# United States Patent

[11] 3,628,713



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[21] Appl. No. **3,097**
[22] Filed **Jan. 15, 1970**
[45] Patented **Dec. 21, 1971**
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[32] Priority **Jan. 29, 1969**
[33] **France**
[31] **6901792**


## [54] MECHANISM FOR THE STEP-BY-STEP TRANSPORT OF DOCUMENTS

**8 Claims, 3 Drawing Figs.**


[52] U.S. Cl. ..... 226/157, 74/125
[51] Int. Cl. ..... B65h 17/22
[50] Field of Search ..... 226/157, 188; 74/125, 124, 122, 149, 148



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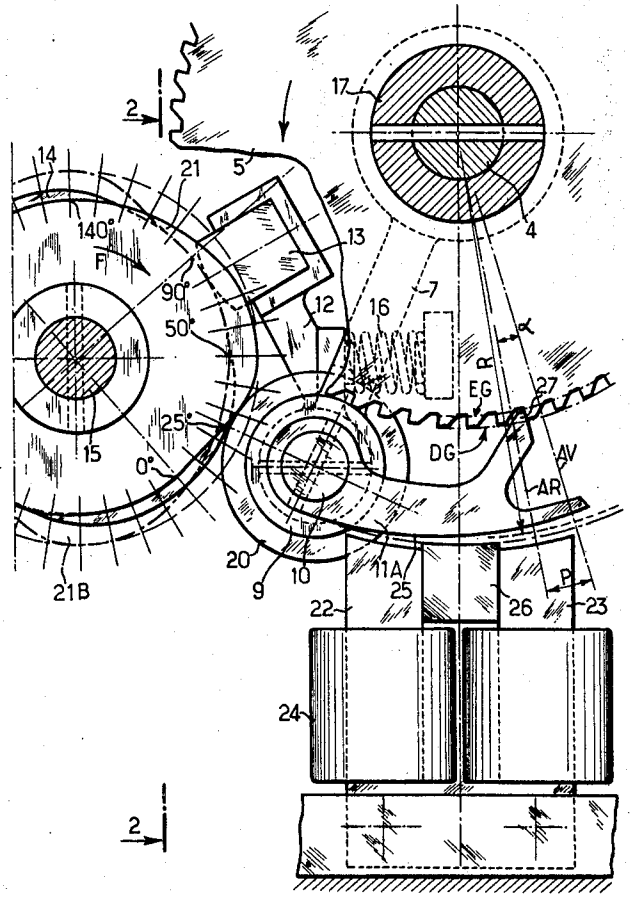
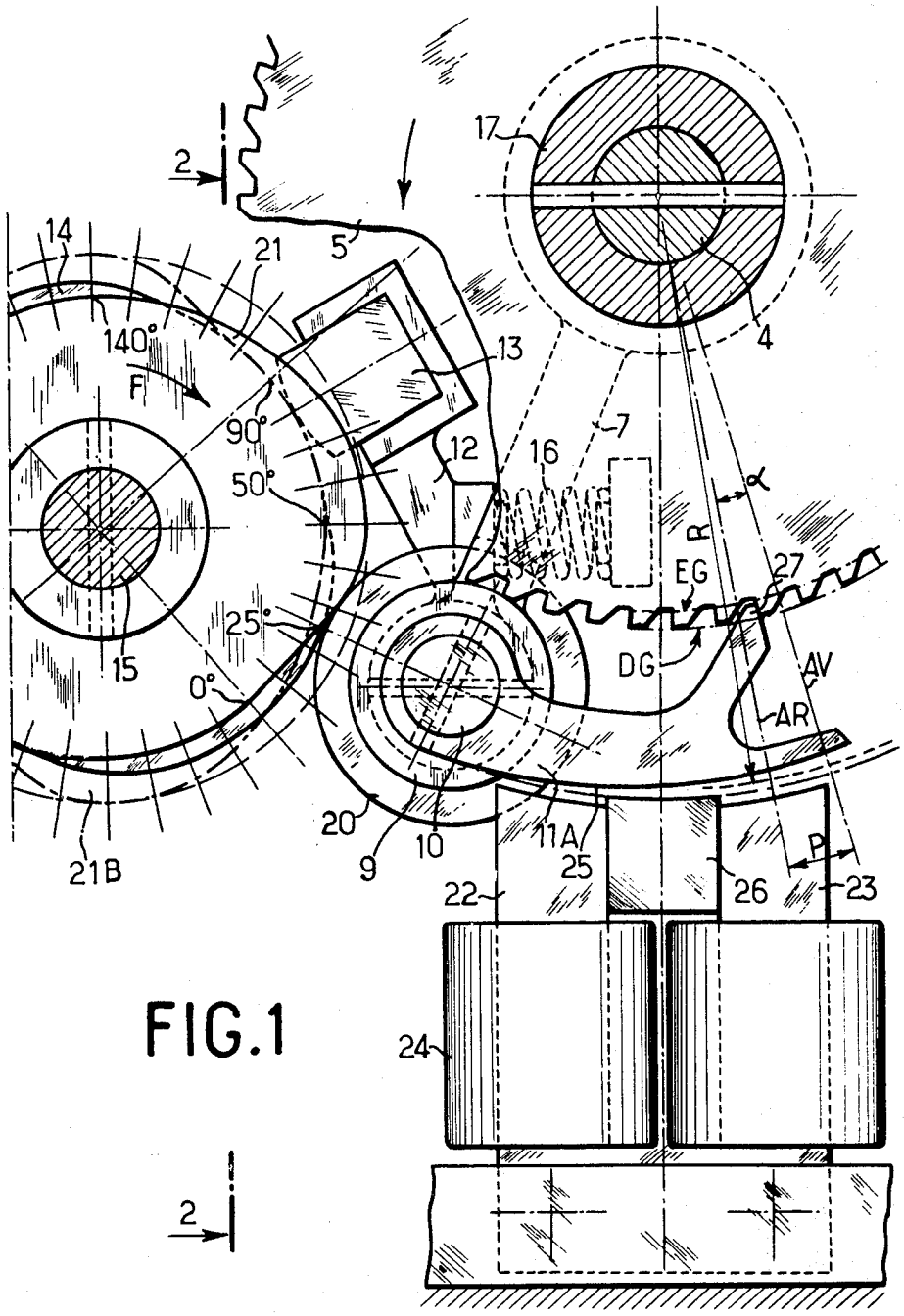
**ABSTRACT:** Apparatus for advancing a record medium step by step wherein the medium is advanced by a drive wheel mounted on a shaft to which is affixed a ratchet wheel, wherein the ratchet wheel is advanced tooth by tooth by an actuating pawl, and wherein said pawl moves into engagement with the ratchet wheel and rotates the ratchet wheel through one tooth pitch by the action of respective ones of a pair of cams.


