

United States Patent

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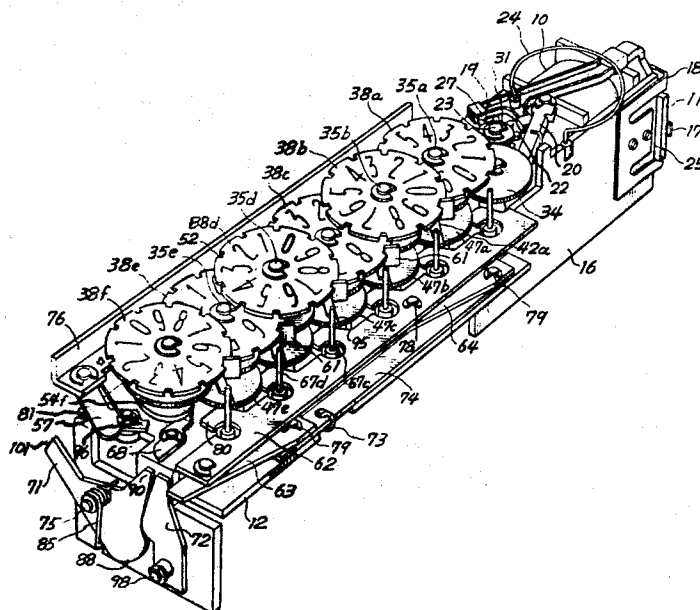
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[54] **ELECTROMAGNETIC COUNTER**
10 Claims, 11 Drawing Figs.

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235/109, 235/144 HC
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G06c 15/42, G06c 27/00
[50] Field of Search. 235/144
HC, 109, 76, 137, 91.1, 91 PR, 91.4, 91.10

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ABSTRACT: An electromagnetic counter having an electromagnetic driving means, a reduction gearing connected to the driving means and indicating members such as figure wheel or dial to indicate a count. The reduction gearing includes counting gear assemblies rotated in accordance with a scale such as decimal system, and the counting gear assemblies accumulate the kinetic energy in resilient members such as springs for rotating the indicating members. Each of the indicating members is adapted to be rotated one pitch by the accumulated kinetic energy for every transferring signal from the previous column. In addition the electromagnetic counter is provided with a zero-setting means. To accomplish the zero-setting operation, the reduction gearing is adapted to be disconnected.



