ABSTRACT: An improved new events counter for registering repetitive events represented by received electrical pulses. The counter includes an electromechanical transducer incorporating a solenoid and a spring biased armature responsive to energization of the solenoid. A display device is advanced to a new position with each oscillatory motion of the armature due to a motion-translating pallet assembly. In its preferred form, the spring balancing the armature is adjustable to enhance the efficiency of the overall electromechanical conversion.
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The present invention relates generally to counting devices and, more particularly, to an improved electromechanical events counter.

It is a primary object of the present invention to provide an improved electromechanical events counter which is capable of efficiently converting a small electrical input to a mechanical output sufficient to drive a series of mechanical counter wheels.

Another object is to provide such an improved events counter which requires only a small number of parts which can be economically manufactured and assembled.

A further object of the invention is to provide an improved events counter of the foregoing type which facilitates any fine adjustment to obtain the desired output torque.

Still another object of the invention is to provide an improved events counter of the type described above which is not subject to magnetic leakage.

Other objects and advantages of the invention will become apparent from the following description and upon reference to the accompanying drawings, in which:

FIG. 1 is a perspective view of an events counter embodying the present invention;

FIG. 2 is an exploded perspective view of the essential elements of the magnetomechanical transducer included in the counter of FIG. 1;

FIG. 3 is a side elevation of the counter of FIG. 1;

FIG. 4 is a top plan of the counter of FIG. 1;

FIG. 5 is a bottom plan of the counter of FIG. 1;

FIG. 6 is a fragmentary elevation of the magnetomechanical transducer included in the counter of FIG. 1 and showing both the advanced and retracted positions thereof; and

FIG. 7 is a fragmentary elevation similar to FIG. 6 except that the elements are shown in intermediate and retracted positions.

While the invention is described in connection with certain preferred embodiments, it will be understood that it is not thereby intended to limit the invention to those embodiments. On the contrary, it is intended to cover all alternatives, modifications and equivalents as may be included within the spirit and scope of the invention as defined by the appended claims.

Referring now to the drawings, the events counter shown in FIG. 1 includes a pair of parallel sideplates 10 and 11 interconnected by a plurality of spacer pins 12 so as to define a space between the two plates 10, 11 for receiving an input coil 13, a count display mechanism 14, and a magnetomechanical transducer 15 for converting the electrical input to a mechanical output for actuating the display mechanism. The electrical input applied to the input coil 13 is generally a low energy pulse produced in response to the occurrence of a given event, such as the starting of an engine. In general, the input pulse may be derived from any event capable of being translated into an electrical pulse, such as variations in pressure, temperature, shock, acceleration, humidity, starting and/or stopping of electrical or mechanical equipment, and the like.

The new events counter provided by this invention is especially useful where minimum size, weight, and power consumption are critical factors.

In order to avoid any magnetic leakage from the magnetomechanical transducer, the sideplates 10, 11 are made of a nonmagnetic material as brass. The electrical input coil 13, when wound upon a bobbin or other means of support, is then assembled with a magnetic core 16, suitably made of iron, which is staked to the sideplates 10, 11 as indicated by the reference numeral 17 in FIG. 1. Each time an electrical pulse is applied to the input coil 13, a magnetic pulse is induced in the iron core 16 as well as a pair of pole pieces 18 and 19, positioned as shown in FIG. 2, secured to opposite ends of the core 16 inside the sideplates 10, 11. The pole pieces 18, 19 project forwardly past the coil 13 for cooperation with the opposite ends of a magnetizable armature 20. It will be appreciated that the core 16 functions not only as a part of the magnetic circuit, but also serves as a structural support member interconnecting the two nonmagnetic sideplates 10, 11, thereby minimizing the number of parts required.

For the purpose of converting the magnetic pulses to a mechanical output for actuating the count display mechanism 14, the two pole pieces 18, 19 and the armature 20 are designed to tilt the armature through a given angular displacement in response to each electrical input pulse applied to the coil 13. Thus, in accordance with one aspect of the present invention, the top and bottom of the armature 20 are beveled so as to form a pair of inclined end faces 20a, 20b substantially parallel to each other. In other words, the side elevation of the armature is in the form of a parallelogram, as can be seen in FIGS. 2—3 and 6—7. For cooperation with the inclined end faces 20a, 20b, the two pole pieces 18, 19 are provided with bent tabs 18a, 19a on the forward ends thereof, each tab being bent inwardly along one of the end faces 20a, 20b in closely spaced relation therewith. More particularly, the tabs 18a, 19a are designed to fit substantially flush, but not necessarily in contact, against the armature end faces 20a, 20b, and substantially coextensive therewith, when the armature is in its advanced position (FIG. 6). When the armature is in its retracted or rest position, the tabs and end faces are not parallel to each other, but they still overlap to a considerable extent so as to provide the required magnetic coupling between.