2
14
21
5
17
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50°
12
16
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EG
27
25°
15
0°
DG
AV
AR
20
9
10
11A
25
P
22
26
23
24
21B
2

FIG.1

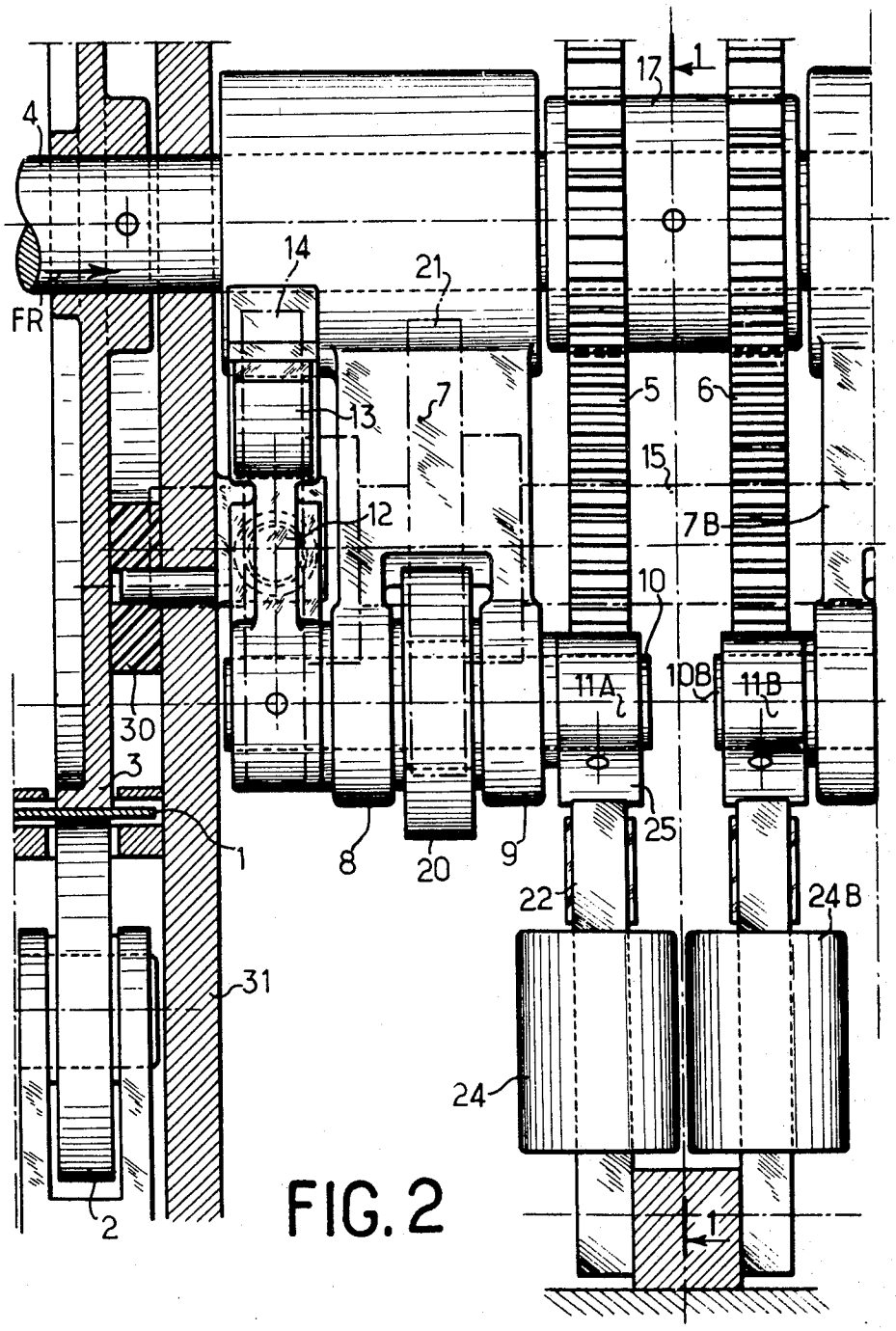
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FIG. 2

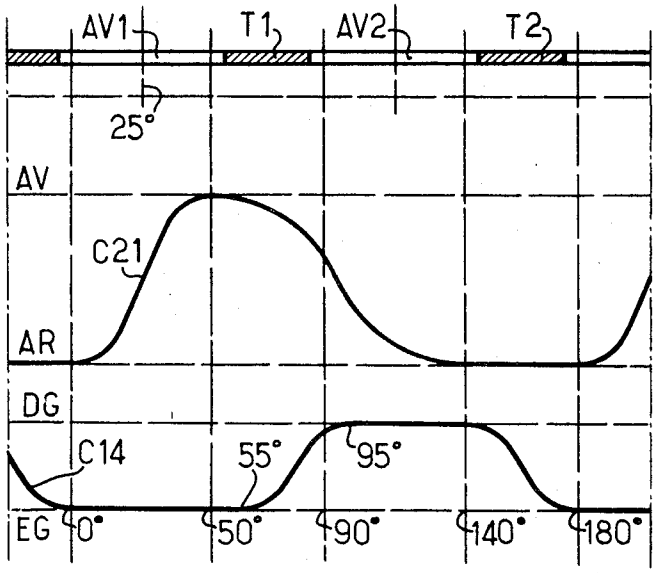


FIG.3

# MECHANISM FOR THE STEP-BY-STEP TRANSPORT OF DOCUMENTS

## BACKGROUND OF THE INVENTION

The present invention relates to improvements in transport mechanisms for advancing documents step by step in punched card or similar machines and concerns more particularly improvements in the mechanisms used for advancing cards or tapes in recording mechanisms such as punches or for advancing line by line one or more strips or sheets of paper in a high-speed printer.