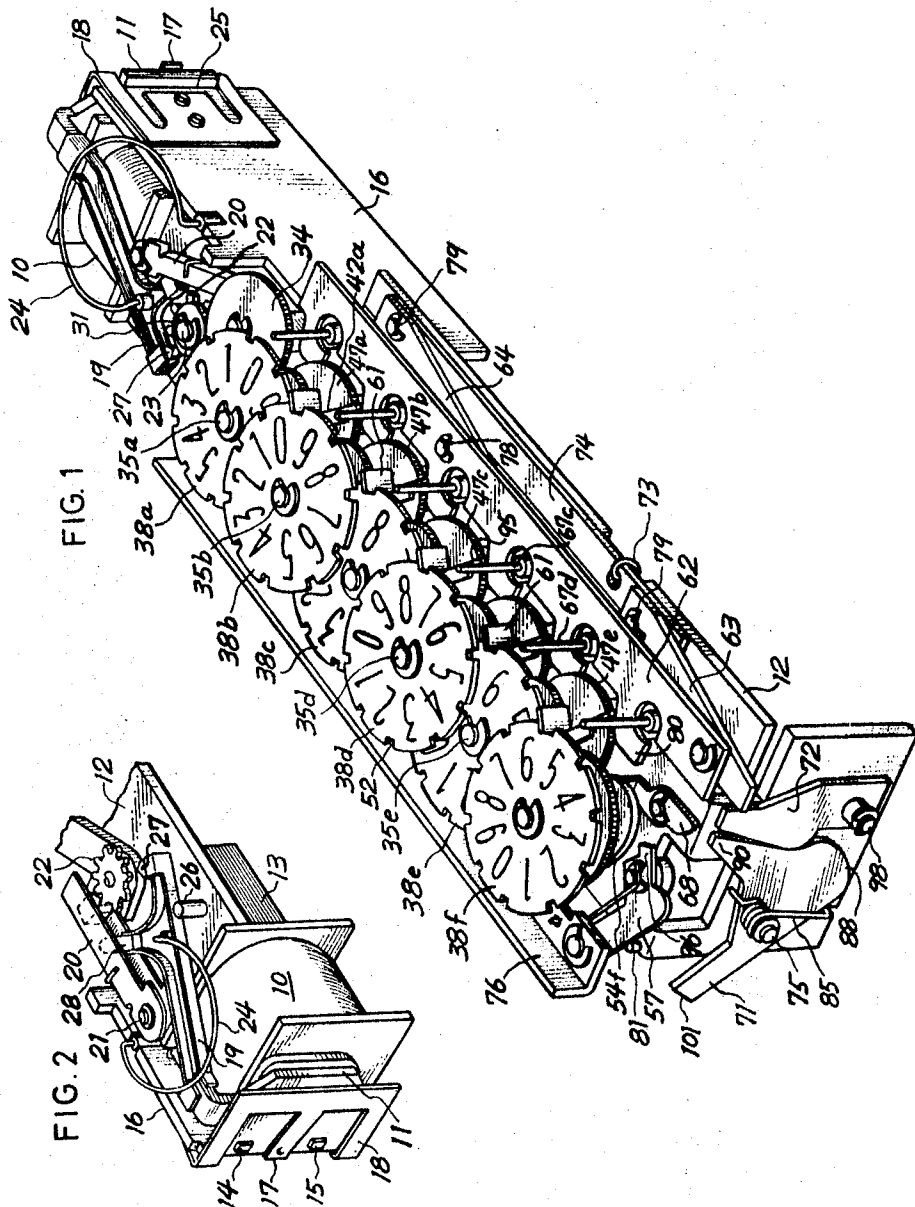


FIG. 4

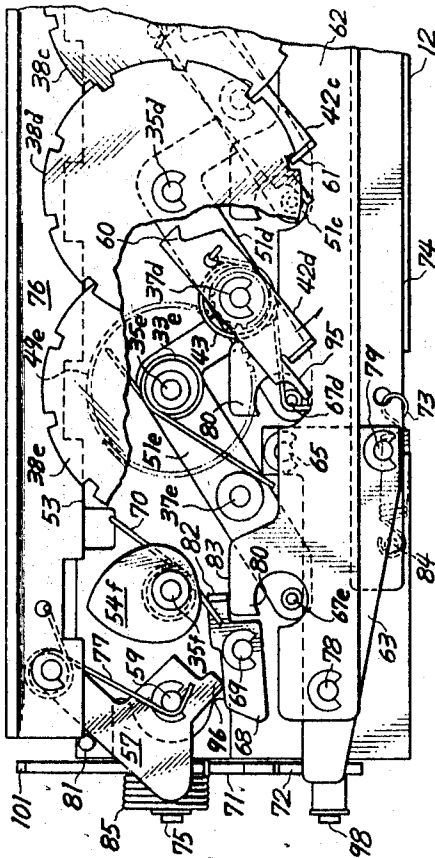
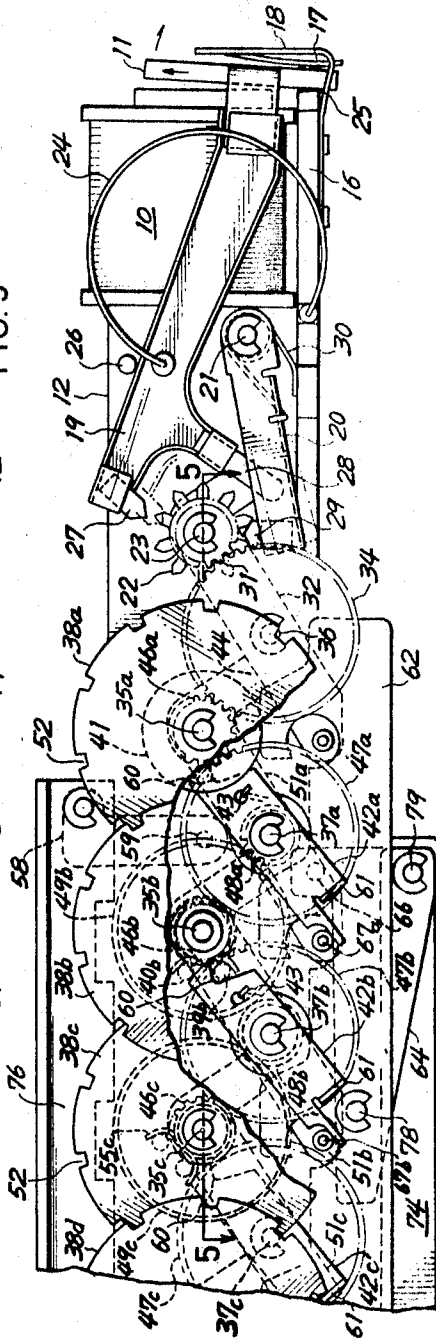
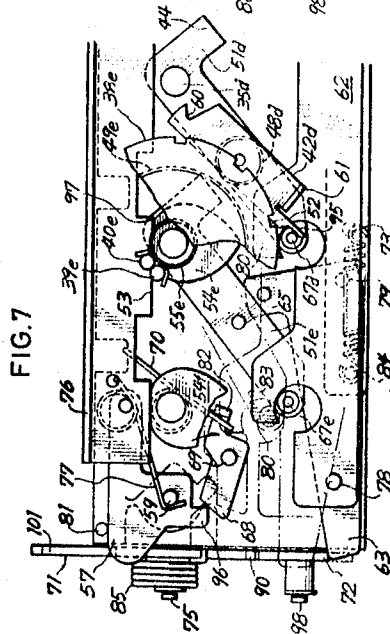
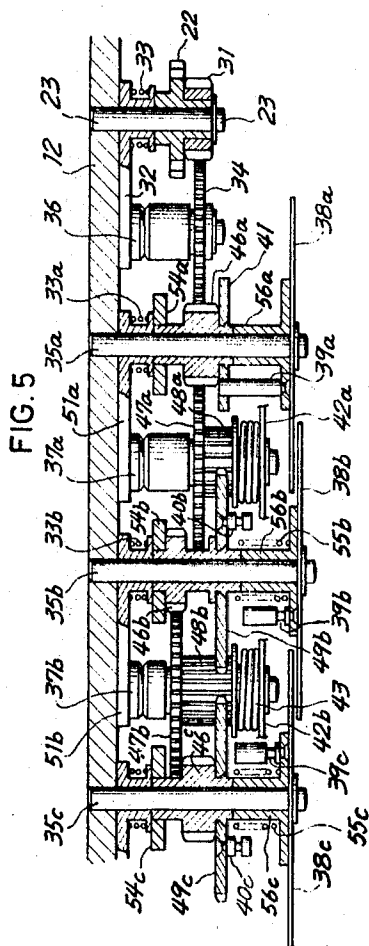
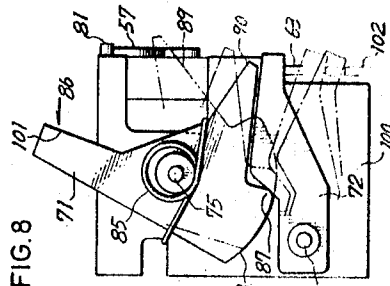
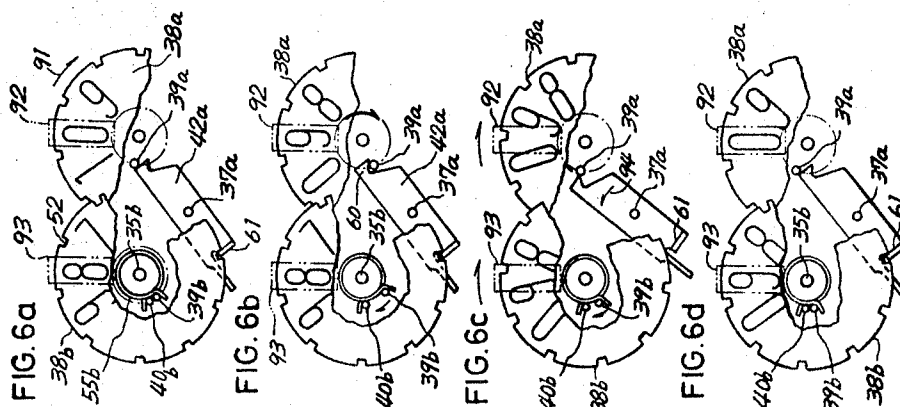


FIG. 3





ELECTROMAGNETIC COUNTER

This invention relates to an electromagnetic counter having a plurality of indicating members to indicate a count.

The transferring mechanism in the conventional electromagnetic counter comprises gears, intermittent motion mechanism and others. To perform the transferring of all of the columns, all figure wheels are mechanically and parallel connected to each other and rotated by a driving means at the same time. This means that the driving means is subjected to momentary heavy load. For this reason, the driving means must be manufactured to have great power sufficient to perform the transferring of the all columns. Therefore the electromagnetic driving means consumes a great quantity of electric power and can not be manufactured in small size. Additionally, it is difficult to operate the counter at high speed, because of the great total inertia of the figure wheels, gears, intermittent motion mechanism and others. Further, since the figure wheel occasionally vibrates because of backlash of the gearing, the figure is illegible during the operation.

