving to the right. Furthermore, the fact that this curve F stays below curve S shows that the set-cam follower 22 remains to the left, relative to the feed-cam follower 31, during this pushing stroke. That is, the roller 30 stays under the left end, as seen in FIGS. 8 and 9, of the ramp 28 to keep the pawl 20 in engagement with the ratchet teeth 12.

In the final interval, curve F is again horizontal, showing that follower 22 is stationary at the end of the pushing stroke. In this same interval, the set cam curve S rises to again meet the other curve F, showing that the set-cam follower 31 is moving relative to the feed cam follower 22. This motion is to the right in FIG. 9, to carry the roller 30 to the right end of ramp 28, as seen in FIG. 9, for retracting the pawl from the ratchet tooth, and returning the parts to the home, or start, position of FIG. 6.

It should be noted in FIG. 10, particularly in the 230° to 310° interval, that is, during the pushing stroke, that the difference between the positions of the followers 22 and 31, which difference is the thing that determines the lifting of pawl 20, is the distance along a vertical line between curves F and S. Thus, although these curves appear close together in this upwardly sloping portion, their separation is actually almost as great as their maximum separation at about 220°. This separation changes slightly during the pushing stroke to help the pawl follow the circular path of the ratchet teeth.

As mentioned above, the toothed member 11 also includes detent teeth 13 which, throughout the major portion of the cycle, are engaged by a spring loaded detent 41 carried by a detent lever, or cam follower, 40 journaled on shaft 25. As shown in FIGS. 6 to 9, a detent cam 42 is so shaped that throughout substantially 227° of the cycle, the detent 41 is maintained in engagement with the detent teeth 13 to restrain rotation of the output shaft 16. The lower arm of the detent cam follower 40 is slightly enlarged to provide a bore 44 to accommodate the detent plunger 41 (FIG. 6), which is slidably mounted therein. A spring 45 forces the detent 41 into engagement with the detent teeth 13. When the detent lever 40 is rocked by its cam 42 (clockwise in FIGS. 1 and 8) during the pushing stroke of the pawl 20, the detent 41 is lifted off the detent teeth 13.

A spring 43 fixed to the forward extending arm of the detent lever 40 urges the lever clockwise in FIG. 1 into contact with the surface of the detent cam 42. The toothed member 11 has 24 equally spaced ratchet teeth 12 and 24 equally spaced detent teeth 13.

The motion of the detent cam follower 40 is shown by the curve D of the graph of FIG. 10. Most of this curve is substantially horizontal, showing no motion of the detent follower 40. This curve D dips in approximately the 220° to 320° interval indicated by vertical lines 56 and 59 in FIG. 10, showing that the follower 40 moves (clockwise in FIG. 8) during the time that the pawl 20 is pushing the ratchet 12. In the final interval, the curve D slopes upward to the starting value, showing that detent 41 reengages the detent teeth 13 as the roller 30 moves to the right under the right end of ramp 28 to retract the pawl 20 from ratchet 12.

Detent cam 42, pawl-feed cam 27 and pawl-set cam 32 are all mounted on the same shaft 50 which is rotated (counter-clockwise) by any suitable drive means, such as a small electric motor (not shown).

It is among the features of the present invention to provide an idle condition for the ratchet drive, quiet starting and stopping of the drive cycle, and unloading of the motor during start-up and idle. To this end, there is provided a plurality of permanent magnets 29, 35 and 46 for maintaining each of the cam follower levers 22,

31 and 40, respectively, disengaged from their respective cams 27, 32 and 42 during motor-start-up and idle operations.

In each of the magnets, the normal magnetic flux paths, or lines, travel through an armature 22', 31' and 40' of its cam follower 22, 31 or 40 to maintain the cam follower inactive, or out of contact with its cam. Each magnet is provided with an electric coil 52 for changing the magnetic flux path of the magnet for releasing the armature. A short current pulse of a few milliseconds is applied to the coil 52 to momentarily change the magnetic flux path and shunt it away from the armature so that the armature is released to the pull of its spring. The short current pulse is applied to the coil 52 in timed synchronism with the rotation of the cams so that the three cam followers will be released at about the 0° position of the cams indicated by the graph of FIG. 10, so that they "drop" only a few ten-thousandths of an inch to engage their cams quietly. As the cams complete their 360 degrees of rotation they rock the cam followers in proximity to the magnets, and since the magnets are no longer shunted, they will attract the armatures, lift them (that few ten-thousandths of an inch), and hold them in an inactive position clear of the cams. The magnets will continue to hold the cam followers out of engagement with the rotating cams until another short current pulse is again applied to the coils 52 for directing the lines of magnetic force away from the armatures 22', 31' and 40'.

It will be apparent that the control of the lifting and lowering of the pawl 20 depends on a camming action of the roller 30 and ramp 28 against each other, and that this action can be accomplished by a ramp surface on either pawl 20 or cam follower 31 cooperating with a roller, a slider, or the like on the other.

It will thus be seen that the objects set forth above, among those made apparent from the preceding description, are attained, and since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matter contained in the above description, or shown in the accompanying drawings, shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. An intermittent feed mechanism comprising:

a toothed member;

a pawl engageable with said toothed member for pushing it;

driving means including an oscillatable pawl carrier for carrying, and for cyclically driving, said pawl in a pushing stroke and in an idle return stroke;

setting means separate from said driving means for reciprocating the pawl in said carrier for cyclically setting said pawl into driving engagement with said toothed member and retracting it therefrom;

the action of said driving and setting means being timed relative to each other for imposing said four motions cyclically on said pawl in the order return, set, push and retract.

2. A feed mechanism as claimed in claim 1 wherein: said driving means and said setting means include a pair of cam followers, a first of which carries said pawl and cyclically oscillates it in said pushing stroke and said return stroke, and the second of which cyclically sets said pawl into engagement with said toothed member and retracts it therefrom.

3. A feed mechanism as claimed in claim 2 wherein: said setting means includes a ramp and a slider, one of which is on said pawl and the other of which is on said second cam follower, and

wherein there is included resilient means for biasing said ramp and slider against each other.

4. A mechanism as claimed in claim 1 further comprising:

a detent means normally engageable with said toothed member for restraining operation thereof when said

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pawl carrier is moving said pawl in the return stroke; and

cam means for cyclically disengaging said detent means from said toothed member during the pushing stroke of said pawl.

5. A mechanism as claimed in claim 2 comprising: a magnet for each of said cam followers for holding it from following its cam; and

means for momentarily changing the magnetic flux path of said magnetic holding means for releasing said cam followers.

6. A feed mechanism as claimed in claim 2 wherein: said setting means includes a ramp on said pawl and a roller on said second cam follower, and

wherein there is included a spring mounted on said first cam follower and acting against said pawl for biasing said ramp against said roller.

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