July 31, 1962 W. A. RAY ETAL 3,047,224

ELECTROMAGNETIC COUNTER

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Fig. 1

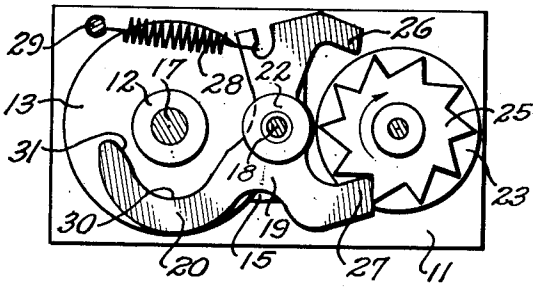


Fig. 2

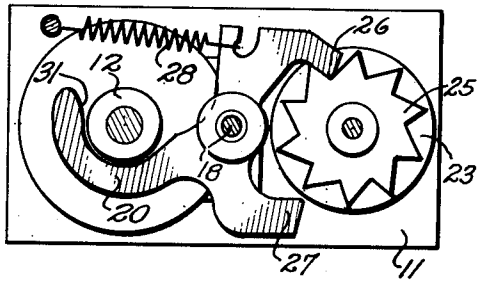


Fig. 3

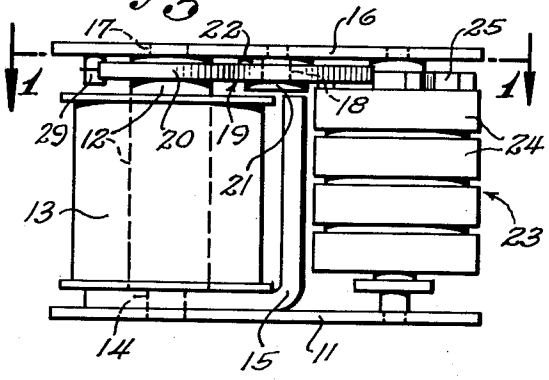
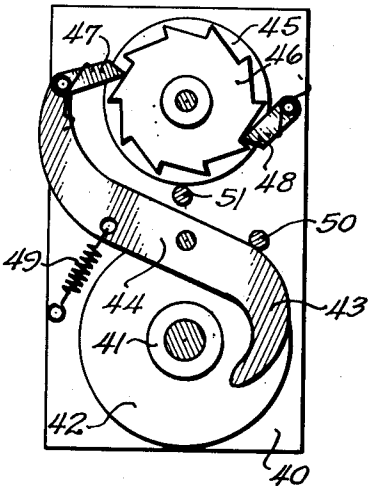