Generally, the zero setting operation of the conventional counter is performed in the following order.

1. A gear for transferring is removed from a gear integral with the figure wheel.
2. a reset plate is engaged with a heart-shaped cam integral with the figure wheel to rotate it to the zero position.
3. The reset plate is removed from the heart-shaped cam.
4. The transferring gear is engaged again with the gear of the figure wheel.

Since the figure wheel is in unstable condition between the above operations 3 and 4, the figure wheel may be rotated for some reason or other, for example by the oscillation of the counter body. As a result the transferring gear may be engaged with an improper portion of the gear of the figure wheel, which will indicate another number except zero. Further, there is the danger that the zero-setting operation can not be performed because of engagement of the reset plate with the tip of the heart-shaped cam.

Therefore, an object of this invention is to provide an electromagnetic counter which may be driven by relatively small electric power and manufactured in small size.

Another object of this invention is to provide an electromagnetic counter which may be reliably actuated at high speed.

Still another object of this invention is to provide a novel electromagnetic counter which may be accurately reset to the zero position.

A further object of this invention is to provide an electromagnetic counter wherein the indicating member is locked so that it does not quiver during the counting operation, whereby the figures may be easily visible.

A still further object of this invention is to provide an electromagnetic counter in which the force exerted upon each member of the device may be decreased to lengthen the life of the device.

These and other objects of this invention and the various features and detail of the operation and construction thereof are hereinafter more fully set forth and described with reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of an electromagnetic counter in accordance with this invention with an outer casing omitted;

FIG. 2 is a perspective view of an electromagnetic driving means as seen from the back side thereof in Fig. 1;

FIG. 3 is a plan view showing the electromagnetic driving means and a lower column portion with parts of dials broken away;

FIG. 4 is a plan view showing a higher column part with certain parts broken away;

FIG. 5 is a sectional view taken on line 5-5, FIG. 3 with parts such as pins being deflected from their positions;

FIGS. 6a to 6d are plan views showing an operation of the transferring mechanism;

FIG. 7 is a plan view showing a zeroizing operation in the higher column with certain parts broken away; and

FIG. 8 is a side view showing the levers for zeroizing as viewed from the left of Fig. 4.

Referring to the drawings, and particularly to Figs. 1, 2 and 3, an electromagnetic driving means comprises a solenoid 10 and an armature 11, and being secured to the back side of a baseplate 12 at a core 13. The armature 11 is loosely fitted to two protrusions 14, 15 projected from an end of a sideplate 16 secured to the baseplate 12 and core 13, and being urged to the end of the side plate 16 by a finger 17 of a spring plate 18 provided on the sideplate 16. The force of the spring plate 18 is also exerted upon the armature to bias it upwardly as shown by the arrow in Fig. 3 to be held in fixed position. The electromagnetic driving means is also provided with a first pawl lever 19 secured to the armature 11, a second pawl lever 20 rotatably mounted on a stationary shaft 21 and a ratchet wheel 22 rotatably mounted on a stationary shaft 23. In normal condition, the first pawl lever 19 is forced to a positioning pin 26 by a spring 24 as shown in Fig. 3.

The first pawl lever 19 has a first pawl 27 and a rod 28 and the second pawl lever 20 has a second pawl 29. The second pawl lever 20 has a U-shaped form in section to enclose loosely the rod 28 and the second pawl 29 is engaged with the ratchet wheel 22 by a spring 30.

When the solenoid 10 is actuated, the armature 11, that is the first pawl lever 19 will be rotated about an edge 25 of the side plate 16 in the counterclockwise direction against the biasing force of the spring 24 to engage the rod 28 with the second pawl lever 20 to rotate it in the counterclockwise direction, so that the second pawl 29 will be removed from the ratchet wheel 22. Thereafter the first pawl 27 engages with the ratchet wheel 22, which will cause the ratchet wheel to rotate slightly more than half-pitch angle. When the solenoid 10 is deenergized, the first pawl lever 19 will be returned to the solid line position in FIG. 3. Following the first pawl lever 19 the second pawl lever 20 returns to the solid line position, so that the second pawl 29 will be engaged with the ratchet wheel 22 to rotate the ratchet wheel remaining angle of one pitch. Thus with this driving means the ratchet wheel 22 is caused to make one pitch rotation for every signal pulse fed to the solenoid 10 in the clockwise direction. The ratchet wheel 22 has ten notches to be rotated one full turn by ten signal pulses.

