United States Patent [19]

Burton

[11] **3,748,445**

[45] **July 24, 1973**

[54] **BIDIRECTIONAL COUNTER**

[76] Inventor: **John S. Burton,** 11349 Elderwood St., Los Angeles, Calif. 90049

[22] Filed: **Feb. 22, 1972**

[21] Appl. No.: **227,972**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 49,389, June 24, 1970, abandoned.

[52] **U.S. Cl.**..... **235/92 C,** 235/92 EV, 235/92 R, 235/131 JA

[51] **Int. Cl.** **G06m 3/14**

[58] **Field of Search** ..... 235/131 R, 131 JA, 235/92 C, 92 EV; 340/379

[56] **References Cited**

UNITED STATES PATENTS

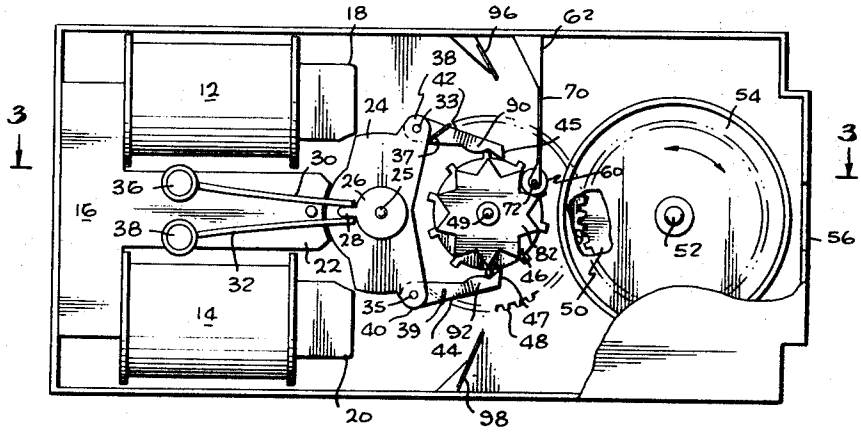
3,268,714	8/1966	Wales	235/92 C
3,047,224	7/1962	Ray et al.	235/92 C
3,238,359	3/1966	Einem et al.	235/92 C
2,558,953	7/1951	Henninger et al.	235/92 C
2,998,188	8/1961	Mast et al.	235/92 C
2,551,656	5/1951	Breitenstein	235/92 C

Primary Examiner—Maynard R. Wilbur
Assistant Examiner—Joseph M. Thesz, Jr.
Attorney—John J. Posta, Jr.

[57] **ABSTRACT**

Herein described is a bidirectional add-subtract counter which includes a pivotal armature, and two coils associated with the armature to actuate the movement thereof. The direction of pivotal movement of the armature is dependent upon the pulses applied to the coils. A pair of pawls actuated by the armature rotates a ratchet through a portion of the index whereby one pawl moves the ratchet in one direction and the other pawl moves the ratchet in a second direction. This is dependent upon the pivotal movement of the armature. Upon application of a pulse to a first coil, the armature rotates and cocks a first pawl which is pivotally connected to the armature, with such pawl being brought into operative contact with the ratchet, while the second pawl is moved out of operative contact with the ratchet. Upon termination of the pulse, the first pawl engages a tooth on the ratchet wheel and rotates the ratchet wheel in a first direction for a single increment. The energy for this motion is supplied by a spring return mechanism coacting with the armature to return the armature to its neutral position, and accordingly, causing arcuate movement in the pawls carried by the armature. A spring which has energy stored therein as the result of the original armature movement, forces the cam wheel to complete the ratchet rotation. A cam included in the pawl is adapted to engage a ratchet tooth to enable clearing of the second pawl from the ratchet teeth during the index motion. An anti-overthrow spring prevents the ratchet and counter wheel from rotating past their index position.