Punching machines are known which operate column by column, in the recording of cards or tapes, and capable of normal operation at the rate of 160 to 200 perforation cycles per second. These known devices, mechanical, hydraulic, electromagnetic, and others, using step-by-step advancement of documents, are not generally adapted for correct and prolonged operation at such speeds.

The object of the present invention is to remedy these inconveniences and provide an improved mechanism for step-by-step advancement, which is precise, sturdy, and of a relatively simple and economical construction offering a particular arrangement suitable for operating correctly and in a prolonged manner under severe requirements of speed and precision.

This mechanism may be utilized for transporting documents step by step at one or the other of two speeds without an interruption of operation. The multiple applications of this mechanism other than those mentioned above may be realized by a convenient adaptation in accordance with the particular conditions of utilization.

## SUMMARY OF THE INVENTION

A transport mechanism in accordance with the invention comprises a secondary shaft with a ratchet wheel, a primary shaft moved by a motor in continuous rotation, carrying on one extremity a first cam and a second cam, a pawl-driving lever, wherein the pawl is normally disposed in cooperative relationship with the teeth of the ratchet, and a control electromagnet adapted to be energized for rendering the pawl inoperative. This mechanism is characterized by the fact that the pawl-driving lever has one extremity hinged on the same axle of rotation as the aforesaid ratchet wheel for step-by-step driving, and carries on a common axle of articulation a rubber roller and a pawl lever, one arm of the latter bearing a contact finger opposite to the corresponding first cam, and said pawl proper comprising a tip adapted for engaging the trapezoidal intertooth regions of the aforementioned ratchet wheel. The body of the pawl comprising a sliding face opposite to said tip and of cylindrical form. The control electromagnet comprises pole pieces similarly of cylindrical form, which are disposed in such a way that when the electromagnet is energized, the tip of the pawl cannot be engaged in the ratchet teeth, while continuing its circular reciprocating movement which is imparted by the driving lever.

A mechanism constructed according to the present invention permits, when it is associated with an identical mechanism, the realization of a step-by-step transport apparatus in which the speed of advance is doubled, but in which the different elements nevertheless remain useful under normal conditions of operation, preserving a normal resistance to wear, coupled with a great precision and absolute security of operation.

## BRIEF DESCRIPTION OF THE DRAWING

The invention will be described with reference to the accompanying drawing, wherein:

FIG. 1 is a view, partly in section, of the principal members of the step-by-step transport mechanism of the invention, taken on line 1—1 of FIG. 2;

FIG. 2 illustrates a part of the transport mechanism, partly in section, taken on the line 2—2 of FIG. 1; and

FIG. 3 is a diagram of the movements of the tip of the driving pawl during the course of a cycle of operation.



## DESCRIPTION OF THE PREFERRED EMBODIMENT

In the mechanism represented schematically, and only in part, in FIGS. 1 and 2, a record card 1 to be driven step by step, for example, in a high-speed punching mechanism, is gripped on an edge between a movable roller 2 and a driving disk 3. Disk 3 is fixed to a secondary shaft 4 which is driven step by step by the mechanism.