Referring to FIGS. 3 and 5, on the stationary shaft 23, a gear 31 and a gear supporting L-shaped lever 32 are rotatably mounted, and the L-shaped lever 32 is forced against an end 44 of a following L-shaped lever 51a of the first column by a spring 33. An intermediate gear 34 rotatably mounted on a shaft 36 secured to the lever 32 is engaged with the gear 31 and a gear 46a of the first column. The gear 46a is provided with same number of teeth as that of the gear 31 to form 1:1 gearing between these gears.

Since each structure of the first column to the sixth column described hereinafter is identical, the same reference numerals are used to identify similar parts and a letter of the alphabet a to f is added to the numeral to clarify the distinctions among the columns.

Referring to FIGS. 3 and 5, shafts 35a, 35b and 35c are secured to the baseplate 12 respectively. On each shaft L-shaped levers 51a, 51b and 51c, gears 46a, 46b and 46c, and sleeves 56a, 56b and 56c are rotatably mounted respectively. The L-shaped levers 51a and 51b have shafts 37a, 37b on which gears 47a, 48a, 47b, 48b, and levers 42a, 42b are rotatably mounted respectively. The levers 51a, 51b are adapted to be rotated by springs 33a and 33b in the clockwise direction in FIG. 3 respectively, and the side of the lever 51a being engaged with the end of the lever 51b to be held in the condition illustrated in FIG. 3. Each set of the gears 47a and 48a, and 47b and 48b is formed in integral piece, the gear 47a is engaged with the gear 46a of the first column and the gear 48a is engaged with a gear 49b which is fixed to the gear 46b of the second column, and other gears are engaged in a similar manner respectively. The gears 46b and 49b are fixed to each other to form a counting gear assembly in the second column

and rotated in accordance with a scale, for example decimal system in this embodiment, thus there is formed a 10:1 reduction gearing between adjacent columns. On the flanges of the sleeves 56a, 56b and 56c, there are fixedly provided dials 38a, 38b and 38c and pins 39a, 39b and 39c. The pin 39a is secured to a disk 41 fixed to the gear 46a and the other pins 39b and 39c are adapted to engage with pins 40b and 40c which are secured to the gears 49b and 49c respectively. An end of a coil spring 55b provided on the shaft 35b is engaged with the pin 39b and other end is engaged with the pin 40b so that both the pins draw and engage each other.

Each of levers 42a, 42b and 42c rotatably mounted on the shafts 37a, 37b and 37c has a hook portion 60 at one end and an upward projection 61 at other end, and the projection 61 is biased to the dial by a spring 43 to be engaged with any one of 10 notches 52 of the following dial except the dial 38a of the first column. The hook portion 60 of the lever for example 42b is positioned in the path of the pin 39b of the previous column, so that the lever 42b is rotated by engagement of the pin 39b with the hook portion in the counterclockwise direction during the rotation of the dial which results in removing of the projection 61 from the notch 52 of the dial 38c of the following column.

When the gear 46a is rotated in the clockwise direction, the gear 49b is rotated in the same direction as the gear 46a through the gears 47a and 48a, so that the spring 55b is wound up because the dial 38b is locked by the projection 61 of the lever 42a. In transferring operation, when the lever 42a is rotated by the pin 39a, the dial 38b is released and rotated clockwise by the spring 55b and arrested by abutment of the pin 39b with the pin 40b, so that the dial is rotated one pitch.

This counter is provided with a zero-setting means. Referring to FIGS. 3, 4 and 5 the zero-setting means comprises heart-shaped cams such as 54a, 54b, 54c, 54f which are secured to the gears such as 46a. A returning plate 76 is provided for free rotational movement on links 57 and 58 rotatably mounted on pins 59 and 59 to form a parallel linkage, and bring removed from the heart-shaped cams by a spring 77 and held in the position of FIG. 4 by engagement of the link 57 with a positioning pin 81.

In zero-setting, the returning plate 76 is moved to the heart-shaped cams by the links 57 and 58 against a spring 77 so that an edge 53 of the returning plate may be engaged with the cam. Levers 62, 63, 64 and 74 are formed into parallel linkage for removing the engagement of gears. The levers 63 and 64 are rotatably mounted on shafts 65, 66 secured to the baseplate 12, and on the levers 63 and 64, the lever 62 and 74 are pivotally carried by pins 78, 78 and 79 and 79 respectively. The lever 62 has six hooks 80 as is clearly seen in FIG. 4. With respect to the fourth column, the hook 80 is adapted to engage with a lower increased diameter portion of a pin 67d fixed to the end of the lever 51d. Movement of the lever 62 to the lower position shown in FIG. 7 causes the hook 80 to engage with the pin 67d, so that the lever 51d is rotated counterclockwise about the shaft 35d, which in turn will cause the lever 42d to rotate in the direction of the arrow together with the lever 51d about the shaft 35d by engagement of an upper reduced diameter portion of the pin 67d with the end portion of the pin 95 of the lever 42d.