10 Claims, 10 Drawing Figures

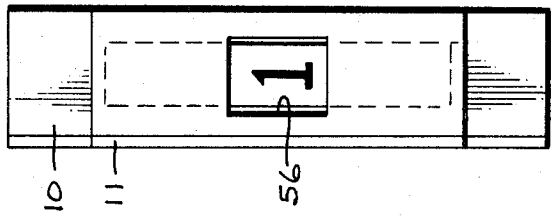


PATENTED JUL 24 1973

3,748,445

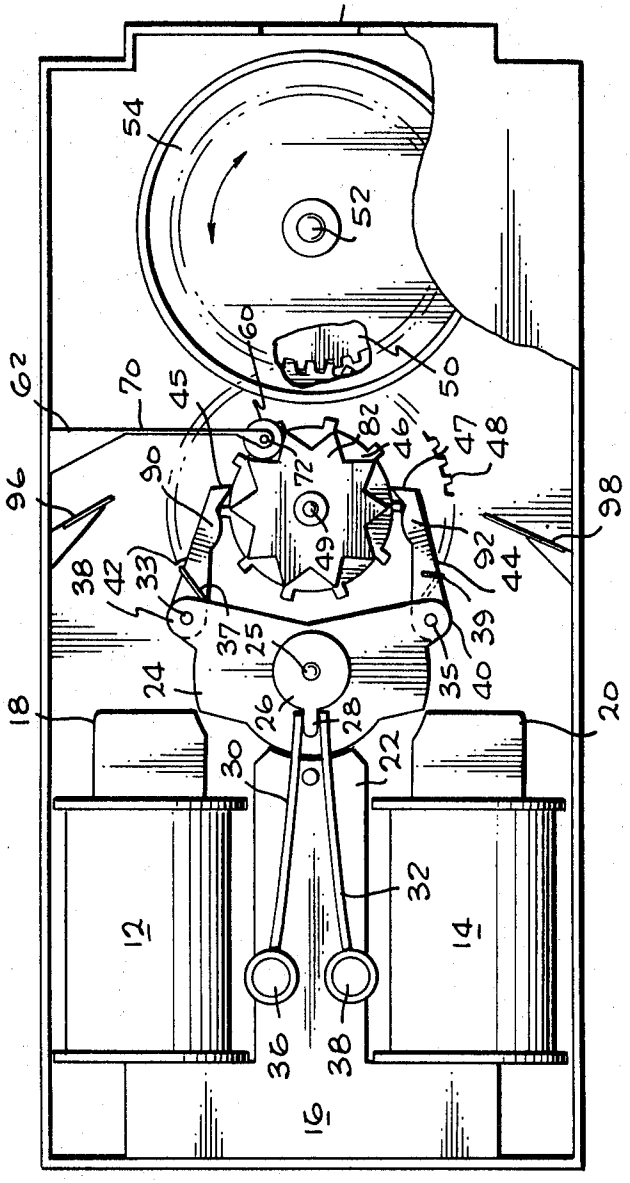
SHEET 1 OF 3

Fig. 2



3 — 1

Fig. 1



3 — 1

Fig. 3

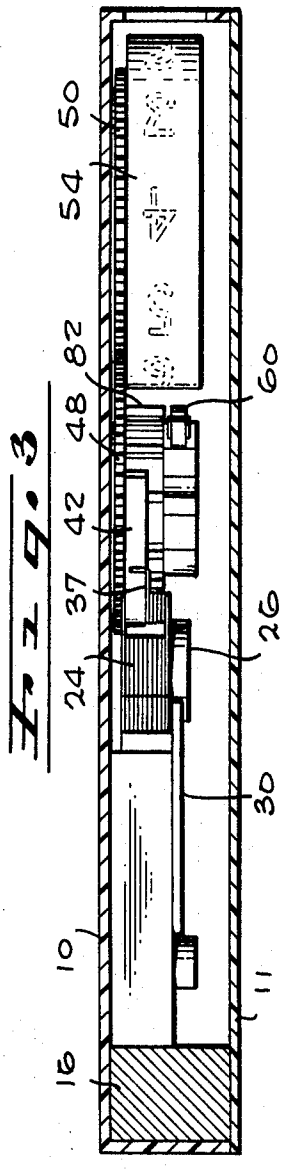


Fig. 3

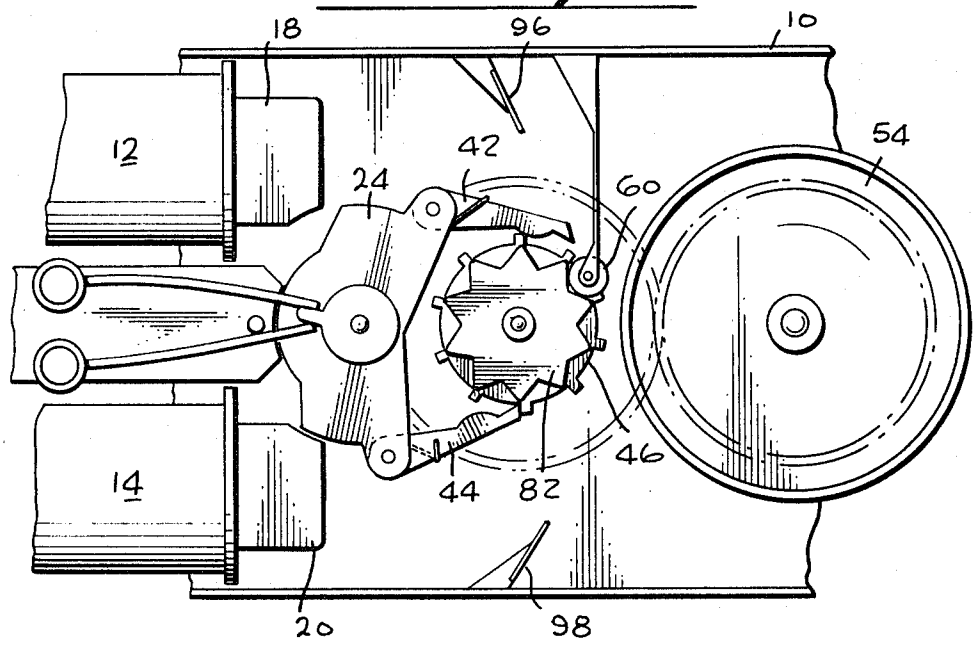

18
96
10
12
42
24
60
54
46
14
44
82
20
98

Fig. 4

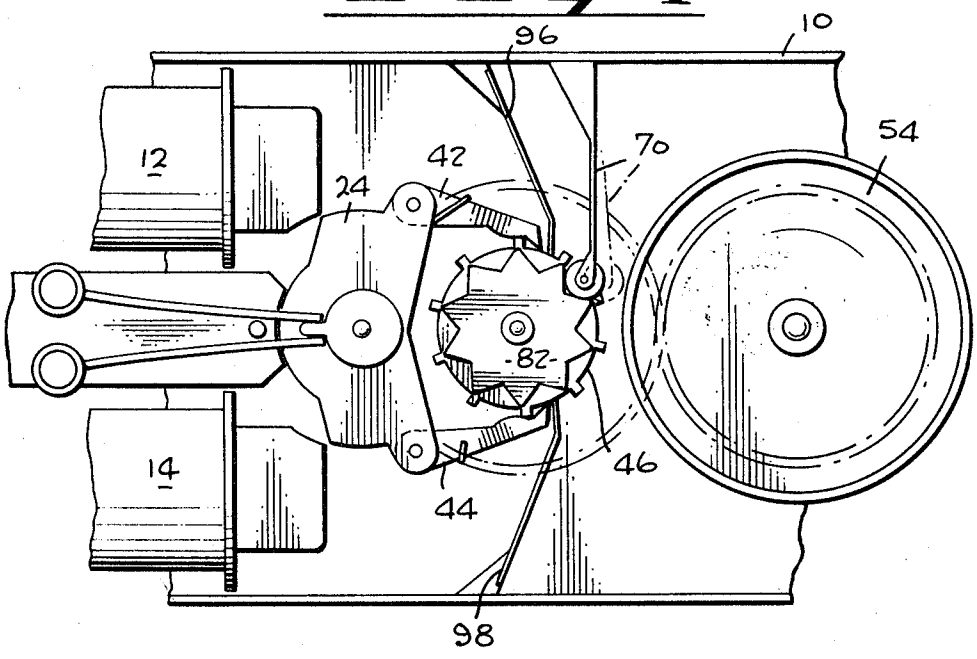

96
10
12
42
70
54
24
82
46
14
44
98

Fig. 6