Fig. 4



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Fig. 5

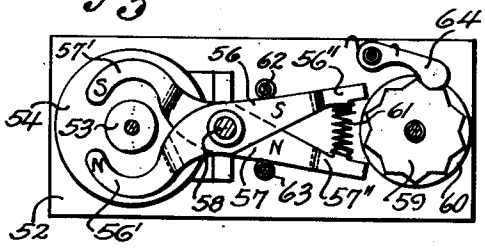


Fig. 7

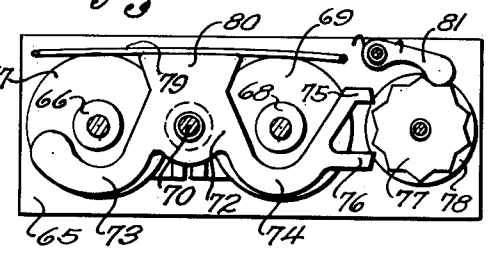


Fig. 6

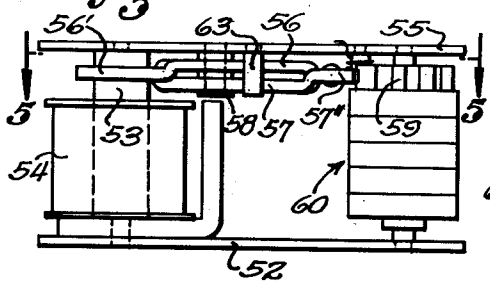


Fig. 8

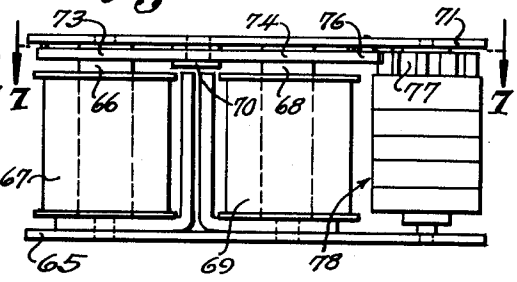


Fig. 9

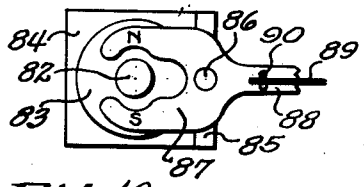


Fig. 10

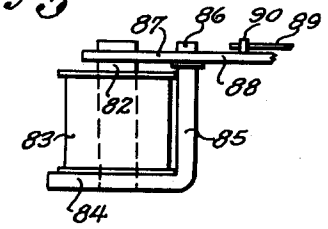


Fig. 11

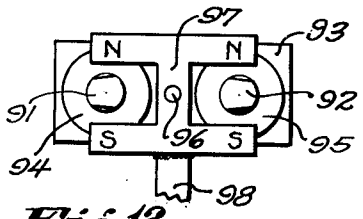
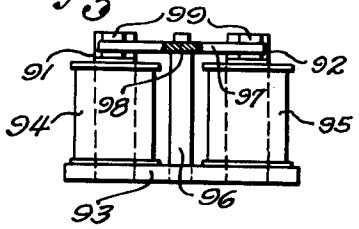


Fig. 12



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United States Patent Office 3,047,224 Patented July 31, 1962

3,047,224

ELECTROMAGNETIC COUNTER

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Filed Feb. 25, 1959, Ser. No. 795,414
4 Claims. (Cl. 235—92)

This invention relates to electromagnetic operators of the pivoted-armature type, and more particularly to electromagnetic devices adapted for operating registering or counting devices.

An object of the invention is to provide an electromagnetic operator which, while extremely compact and simple, is capable of producing a relatively long but powerful stroke; this object being accomplished, in general, by providing an electromagnet a portion of whose core is substantially straight and has a pole-face at one end, and by arranging an armature so that it can rock in a plane perpendicular to this core-portion and cooperate with a side of this portion adjacent said pole-face, instead of with the pole-face itself.

Another object is to provide an electromagnetic operator, of the character described in the preceding object, wherein the range of movement of the armature relative to the core is relatively large, while the working gap between these parts does not become proportionately large when the electromagnet is deenergized, so that the efficiency of the operator is high. We accomplish this object by making said core-portion cylindrical and by shaping the cooperating part of the armature so that it conforms generally to the curvature of this core-portion.

Another object of the invention is to provide an electromagnetic operator of the general character described above wherein the armature is rockable, selectively, in either direction from a normal position to which it is biased.

Another object is to provide means whereby said selective rocking of the armature is effected in accordance with the direction of current supplied to the electromagnet, the armature then being at least in part of permanent-magnet material.

Another object is to provide an electromagnetic operator, capable of selectively effecting movement of a device in opposite directions, comprising a single electromagnet and a pair of cooperating armatures operable individually in accordance with the direction of current supplied to the electromagnet.

Another object is to combine a counting device with each of the electromagnetic operators described above to provide compact, reliable, high-speed electromagnetic counters.

Further objects and advantages of our invention will become apparent from the following description and accompanying drawing, and from the appended claims.

In the drawing:

FIGURE 1 is a view from the top, taken along the line 1—1 of FIG. 3, of an electromagnetic counter embodying features of this invention;

FIGURE 2 is a view of the structure of FIG. 1 taken in the same manner as in that figure but showing the parts in the positions to which they are moved when the electromagnet 12, 13 is energized;

FIGURE 3 is a front elevation of the structure shown in FIGS. 1 and 2;

FIGURE 4 is a view, taken in the same manner as in FIG. 1, of a modified electromagnetic counter according to our invention;

FIGURES 5 and 6, and FIGURES 7 and 8 are views, taken in the same manner as in FIGS. 1 and 3 respectively, of two further-modified electromagnetic counters according to our invention; and

FIGURES 9 and 10, and FIGURES 11 and 12, are more-or-less diagrammatic top and front showings of two still-further modified forms of electromagnetic operators according to our invention.