A lever 68 adjacent to the link 57 is adapted to rotate about a shaft 69 secured to the baseplate 12 and a bent portion 82 being forced against an edge 83 of the lever 62 by a spring 70 engaged with the bent portion 82. The lever 68 is arranged to engage with the end of the link 57 and arrest the rotation thereof as hereinafter described. A spring 73 provided between the lever 74 and a pin 84 on the baseplate 12 has greater tension than that of the spring 70 and causes the levers 63 and 64 to rotate clockwise to engage the end of the lever 63 with a lever 72, thereby the parallel linkage is held in the position of FIG. 4. Referring to FIG. 8, the lever 72 is rotatably mounted on a shaft 98 secured to the sideplate 100 formed at the end of the baseplate 12 by bending, and a lever 71 is rotatably mounted on a shaft 75 and being rotated in the

clockwise direction by a spring 85 to engage with the side of the lever 72 at an end 87 thereof. Rotation of the lever 71 in the direction of arrow 86 causes the lever 72 to rotate clockwise. A side edge 88 of the lever 71 is formed in circular shape coaxial with the shaft 75. Therefore, under the condition that the edge 88 engages with the lever 72 as shown by the chain line 89, the lever 72 is not rotated through the lever 71 is rotated. The lever 71 is so arranged that an end 90 thereof can be engaged with the link 57 to rotate it in the clockwise direction in FIG. 4 after the end 87 has passed the lever 72 and hence the rotation of the lever 72 has finished.

In operation, as set forth above, upon every actuation of the lever 19 of the electromagnetic driving means, the ratchet wheel 22 is rotated one pitch in the clockwise direction in FIG. 3. Rotation of the ratchet wheel 22 causes the gear 46a and the dial 38a to rotate clockwise in 1:1 rotational ratio. Thus the count of the signal pulse received by the solenoid 10 is indicated by the dial 38a bearing figures 0 to 9. Clockwise rotational force of the ratchet wheel 22 to the gear 34 acts in cooperation with the force of the spring 33 to rotate the lever 32 in the clockwise direction to be forced to the end 44 of the lever 51a, so that proper and reliable engagement between the gear 34 and the gear 46a may be insured.

The transferring operation of this device will now be described with reference to FIGS. 6a to 6d. Reference numerals 92 and 93 designate indicating windows, hence FIG. 6a showing count 80. Under the condition of FIG. 6a, the pin 39a of the first column is situated in the position in advance of the lever 42a as viewed from the rotational direction of arrow 91. The dial 38b of the second column is arrested by the engagement of the projection 61 of the lever 42a with the notch 52 and the pins 39b and 40b engage each other. FIG. 6b shows the condition of count 89 after counting 81 to 88 from the condition of FIG. 6a. The pin 39a is rotated nine pitches in the direction of the arrow 91 and located near the hook 60 of the lever 42a. The dial 38b is still held stationary as a result of the engagement of the projection 61 with the notch 52 and the pin 40b is rotated 9/10 pitch through the gearing thus serving to increase the torsion of the spring 55b and hence energy is accumulated in the spring. When the figure of the dial 38a engages changes from 9 to 0 as shown in FIG. 6c, the pin 39a engages with the hook 60 to rotate the lever 42a in the direction of arrow 94, which results in release of the dial 38b. Thus the dial 38b is rotated by the rotational force in accordance with the energy accumulated in the spring 55b and stopped by engagement of the pin 39b with the pin 40b. When one revolution of the dial 38a is completed, the pin 40b is advanced just one pitch from the condition of FIG. 6a thus the figure of the dial 38b being advanced from 8 to 9, which means count 90 as shown in FIG. 6d. At the same time the lever 42a returns to the same position as FIG. 6a and the projection 61 engages with the notch 52 to lock the dial 38b. Transferring operation of the following column will be taken place in the similar way to the above described manner. However, there is a difference that driving force of the electromagnetic driving means is exerted directly on the pin 39a to rotate the lever 42a in the first column, but rotation of the lever such as 42b is accomplished by the energy accumulated in the spring 55b.