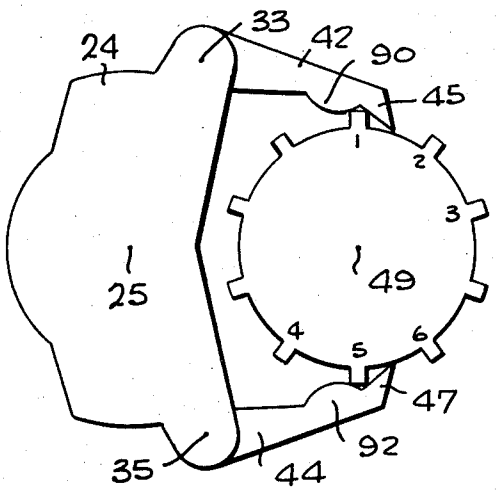


Fig. 7

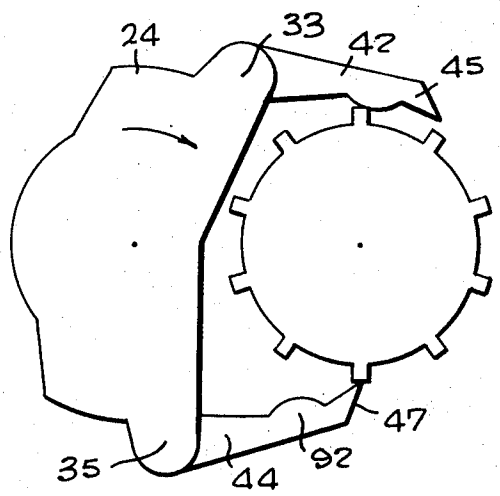


Fig. 8

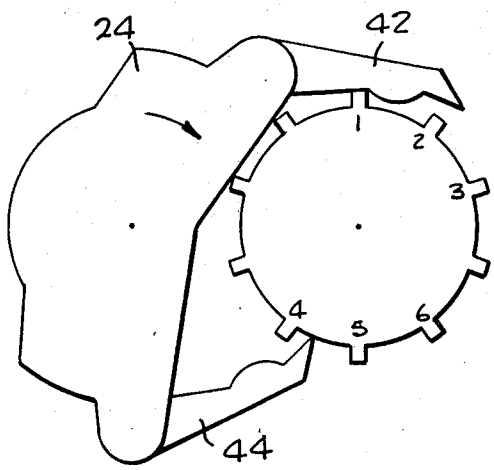
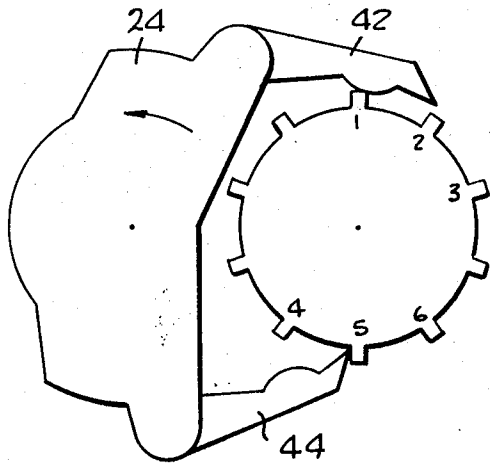


Fig. 9



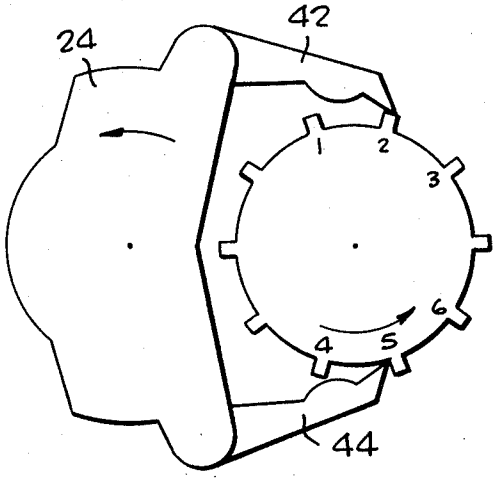


Fig. 10

BIDIRECTIONAL COUNTER

CROSS REFERENCES

This application is a continuation-in-part of my co-pending U.S. Pat. application, Ser. No. 49,389, filed June 24, 1970, now abandoned.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to counters and more particularly to a novel improved electrically actuated mechanical pulse counter. The invention further relates to an improved bidirectional modular counter which includes apparatus for enabling the subtract actuating pawl to escape the ratchet wheel when subtracting. Furthermore, the invention provides for movement of the ratchet wheel only after an actuating pulse has been terminated.