In FIGS. 1–3 the numeral 11 indicates a base plate, preferably of nonmagnetic material, on which is mounted an electromagnet comprising a cylindrical core 12 and an annular energizing coil 13 around the lower portion of the core. Core 12 has a reduced bottom portion 14 which serves as a rivet to secure the core to the base with one arm of an L-shaped bracket 15 therebetween, this bracket being of magnetic material and forming a flux-conducting extension of the core.

On the top of the electromagnet is a plate 16, of nonmagnetic material and coextensive with base 11, which is secured to core 12 by a rivet-forming extension 17 of the same. At the underside of plate 16, and pivotally mounted on a shouldered rivet 18 secured to the plate, is a flat member 19 of magnetic material having at its left a crook-shaped armature portion 20 cooperable with the side of core 12 above coil 13, adjacent the flat end or pole-face of the core. The rivet 18 is of magnetic material and its head 21 is disposed closely adjacent the top of the vertical arm of core-bracket 15 to augment the path for magnetic flux through the electromagnet and the armature. The member 19 is clearanced from plate 16 by a washer 22 around the rivet 18.

Mounted between base 11 and plate 16 at the right of the electromagnet is a counting device 23, which may be of the well-known "Veeder" type, having a plurality of number wheels 24. Actual numbers on the wheels, as well as carry-over means between the individual wheels, have been omitted for the sake of simplicity. At its top the counting device has, for its operation, a ten-toothed star wheel 25.

The portion of member 19 at the right of its pivot is formed to provide a bifurcated pawl comprising a pair of teeth 26 and 27 alternately engageable with teeth at opposite sides of the star wheel 25. The armature-pawl member 19 is normally in the position shown in FIG. 1 under the force of a tension spring 28 connected by its ends to the member and to a pin 29 secured to plate 16, rocking of the member under the force of this bias being limited by engagement of the pawl tooth 27 with the star wheel.

When the electromagnet is energized by passage of current (which may be A.C. or D.C.) through its coil 13, the armature portion of member 19 is attracted to the side of core 12 so that the member rocks clockwise about its pivot. In this movement of the member the pawl tooth 27 is withdrawn from the star wheel and the other tooth 26 engages the adjacent tooth of the wheel and drives the same in clockwise direction until the moving parts reach their final positions, as shown in FIG. 2, with tooth 26 in a valley between the star-wheel teeth and firmly engaging the wheel. The arrangement is preferably such that there is then a small air-gap between the armature portion 20 and the side of core 12.

When the electromagnet is subsequently deenergized the member 19 rocks counterclockwise under the force of spring 28 so that pawl tooth 26 is withdrawn from the star wheel and the other tooth 27 engages the adjacent tooth of the wheel and drives the same in clockwise direction.

A full cycle of operation of the electromagnet effects movement of the counter through one-tenth of a revolution, it being moved through slightly more than one-twentieth of a revolution when the electromagnet is energized, and through a complemental angle upon deener-

gization of the electromagnet. The mass of member **19** at opposite sides of its pivot is substantially balanced so that there is little tendency for the member to rebound in operation.

As can be seen in FIG. 2, the edge **30** of the armature portion of member **19** is shaped to conform generally to the curvature of core **12**. By so shaping this portion the magnetic linkage between the armature and the core is increased, and the working gap between these parts does not become excessive even when the armature is required to rock through a relatively large angle, as in the operation of a counting device. The edge **31** of the armature adjacent its tip is formed so that it does not pass very close to the core when the armature is attracted.

In FIG. 4, which is a view (taken in the same manner as in FIG. 1) of a modified embodiment of our invention, the numeral **40** indicates a base supporting an electromagnet, comprising a cylindrical core **41** and an energizing coil **42**, with which electromagnet the armature portion **43** of a pivoted member **44** cooperates. The operation of member **44** by the electromagnet is substantially the same as that of member **19** in the arrangement of FIGS. 1–3 and need not be described further.