The operation of the zero-setting means will now be described referring to FIGS. 7 and 8. Rotating the lever 71 in the direction of the arrow 86 by pushing the projected part 101, the lever 72 will be rotated by engagement of the end 87, which will cause the lever 63 to rotate to the chain line position 102 in FIG. 8. Rotation of the lever 63 causes the lever 62 to move from the chain line to the solid line in FIG. 7, so that the pin, for example 67d, and hence the lever 51d is rotated by engagement of the hook 80 thereby the gear 48d will be removed from the gear 49e. These actuations are made in all of the columns at the same time, thus gearings between all columns are disconnected from each other, which means that each of the heart-shaped cams on the shafts 35a to 35f may be rotated. Therefore, the heart-shaped cam, for example cam 54e is rotated by the spring 55e and stopped by abutment of

the pin 40e to the pin 39e integral with the dial 38e. Since the dial 38e is located in any one of the predetermined 10 positions corresponding to the figures of the dial, the position of the heart-shaped cam 54e is limited in the determined position.

Thereafter the lever 42d is also rotated together with the lever 51d by the pin 67d as previously described so that the projection 61 is removed from the notch 52 of the dial 38e, thus the heart-shaped cam 54e and the dial 38e are combined by the spring 55e and can be freely rotated together.

Further rotating the lever 71, the link 57 is rotated clockwise in FIG. 7 to engage the plate 76 with the heart-shaped cams. At this time, if the edge 97 of the plate 76 engages with the tip of the heart-shaped cam 54e, it can not rotate the cam. However, as previously set forth, since the position where the cam can be located is determined, it is possible to prevent the engagement of the edge 97 of the plate 76 with the tip by selecting the position of the cam. Thus the heart-shaped cam can be rotated by the plate 76 so that each dial is reset in the zero position.

Referring to FIG. 7, when the link 57 is rotated to the solid line position, the lever 68 is rotated by the spring 70 from the chain line to the solid-line position, because the lever 62 has been located in the lower position shown by the solid line, thereby returning actuation of the link 57 by the spring 77 is arrested by the engagement of the end 96 with the end of the lever 68. Thus the heart-shaped cams are held in the zero position and hence in the stable condition brought by engagement of the plate 76 with the notch of the heart-shaped cam. During this stable condition, it is desirable to engage the intermediate gear such as 48d with the gear such as 49e. If the engagement of the intermediate gear is taken place under the unarrested condition of the heart-shaped cam, the zero position which has been obtained by the heart-shaped cam may be changed. To perform the zeroing, the operation is made in hereinafter described order.

Returning of the lever 71 causes the lever 72 and 62 to return to the solid line in FIGS. 4 and 8. During this operation, the lever, for example 51d, is rotated clockwise, and firstly the projection 61 of the lever 42d engages with the notch 52 of the dial 38e to hold it in the zero position, secondarily the gear 48d will engage with the gear 49e. Thereafter the lever 68 is rotated counterclockwise by the lever 62 against the force of the spring 70, which in turn causes the link 57 to free. Thus the link 57 is returned by the spring 77, all of the member of this counter are returned to the initial state and each dial indicates figure zero in the window.

From the foregoing it will be observed that this invention provides a novel electromagnetic counter having indicating means which is easily visible, because the indicating means of higher columns than first column are locked during the counting operation in the first column. In addition, since energy for transferring is progressively accumulated in springs by reduction gearings and the driving means is not subjected to momentary heavy load, the counter in accordance with this invention can be driven by small torque. When torque necessary for accumulating the energy in the spring of n -column is A , torque on the shaft of the first column corresponding to torque A is $(1/10^{n-1})A$, because there are provided 10:1 reduction gearings between columns. Since each torque A of columns has a same value, total torque of the counter having n columns is

$$A_0 + A \left(\frac{1}{10} + \frac{1}{100} + \frac{1}{1000} + \dots + \frac{1}{10^{n-1}} \right) \cong A_0 + \frac{1}{10} A$$

wherein A_0 is the torque necessary for driving the members of the first column. Therefore if the driving means has a power sufficient to drive the second column with remaining power, the means will drive the counter having a plurality of columns. Thus, in accordance with this invention it is possible to drive the counter by a driving means of low power at high speed.

Further, this invention has following advantages in the zero-setting means.

1. Zero-setting operation is easily performed, because each column can be freely rotated independently when operated.

2. Since the heart-shaped cam is stopped at the preferable position where the returning plate does not engage with the tip of the cam, the zero-setting operation may be made in reliable manner.

3. Since the dial and the counting gear assembly are locked until the intermediate gear engages with the counting gear assembly, the zero position is not changed by the returning of the intermediate gear.

The electromagnetic counter in accordance with this invention may be applied to a stop watch. More particularly the gearing between the counting gear assemblies is composed in the same scale as the watch and connecting the electromagnetic driving means with the oscillator having standard frequency.