2. Discussion of the Prior Art

In the prior art many attempts have been made to provide an effective count-up/count-down mechanical counter capable of rotating a counter or number wheel in a direction dependent upon the pulses applied thereto. The count pulses are applied to predetermined input terminals. The number wheel in response to these pulses is advanced a certain amount. For example, if two pulses are applied in a positive going direction, or to a positive input means, the number wheel is rotated in a forward direction two increments. Conversely, if two pulses would be provided in a negative going direction or to a second input means, the number wheel is retracted two increments. A problem has arisen in the prior art whereby if a single gear ratchet wheel is used to advance the number wheel, the pawl which engages the ratchet has heretofore interfered with the return or direct indexing of the ratchet. Further, a problem arises whereby a single pawl is used to push the ratchet in a forward direction, the subtract pawl which is used to move the ratchet in a second direction interferes with the movement.

Thus the need has arisen to provide mechanism for clearing the unused pawl from the way of the teeth as they make the turn. Further, to complete the individual turn, the original pawl, that is, the pawl which is engaging the ratchet wheel and causing it to rotate, must be cleared from the path of the ratchet wheels.

A ratchet mechanism which pushes on its return stroke must end up with the pawl touching the ratchet tooth at the end of its stroke. In a bidirectional ratchet the subtract wheel, or add wheel, whichever is the case, must escape the ratchet wheel when adding or subtracting. Heretofore, this escape action has been very difficult, if not impossible, in the standard ratchet and pawl mechanism.

Additionally, prior art counters generally provide for movement of the ratchet wheel in real-time with application of the add/substract pulse to the counter. In decade counters which employ a series of in-line, discrete modules, pulses are applied to the first decade counter, and, when this counter changes from 9 to zero, a pulse is applied to the next adjacent decade counter, moving the index wheel one increment. Similar action takes place between adjacent counter modules.

Difficulties have arisen with the above module counters because switching motion of the commutators carried by the ratchets took place during the application of the actuating pulse, resulting in inconsistencies and

inaccuracies. A better transfer of pulses would ensue from application of pulses through static rather than dynamic commutators.

Applicant provides a mechanism for enabling application of a pulse while the ratchet wheel and commutators associated therewith are motionless, and further provides for movement of same only after termination of the pulse.

SUMMARY OF THE INVENTION

To overcome the above difficulties, the bidirectional counter of the present invention was developed. The bidirectional counting mechanism includes an electrically actuated armature having two independent movements. Particularly, the armature moves in a semicircular direction. A pair of pawls are included each being moved by one of the two movements of the armature or in opposite directions depending upon the electrical pulses applied to the coils associated with the armature. A ratchet wheel is included which includes teeth adapted to be engaged by the pawls to partially index in one direction by one pawl and in a second direction by the other pawl.

A cam wheel is provided adjacent the ratchet wheel and connected to rotate therewith. A spring loaded detent wheel is provided and engageable with the apex of the points of said cam wheel and is adapted to aid in movement of the ratchet wheel between index position and to maintain said cam wheel in fixed index positions.

A cam is integrally formed on each one of the pair of pawls and is adapted to engage the ratchet teeth of the ratchet to clear the pawls over the teeth when the ratchet is moved in one of two rotating directions.

A pulse is first applied a solenoid causing the armature to rotate about its pivot point. A spring return mechanism is provided to return the armature to its initial, neutral position. Upon application of the pulse, a first pawl slips down between the teeth of the ratchet wheel due to the presence of a biasing spring which tends to force the pawl against the ratchet wheel. The second pawl is moved out of engagement with the ratchet wheel by the coaction of a ratchet tooth with the cam integrally formed on the pawl.