Mounted on the other end of the base **40** is a counting device **45** of the same kind as that shown in FIGS. 1–3 but having a different form of star wheel **46** with which a pivoted pawl **47**, carried by member **44**, cooperates in a conventional manner; there being also a retaining pawl **48** as is required in this arrangement since the counter is driven (through one-tenth revolution) only during the power stroke of the armature-pawl member **44**. This member **44** is biased by a tension spring **49** into engagement with a stop **50**, there being another stop **51** limiting clockwise rocking of the member in response to energization of the electromagnet.

In the further-modified form of our invention shown in FIGS. 5 and 6 there is, mounted on one end of a base **52**, an electromagnet comprising a cylindrical core **53** and an energizing coil **54**. At the underside of the top plate **55** of the counter is a pair of crossed arms **56** and **57** pivotally mounted generally at their middle on a pin **58** secured to the top plate, the crossed portions of the arms being maintained in spaced relation to each other by a nonmagnetic washer.

The left-hand ends **56'** and **57'** of arms **56**, **57** are crook-shaped and arranged to cooperate with opposite sides of core **53**, while the right-hand ends **56''** and **57''** of the arms are shaped and arranged to cooperate, as pawls, with a star wheel **59** for operating a conventional counting device **60** mounted on the other end of the base. As is better seen in FIG. 6, the end portions of each of arms **56**, **57** are preferably bent so that they are in a common plane. A spring **61** compressed between the arm-portions **56''**, **57''** biases the arms into engagement with individual stops **62** and **63** on the top plate.

The arms **56** and **57** are of permanent-magnet material and are polarized as indicated in the drawing by the letters N and S. In operation of this counter the electromagnet **53**, **54** is energized by direct current only. When the direction of flow of this current is such that the top of core **53** has an S polarity the arm **56**, whose end **56'** adjacent the core has an N polarity, is attracted toward the side of the core so that the pawl end **56''** of the arm engages the star wheel **59** and drives it in counter clockwise direction to initiate a movement of addition in the counting device. When the electromagnet is then deenergized the arm **56** returns to its biased position and a spring-loaded carry-over member **64** effects completion of the counting cycle in a usual manner. In this (adding) operation of the counter the other arm **57**, whose end **57'** adjacent the core is of S polarity, remains stationary since the electromagnetic force is then in a direction to repel it.

To effect subtraction, the polarity of the direct current supplied to the electromagnet is reversed so that the core

end assumes an N polarity and arm **57** is attracted to effect clockwise rotation of the star wheel.

The arms **56**, **57** may be wholly of permanent-magnet material, or the portions **56''**, **57''** may be of other material and rigidly joined to the remainder of the arms. To avoid possible magnetic sticking, direct engagement of the arms with the core may be prevented by means of suitable stops (not shown) arranged in generally the same manner as stops **62**, **63**, or by means of a thin sleeve of nonmagnetic material around the upper part of the core.

In the modification of FIGS. 7 and 8 there are two individually energizable electromagnets mounted side by side on a base **65**. One of these electromagnets comprises a cylindrical core **66** and associated coil **67**, the other a similar core **68** and coil **69**. Mounted on a pivot pin **70**, depending from the undeside of the top plate **71** at a point equidistant from cores **66** and **68**, is a flat member **72** of magnetic material having crook portions **73** and **74** arranged to cooperate with a side of the respective cores.

At its right-hand end the member **72** is formed to provide a pair of fingers or pawls **75** and **76** cooperable with a star wheel **77** operatively connected to a counting device **78** mounted on the base. The member **72** is normally held in the position shown in the drawing, with its crook portions **73**, **74** equidistant from the respective cores, by the force of a relatively straight piece of spring wire **79** bearing against the straight edge of a rearward extension **80** of the member, the ends of wire **79** being bent and inserted in openings through the top plate **71**.

To effect addition, the electromagnet **66**, **67** is energized so that the crook portion **73** of member **72** is attracted toward core **66**, and by engagement of pawl **75** with the star wheel the same is turned in counterclockwise direction. A spring-loaded carry-over member **81** is provided to complete the movement of the star wheel when the electromagnet is deenergized. Rotation of the star wheel in the opposite direction, to effect subtraction, is accomplished in a similar manner by energization of the other electromagnet **68**, **69**. The crook portion **73** of member **72** is preferably enlarged at its extremity, as shown, to balance the member.