While a particular embodiment of this invention has been illustrated and described herein, it is not intended to limit the invention to such a disclosure, and changes and modifications may be incorporated and embodied therein within the scope of the following claims. For example, if the zero-setting means is not necessary, the ratchet wheel 22 may be formed integrally with the gear 46a omitting the intermediate gear 34.

We claim:

1. An electromagnetic counter comprising; electromagnetic driving means actuated by a signal pulse, a ratchet wheel rotated by said electromagnetic driving means, a gear rotatable with said ratchet wheel, a reduction gearing engaged with said gear and including counting gear assemblies provided at every column and rotated in accordance with a desired scale, resilient members adapted to be deformed by the rotation of said counting gear assemblies to accumulate the kinetic energy, indicating members adapted to be rotated by the kinetic energy accumulated in each resilient member, arresting members to arrest said indicating members, locking means engageable with said indicating members, and releasing members for actuating said locking means upon transfer to free the indicating member of the following column.

2. An electromagnetic counter in accordance with claim 1 wherein each resilient means comprises a coil spring provided coaxially with the counting gear assembly and the ends thereof are engaged with the arresting member and the indicating member respectively.

3. An electromagnetic counter in accordance with claim 1 wherein each locking means comprises a lever of which one end may be engaged with the indicating member and other end may be engaged with the releasing member.

4. An electromagnetic counter in accordance with claim 1 wherein each arresting member comprises a pin secured to the counting gear assembly and each resilient member is provided between the pin and a pin secured to the indicating member, so that the rotation of the indicating member is arrested by engagement of the latter pin with the former pin.

5. An electromagnetic counter comprising; electromagnetic driving means actuated by a signal pulse, a ratchet wheel rotated by said electromagnetic driving means, a gear rotatable with said ratchet wheel, a first column counting gear assembly rotated by said gear through a disengageable intermediate gear, a reduction gearing engaged with said first column counting gear assembly, and including counting gear assemblies and disengageable intermediate gears provided at every column whereby each counting gear assembly may be rotated in accordance with desired scales, resilient members adapted to be deformed by the rotation of said counting gear assemblies to accumulate the kinetic energy, indicating members adapted to be rotated by the kinetic energy accumulated in each resilient member, arresting members to arrest said indicating members, locking means engageable with said indicating members, releasing members for actuating said each locking means upon transfer to free the indicating member of the following column, heart-shaped cams secured to the counting gear assemblies, removing means operable to disengage the intermediate gears and locking means during the

zero-setting operation and zero-setting means adapted to engage with said heart-shaped cams after the disengagement of the intermediate gears and locking means.

6. An electromagnetic counter comprising; electromagnetic driving means actuated by a signal pulse, a ratchet wheel 5 rotated by said electromagnetic driving means, a gear rotatable with said ratchet wheel, a first column counting gear assembly rotated by said gear through a disengageable intermediate gear, a reduction gearing engaged with said first column counting gear assembly and including counting gear assemblies and disengageable intermediate gears provided at 10 every column whereby each counting gear assembly may be rotated in accordance with desired scales, resilient members adapted to be deformed by the rotation of said counting gear assemblies to accumulate the kinetic energy, indicating members adapted to be rotated by the kinetic energy accumulated in each resilient member, arresting members to arrest said indicating members, locking means engageable with said indicating members, releasing members for actuating said each locking means upon transfer to free the indicating member of 20 the following column, heart-shaped cams secured to the counting gear assemblies, removing means operable to disengage the intermediate gears and locking means during zero-setting operation, zero-setting means adapted to engage with said heart-shaped cams after the disengagement of the inter- 25

mediate gears and locking means and means for locking said zero-setting means until the intermediate gears and locking means return.

7. An electromagnetic counter in accordance with claim 5 wherein each resilient means comprises a coil spring provided coaxially with the counting gear assembly and the ends thereof are engaged with the arresting member and the indicating member respectively.

8. An electromagnetic counter in accordance with claim 5 wherein each locking means comprises a lever of which one end may be engaged with the indicating member and other end may be engaged with the releasing member.

9. An electromagnetic counter in accordance with claim 5 wherein each arresting members comprises a pin secured to the counting gear assembly and each resilient member is provided between the pin and a pin secured to the indicating member, so that the rotation of the indicating member is arrested by engagement of the latter pin with the former pin.

10. An electromagnetic counter in accordance with claim 5 wherein the locking means is adapted to be disengaged from the indicating member after the intermediate gear has been disengaged from the counting gear assembly in the zero-setting operation.

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