Upon termination of the pulse, the spring return mechanism returns the armature to its neutral position. Likewise, the first pawl is moved, causing movement of ratchet wheel. In Applicant's design, the pawls are adapted to push the ratchet wheels perhaps 70 percent of the total desired indexing increment. The detent wheel with spring bias attached thereto moves the ratchet wheel the balance of the indexing increment.

In one embodiment anti-overthrow springs are provided which prevent the ratchet and the number wheel from rotating past the index points due to the stored kinetic energy thereof. One of the springs is lifted by the appropriate pawl during the pawl action and permits the ratchet wheel to rotate. The spring associated herewith then drops back in place during the ratchet power stroke and snubs the ratchet wheel to a stop at the end of the stroke.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features and advantages will become more apparent to those skilled in the art when taken into consideration with the following detailed description wherein like reference numerals indicate like and

corresponding parts throughout the several views wherein:

FIG. 1 is a side view of the counter mechanism in accordance with one aspect of this invention which has the cover removed so that the integral parts thereof can be clearly illustrated.

FIG. 2 is an end elevation view.

FIG. 3 is a cross-sectional view of FIG. 1 taken along lines 3—3.

FIG. 4 is a partial view showing the armature, spring return mechanism and pawls in a neutral position.

FIG. 5 is a partial view similar to that shown in FIG. 4 which shows the position of the armature, spring return mechanism and pawls during pulse application.

FIG. 6 is a partial view of the respective positions of the armature, pawls and ratchet wheel at rest.

FIG. 7 is a partial view of the respective positions of the armature, pawls and ratchet wheel shortly after pulse application.

FIG. 8 is a partial view of the respective positions of the armature, pawls and ratchet wheel after pulse application completion but before termination thereof.

FIG. 9 is a partial view of the respective positions of the armature, pawls and ratchet wheel shortly after pulse termination.

FIG. 10 is a partial view of the respective positions of the armature, pawls and ratchet wheel after pulse termination and after return of the pawls and armature to the at rest position.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to a more detailed description of this invention, there is shown in FIG. 1 a housing 10 which is provided to encase all of the integral parts of the counter mechanism in accordance with one aspect of the present invention. The housing 10 is somewhat rectangular in shape and may be relatively thin, as shown in FIG. 2. The thinness is preferred when used in modules. A cover 11, as shown in FIG. 2, is placed over the housing 10 to respectively cover the counter mechanism parts. A pair of solenoids 12 and 14 are mounted within the housing 10 which receive the count pulses from an outside or external source. A magnetic field structure in the form of a three-legged iron core 16 is provided which includes a first leg 18, a second leg 20 and a center leg 22. The coils 12 and 14 are preferably wound around the legs 18 and 20 and are actuated one at a time for either the add or subtract direction. An armature 24, which is pivotally mounted at a pivot 25 to the housing 10, is rotated in a direction dependent upon the field in the core 16.

The armature 24 may have a pair of extending arms 38 and 40 therefrom. Mounted on one surface of the armature 24 is a return cam 26 which includes an extending tip 28 which protrudes towards the center leg 22 of the core 16. A pair of springs 30 and 32 are connected onto the center leg 22 of the armature 16 by the retainer screws 36 and 38. These springs 30 and 32 are preferably leaf springs which are adapted to engage the extending tip 28 of the return cam 26.

The end of center arm 22 of iron core 16 is a concave structure which receives a convex structure of the armature 24. The legs 18, 20 and 22 provide a magnetic field to the armature 22 and when electrical signals are applied to coils 12 and 14. The armature 24 is caused to rotate in a field depending upon the direction of the windings of the coils 12 and 14 and depending upon which of the coils 12 and 14 is energized.

Pivotally mounted at pivot points 33 and 35 to extension arms 28 and 40, respectively, is a pair of pawls 42 and 44. Each of the pawls 42 and 44 have an inwardly extending tip 45 and 47 which are adapted to engage teeth of a ratchet wheel 46 which is pivotally mounted to the housing 10 by a pivot 49. Coil springs 37 and 39 bias pawls 42 and 44 against ratchet wheel 46. Mounted on pivot 49 and adapted to actuate with the ratchet wheel 46 is a gear 48. The gear 48 engages a gear 50 which is pivotally mounted by the axle 52 within the housing 10. A number wheel 54 is coupled to the gear 50 and is adapted to rotate therewith. The housing 10 includes an opening or window 56 so that the numbers on the count wheel 54 may be visually observed therethrough, as shown in FIG. 2.