In the modification of FIGS. 9 and 10 there is an electromagnet comprising a cylindrical core **82** and associated coil **83** mounted on a base **84**, preferably of magnetic material, having a bent-up end portion **85** providing at its top a pivotal support **86** for a generally U-shaped permanent magnet **87** (polarized as indicated by the letters N and S) rockable in the general plane of the exposed upper portion of core **82** and with that portion between its side arms. The permanent magnet **87** has an extension **88** adapted to carry on its outer end (not shown) means, such as the pawls **75**, **76** shown in FIGS. 7–8, for actuating a counter assembly of the kind shown in those figures. This permanent magnet is normally maintained in the position shown, with its arms equidistant from the sides of core **82**, by the force of a straight spring **89** fixed at its outer end (not shown) and having its other end disposed between a pair of pins **90** secured to the extension **88**.

When the electromagnet **82**, **83** is energized by passage of direct current in a direction to produce an N pole at core **82**, the permanent magnet is rocked in clockwise direction due to attraction of its S arm toward the core and repulsion of its N arm. If the direction of the current is reversed, the permanent magnet will obviously rock in an opposite direction. This permanent magnet may be relatively weak since its polarization need be only sufficient to ensure that it moves in the right direction when the electromagnet is energized.

In the modification of FIGS. 11 and 12 there is a single substantially U-shaped electromagnet formed by a pair of cylindrical cores **91** and **92** and a base plate **93**, of magnetic material, having openings in which the lower ends of these cores are pressed. Around each of the cores is a coil, indicated at **94** and **95**, which it is to be assumed

are interconnected in series or in parallel for joint energization of the electromagnet. Pivotally supported on a post **96** secured to the base is an H-shaped permanent magnet **97**, polarized as indicated by the letters N and S, disposed with the upper ends of the cores between the respective opposite ends of the arms of the permanent magnet. Secured, as by welding, to the permanent magnet is an arm **98** to which pawl means for actuating a counter wheel may be connected. It is to be assumed that the permanent magnet **97** is biased to the position shown in the drawing by means such as those shown in the arrangement of FIGS. 7–8 or of FIGS. 9–10.

Upon passage of current through the coils **94, 95** in a direction to produce an N magnetic pole at core **91** and an S pole at core **92**, the permanent magnet rocks clockwise under the magnetic attraction of its left-hand S end and its right-hand N end, the magnetic repulsion of its other polar ends contributing to its movement. It is obvious that if the direction of the current in the electromagnet is reversed the permanent magnet will rock in the opposite direction.

This permanent magnet need be magnetized only sufficiently to ensure that its initial movement is in the right direction. The upper portion of the cores **91, 92** may be formed to provide flat surfaces **99** (FIG. 12) engageable by the arms of the permanent magnet, a thin nonmagnetic separator preferably being provided on these surfaces to prevent the possibility of magnetic sticking of the parts when the electromagnet is deenergized.

The embodiments of our invention herein shown and described are obviously susceptible of modification without departing from the spirit of the invention, and we intend therefore that no limitation be placed on the invention except as defined by the scope of the appended claims.

We claim as our invention:

1. In an electromagnetic counter: a base; an electromagnet adapted to be energized by direct current of selected polarity, mounted on one end of said base; said electromagnet comprising an elongated core projecting perpendicularly from a surface of the base, and an energizing coil around said core and arranged so that a part of the core adjacent one of its ends is exposed; a pair of elongated armature members each pivotally mounted on said base so that it can rock in a plane parallel to that of said base-surface and in the general plane of said exposed part of the core; each of said armature members having adjacent one of its ends a portion of permanent-magnet material disposed adjacent a side of said exposed part of the core, said armature-member portions being of opposite polarity and disposed at opposite sides of said core-part, the other ends of the armature members extending toward the other end of said base; and a counting device mounted on said other end of the base and having actuating means operable by said other ends of the armature members.

2. An electromagnetic counter according to claim 1 wherein said core is cylindrical, and each of said armature-member portions is shaped to conform generally to the curvature of said sides of the exposed part of the core.

3. An electromagnetic counter according to claim 1 wherein said armature members are pivoted at points intermediate their ends.

4. An electromagnetic counter according to claim 3 wherein said armature members are disposed in crossed relation to each other.

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