A similar arrangement may be provided for driving the card by the opposite edge. The advancement and the halting of the card in the apparatus may be controlled in a known manner by means of roller 2, according to whether the roller is pressed against or removed from driving disk 3. Shaft 4, as will be described later, may be driven by one or the other of two ratchet wheels 5 and 6, mounted on a hub 17 keyed to shaft 4, these two wheels each being able to be actuated alternatively by a pawl. A pawl-driving lever 7 is mounted to be able to oscillate on shaft 4. This lever is provided with two bearings 8 and 9 in which can oscillate a common axle of articulation 10 on which is keyed to one end, a pawl 11A, and to the other end, a pawl lever 12. The latter is provided with a contact finger 13 disposed to be urged by a spring 16 against the periphery of a first cam 14. Cam 14 is fixed to a primary shaft 15, which is driven in a continuous rotation in the sense of the arrow F, under the action of a motor not shown. A rubber roller 20 is mounted to turn freely on the common axle of articulation 10 and it is constantly urged, similarly under the action of spring 16, against the periphery of a second cam 21, which is driven in rotation, as cam 14, by primary shaft 15. In order to clarify the drawing, the outlines of shaft 15 and of cams 14 and 21 have been represented only by mixed dashes in FIG. 2.

When shaft 15 is rotating, the action of cam 21 on roller 20 imparts to driving lever 7 an oscillatory movement in the course of which pawl 11A drives ratchet wheel 5 in a step-by-step rotational movement under conditions which will later be described more precisely. Through the oscillatory movement of lever 7, pawl 11A is animated with a reciprocating movement in front of the fixed pole pieces 22 and 23 of electromagnet 24.

On the side opposite pawl 11A, the pole pieces of the electromagnet have the form of a portion of a cylinder of which the axis is located on the axis of shaft 4. Pawl 11A is provided with a sliding face 25 of similar cylindrical form and disposed in such a fashion that when the electromagnet is energized, the sliding face of the pawl is caused by magnetic attraction to rub against a support block 26 affixed to the pole pieces and projecting slightly from between the latter. This block is constituted of a nonmagnetic material, preferably self-lubricating. In this manner, when the electromagnet is energized, the pawl 11A is attracted and rotates lever 12 with its contact finger, which is therefore held away from cam 14 as long as tip 27 of the pawl is held out of engagement with the teeth of ratchet wheel 5. Thus, ratchet wheel 5 is prevented from being driven by the pawl so long as electromagnet 24 is energized.

In FIG. 3, the curve C21 indicates the movements of the tip 27 of the pawl between an advanced position AV and a rearward position AR along the periphery of ratchet wheel 5 under the action of cam 21 in the course of a cycle of advance of the ratchet. The curve C14 indicates the movements of the tip of the pawl between an engaged position EG and a disengaged position DG with the teeth of the ratchet wheel, under the action of cam 14, when the penetration movements of the pawl into the ratchet wheel are not prevented by energization of electromagnet 24.

In the example described, cam 21 (FIG. 1) is provided with two bosses in order to reduce the velocity of rotation of shaft 15; i.e., a cycle of advance of the pawl is effected for each half-turn of the shaft. Hence, in FIG. 3, a cycle of movement of the pawl is indicated for a rotation of 180° of motor shaft 15.

In FIGS. 1 and 2, the position of the different members of the apparatus correspond to the indicated 25° position on the diagram of FIG. 3, wherein the pawl is substantially in the mid-

dle of its course of advancement. Ratchet wheel 5 is represented in FIG. 1 as comprising 60 teeth, with a tooth pitch P on the wheel corresponding to an angle $\alpha$ of 6°. However, the amplitude of oscillatory movement imparted to the pawl is slightly greater than 6° in order for the pawl to be driven back into a rearward position from which it can descend behind the following tooth without touching it.

In order to furnish an indication of the dimensions of the device represented in FIG. 1 and 2, it is to be recalled that this device is for advancing column by a column a record card, in which the standard dimensions between two successive columns is 2.21 millimeters. Since ratchet wheel 5 is provided with 60 teeth, a card is advanced through 60 columns by one revolution of driving disk 3 for which the radius R is 21.10 millimeters.