As the armature 24 is rotated, for example, in a clockwise position, the tip 45 of pawl 42 engages one of the teeth of the ratchet wheel 46 and advances it in a clockwise direction. On the other hand, if the armature 24 is rotated in the other or counterclockwise direction, the tip 47 of pawl 44 engages one of the ratchet teeth on the ratchet wheel 46 causing it to rotate the ratchet in a counterclockwise direction. As the ratchet rotates, the gear 48 engages the gear 50 and causes the number wheel 54 to rotate.

In accordance with one principle of this invention, the pawls 42 or 44 push the ratchet wheel a portion of the total index increment, for example, 70 percent in a manner more clearly hereafter set forth. A spring loaded detent wheel 60, as will be described, causes the ratchet to continue its stroke.

A support member 62 is suitably connected to the housing and carried detent wheel 60. The support member 62 includes a flexible extension arm 70 which angularly extends into the housing 10. The detent wheel 60 is rotatably mounted to the flexible arm 70 at pivot 72 and engages a cam gear 82. The cam gear 82 has a plurality of points protruding therefrom which include pointed apexes thereon. The wheel 60 is adapted to force between the apexes of the cam gear 82 forcing gear 82 to turn further thus to complete the rotation to a predetermined set of fixed index positions. The detent wheel is forced downwardly between a pair of apexes by the spring action of the flexible extension arm 70. FIG. 4 effectively illustrates the action of this improvement.

Pawls 42 and 44 each include cam means 90 and 92 integrally formed on the inner surfaces of the pawls 42 and 44 so that upon specific rotation of ratchet wheel 46, either of the cams 90 and 92 respectively, engage the interfering ratchet teeth, causing either the pawl tip 45 or 47 to be lifted above the oncoming teeth so that they will not interfere therewith, as shown in FIGS. 5–9.

In one embodiment of the invention, a pair of anti-overthrow springs 96 and 98 (shown only in FIG. 4, for clarity) are suitably connected on one end thereof of the housing 10. The springs 96 and 98 are preferably leaf springs and are attached to housing 10 in a manner so as to angularly dispose the springs 96 and 98 towards the pivot 49 of ratchet 46. The springs 96 and 98 are relatively straight in their projection, except that the tip ends therein are bent inwardly towards the center of the ratchet wheel 46 and are adapted to engage the ratchet 46 and the associated teeth thereon. The two

anti-overthrow springs 96 and 98 are so constructed as to prevent the ratchet 46 and its associated number wheel 54 from rotating past the index point due to the kinetic energy thereof obtaining during movement thereof by pawls 42 or 44. The springs are lifted from the ratchet wheel 46 by the inclined tip of the proper pawl during the advancement thereof and thus allows the ratchet wheel 46 to rotate. This is accomplished by the pawls 42 and 44 having an inclined side opposite the cams thereof and on the tips 45 and 47 thereof. When the pawls 42 and 44 are moved from interference with the springs 96 and 98, respectively, the springs then drop back into place. Springs 96 and 98 effectively secure the ratchet wheel 46 at the end of the stroke.

In FIG. 4, we see armature 24 held in a neutral, at rest, position by springs 30 and 32. In FIG. 5, we see the position of springs 30 and 32 after solenoid 14 has been actuated to rotate clockwise about pivot 25. In this latter position, it can be seen that energy is being stored in spring 30 for later use in returning armature 24 (and the pawls 42 and 44) to their original neutral position.

Reference will now be made to drawings 6–10 which show the respective positions of the ratchet wheel 46, the teeth on ratchet wheel 46, pawls 42 and 44, cams 90 and 92, and armature 42 during the operation of the counter. FIG. 6 is a showing of the operative members in a neutral position. It can be seen that pawl 42 maintains contact with tooth 1 of ratchet wheel 46 on its underside at a point between tip 45 and cam 90. Likewise, pawl 44 maintains contact with tooth 5 of ratchet wheel 46 on its underside at a point between tip 47 and cam 92. As noted earlier, coil springs 37 and 39 bias pawls 42 and 44 against ratchet wheel 46.