The operation of the apparatus will now be described with reference to the diagram of FIG. 3. Considering a 0° point, chosen as a reference for departure. At this moment the tip 27 of pawl 11A is engaged in the teeth of the ratchet wheel (level EG of curve C–14), and after a slight delay the pawl is brought into contact with a tooth of the wheel, which is then driven by said pawl with a movement first accelerating and then decelerating, until the 50° point (curve C21) where the wheel halts. At the 25° point in the cycle, the ratchet wheel and all parts of the apparatus to which it is affixed are being thrust forward with a maximum velocity which corresponds to the maximum slope of curve C21 at this point in the cycle. In order to obtain the precise positioning of a document and the halting of all the parts driven by the pawl without shock, such pawl must follow the rule of deceleration which is imposed on the pawl by cam 21, the form of the latter being provided to halt the pawl, without shock, at the 50° point in the cycle. To effect this, the mechanism is provided with a frictional device in which the action is regulated to be sufficient to obtain the desired result. This braking device comprises a rubber ring 30, which is attached to a fixed wall 31 of the mechanism, and against which disk 3 is urged by a force FR exerted axially on shaft 4 of the mechanism by an appropriate means, for example, by a spring which is not shown. From the 50° point to the 140° point of the cycle, the pawl is drawn back to its rearward position (until at level AR of curve C21). It is only starting at the 55° point that the tip of the pawl commences to disengage from the ratchet teeth, that is, after the aforementioned pawl is clearly removed from the side of the tooth which it has completed pushing. Under these conditions, the disengagement of the pawl is effected from the 55° point to the 90° point without any rubbing of the pawl against the tooth of the ratchet. The pawl is then held in position disengaged from the teeth (level DG of FIG. 3) from the 95° point to the 140° point, whereupon it is engaged anew from the 140° point to the 180° point, again without rubbing against the teeth. Then a new cycle commences.

The advancement mechanism comprises two similar pawl mechanisms coupled to shaft 4 so that there can be obtained an advancement velocity for documents double that which can be obtained with a single mechanism. FIG. 2 shows only a part of the second mechanism. In the example described, this mechanism is of construction which is symmetrical to the first mechanism. This arrangement is advantageous for the machining of ratchet wheels 5 and 6, which are both affixed to hub 17; however, a pawl mechanism identical to the first can be disposed on shaft 4. The actuating cams of the second pawl mechanism are also mounted on primary shaft 15, but these cams are displaced angularly 90° relative to the cams of the first mechanism. In FIG. 1 there is represented by mixed dashes a cam 21B disposed for actuating pawl 11B (FIG. 2), mounted on axle 10B, which is able to oscillate in the bearings of a pawl driving lever 7B. Cam 21B is comprised, as is cam 21, of two bosses which are displaced by 90° with relation to the bosses of cam 21. The second pawl is brought into engagement with its ratchet wheel, from the 50° point to the 90° point of the cycle (FIG. 3) and then is advanced from its rearward position to its advanced position from the 90° point to the 140° point, while the first pawl is held in the disengaged position. Thus, while the first pawl is disengaged, a tooth is advanced a step under it by the second pawl, after which the first pawl is engaged (FIG. 3) from the 140° point to the 180° point while the second pawl is disengaged (with a delay of 5°). Next, the ratchet wheel is advanced a step from the 0° point (180°) to the 50° point while the second pawl is in the disengaged position. Under these conditions, shaft 4 is halted from the 50° point to the 90° point and from the 140° point to the 180° point, during which are permitted two recording operations (punching) T1 and T2 per cycle, the document being advanced during the intervals AV1 and AV2. The cams being doubled, each pawl mechanism effects two cycles per revolution of shaft 15 and the combined function of the two mechanisms furnishes four advancement steps and four halted periods for recording for each revolution of shaft 15. Because of this, in a card punching machine operating at the rate of 160 cycles per second, the rate of rotation of primary shaft 15 is only 2,400 revolutions per minute.

A mechanism according to this invention presents great flexibility of employment by the fact that at any moment the advance of a document can be halted or reestablished by energizing simultaneously the two electromagnets 24 and 24B and then deenergizing them. The velocity of advance of a document can also be reduced by half by energizing only one or the other of the two electromagnets.