The application of a pulse to solenoid 14 causes armature 24 to start rotating clockwise about pivot 25. FIG. 7 shows the operative members just after application of the pulse. Here we see pawl 42 having tip 45 cammed out from between teeth 1 and 2 by counterclockwise rotation about pivot 33 due to the camming interaction between cam 70 and tooth 1. Tip 47 is likewise being moved counterclockwise about pivot 35 and from between teeth 5 and 6 by the camming action effected by and between tooth 5 and tip 47.

FIG. 8 shows the operative members in position upon completion of the pulse actuation. Here we see tooth 1 as having cammed tip 45 out from between teeth 1 and 2 and over tooth 2. Tip 47 in turn has been forced between teeth 4 and 5 by coil spring 39. It should be noted that the ratchet wheel has not moved during the action heretofore taking place, having been held motionless by detent wheel 60.

In FIG. 9, we see the operative members shortly after termination of the pulse. Here armature has started its return to the neutral position in response to the force of return spring 30. The tip 47 of pawl 44 slides on ratchet wheel 46 between teeth 4 and 5 until it abuts the base of tooth 5. Cam 90 maintains tip 45 from dropping between the teeth on ratchet wheel 46.

FIG. 10 shows armature 24 in its neutral position. Here we have ratchet wheel 46 rotated about 70 percent of its index increment by the force of tip 47 on the base of tooth 5. Tip 45 now rests on top of tooth 2. As was previously described, detent wheel 60 then forces itself into its unloaded position on cam wheel 82, thereby causing ratchet wheel 46 to rotate the balance of its index increment, as is shown in FIG. 4. Tips 45 and 47 now rest between teeth 2–3 and 4–5 respectively, awaiting the application of another pulse.

Having thus described one preferred embodiment of this invention, what is claimed and desired to be secured by Letters Patent is:

1. A bidirectional counter mechanism including:
a pivoted armature movable in a first and second direction,
a first pawl pivotally connected to said armature,
a second pawl pivotally connected to said armature,
said first pawl and said second pawl being independently movable about its pivot with respect to one another,
a ratchet wheel having teeth adapted to be engaged by said first pawl to move the ratchet wheel in a first direction and adapted to be engaged by said second pawl to move said ratchet wheel in a second direction,
means for maintaining said second pawl out of engagement with said teeth when the first pawl is moving the ratchet wheel in said first direction,
means for maintaining said first pawl out of engagement with said teeth when the second pawl is moving the ratchet wheel in said second direction,
actuation means for applying a force for moving said armature in a first direction while the ratchet wheel remains substantially unmoved,
and return means for simultaneously moving both said armature and said ratchet wheel in a second direction after removal of the force developed by said actuation means.

2. The mechanism set forth in claim 1 wherein said first and second pawls have cam means integral therewith and wherein said means for maintaining said first and second pawls out of engagement are said cam means.

3. The mechanism set forth in claim 2 including a cam wheel connected to said ratchet wheel and adatped to move in unison therewith, and
a biased detent wheel engagable with said cam wheel and adapted to maintain said cam wheel in a series of predetermined positions.

4. The mechanism set forth in claim 3 wherein the cam means are integrally disposed on each pawl and are adapted to engage the teeth of the ratchet wheel for selective camming of the pawls from between the teeth.

5. The mechanism set forth in claim 4 including a pair of spring means adapted to engage teeth on the ratchet wheel to prevent undesired rotation thereof, with said pawls being adapted to selectively remove one of said spring means during the movement of said armature to a predetermined position.

6. The mechanism set forth in claim 5 including means to bias said pawls against the ratchet wheel.

7. A mechanism set forth in claim 1 wherein the return means moves the ratchet wheel through less than a complete index increment.

8. A mechanism set forth in claim 7 including detent means to move the ratchet wheel through the balance of the complete index movement.

9. A mechanism set forth in claim 1 including a numbered count wheel adapted to rotate concurrently with said ratchet wheel.

10. A mechanism set forth in claim 1 wherein said actuation means is electrical in nature and said return means is mechanical in nature.

* * * * *