It is evident that the example described is in no way limiting and that all modifications and adaptations can be drawn from the described arrangement, according to the situation and application, without departing from the invention.

I claim:

1. A transport mechanism for advancing a card or tape step by step comprising:
- a secondary shaft having a ratchet wheel,
- a primary shaft moved by a motor in continuous rotation, carrying on one extremity a first cam and a second cam,
- a pawl-driving lever,
- a pawl normally disposed in cooperative relation with the teeth of the ratchet,
- a control electromagnet adapted to be energized for rendering the pawl inoperative,
- one extremity of said pawl driving lever being mounted for rotation on said secondary shaft,
- said pawl driving lever carrying a friction roller and a pawl lever on a common axle of articulation,
- an arm of said pawl lever bearing a contact finger opposite to said first cam,
- the pawl proper comprising a tip adapted for engaging in the trapezoidal intertooth regions of said ratchet wheel and the body of said pawl comprising a sliding face opposite to said tip and of cylindrical form,
- said control electromagnet comprising pole pieces similarly of cylindrical form, which are disposed in such a way that when the electromagnet is energized, the tip of the pawl cannot be engaged in the ratchet teeth, while the pawl continues its circular reciprocating movement which is imparted to it by the driving lever.

2. A transport mechanism according to claim 1, wherein the cam faces of the two cams are arranged such that after effecting a driving step, the driving lever draws back the pawl toward the rear before the movement of disengagement from the intertooth regions has been imparted to the tip of the pawl.

3. A transport mechanism for advancing a card or tape step by step comprising two transport mechanisms as set forth in claim 1, wherein said primary shaft carries a pair of cams, wherein the secondary shaft carries two ratchet wheels, and wherein the cam pairs are oriented angularly in such a manner that the movements of advancement effected by the two transport mechanisms when both are operating are out of phase by half of the duration of a driving cycle.

4. A transport mechanism for advancing a card or tape step by step comprising two transport mechanisms as set forth in claim 2, wherein said primary shaft carries a pair of cams,

wherein the secondary shaft carries two ratchet wheels, and wherein the cam pairs are oriented angularly in such a manner that the movements of advancement effected by the two transport mechanisms when both are operating are out of phase by half of the duration of a driving cycle.

5. Apparatus for advancing a medium step by step comprising:

a drive wheel for gripping said medium and rotatable for moving said medium,

a first rotatable shaft having a ratchet wheel and coupled to said drive wheel,

a second shaft adapted to be rotated and having a pair of cams, the bosses of said cams being angularly displaced,

a pawl-driving lever rotatable about the axis of said first shaft,

a third shaft rotatably supported at one extremity of said pawl driving lever,

a pawl mounted on said third shaft and disposed to engage the teeth of said ratchet wheel,

a first cam follower member mounted on said third shaft and urged to follow one of said cams, whereby said pawl is controlled to cyclically engage the teeth of said ratchet wheel, and

a second cam follower member mounted to drive said pawl-driving lever and urged to follow the other one of said cams, whereby said pawl is controlled to reciprocate along the periphery of said ratchet wheel.

6. The apparatus of claim 5 further including an electromagnet member selectively energizable for attracting said pawl from engagement with said ratchet wheel.

7. A mechanism employed with step-by-step document transport equipment comprising in combination:

a pair of cams adapted to be rotated, the bosses of said cams being angularly displaced,

a wheel having teeth uniformly disposed along the periphery thereof,

a shaft mounted for rotation,

a pawl mounted on said shaft and disposed to engage the teeth of said wheel,

a first cam follower member mounted on said shaft and urged to follow one of said cams, whereby said shaft is controlled to oscillate about the axis thereof and thereby actuate said pawl to cyclically engage the teeth of said wheel, and

a second cam follower member coupled to said shaft and urged to follow the other one of said cams, whereby said shaft is controlled to oscillate transversely to said axis thereof, and thereby actuate said pawl to reciprocate along the periphery of said wheel.

8. The mechanism of claim 7 further including an electromagnet member selectively energizable for attracting said pawl away from engagement with said ratchet wheel.

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