When the two pole pieces 18, 19 are magnetized in response to the application of an input pulse to the coil 13, the opposed surfaces of the end tabs 18a, 19a attract the corresponding armature end faces 20a, 20b so as to drive the armature 20 through a given angular displacement. The beveled configuration of the cooperating end tabs and armature end faces provides a relatively high and constant torque output for any given electrical input pulse. By reason of this beveling, an increase in pole face area results, thereby reducing the reluctance of the air gap. The permeance of the working gap, therefore, increases less rapidly with motion, which has the effect of providing a higher starting torque and less rapid rise in torque. After the armature has completed the advancing stroke effected by the magnetic attraction of the pole pieces 18, 19, the armature is returned to its advanced position by the biasing action of a coiled return spring 21. This return spring 21 is mounted around the armature shaft 22, between the sideplate 11 and the adjacent side of the armature 20. One end of the return spring 21 is held in a preload condition against armature 20, while the other end is held in a fixed position, so that the spring biases the armature against the driving magnetic forces applied by the pole pieces 18, 19. When the pole pieces 18, 19 are magnetized due to a typical operating stroke of a typical magnetic coupling between the input coil 13, the driving force applied to the armature is sufficient to overcome the biasing force of the spring 21; but as soon as the coil 13 is deenergized, the spring 21 functions to return the armature to its retracted or rest position.

In accordance with one aspect of this invention, the armature 20 is made integral with a pallet 23 for the purpose of translating the oscillatory motion of the armature 20 into unidirectional rotational movement of the counter wheels 24, 25, 26, and 27. In the illustrative embodiment, the armature 20 and pallet 23 are made integral with each other by fixing both elements to a common shaft 22. Also, to resist the G forces of vibration, shock, and acceleration, the armature is substantially symmetrical about the shaft 22 so as to provide a balanced armature, and the pallet 23 is generally in mechanical engagement with the armature 20 since it is integral therewith. Also, the pallet cooperates with a plurality of laterally projecting pallet pins 28 mounted on the first counter wheel 24 to advance the counter wheel one position in response to each cycle of tilting movement of the armature 20.

Operation of the armature and pallet arrangement will be more clearly understood by reference to FIGS. 6 and 7, where FIG. 6 illustrates the advancing stroke cycle (advanced position of armature and pallet shown in solid lines), and FIG. 7 illustrates the return stroke (retracted position of armature and pallet shown in solid lines).
Referring first to FIG. 6, as the armature 20 is advanced by the magnetic attraction of the pole pieces 18, 19, the pallet 23 is rotated in the same angle as the armature. Consequently, the leading end 23a of the pallet engages and advances one of the pallet pins 28' so as to advance the counter wheel 24 halfway toward the next position. Also during the advancing movement of the pallet, the trailing end 23b of the pallet is withdrawn outside the circular path of the pins 28 and positioned adjacent a second pin 28". Consequently, during the retracting movement of the armature and pallet (refer now to FIG. 7), the inner edge 23c of the pallet adjacent the trailing end, cams the pallet pin 28" in the same direction of the first pin 28' advanced by the leading end of the pallet, thereby completing the advancing movement of the counter wheel to the next position. In other words, the leading end of the pallet advances the counter wheel halfway toward the next position during advancing movement, while the trailing end of the pallet cams the wheel through an equal angular distance so as to complete the indexing movement of the counter wheel to the next position. Thus, it can be seen that each input pulse applied to the coil 13 gives rise to one cycle of oscillatory movement of the armature 20 and pallet 23, which in turn indexes the counter wheel one position.

In order the combined count accumulated over a number of repetitive pulses applied to the coil 13, the count display mechanism 14 includes a plurality of counter wheels 24—27. In the particular embodiment illustrated, four counter wheels are employed to represent the units, tens, hundreds, and thousands, although it is to be understood that any number of counter wheels may be used without departing from the spirit and scope of the invention. Conventional gearing is provided between the various counter wheels so that the second wheel 25 is indexed one position for each 10 positions of the first wheel 24, the third wheel 26 is indexed one position for 10 indexing movements of the second wheel 25, and the fourth wheel 27 is indexed one position for each 10 indexing movements of the third wheel 26. Since this gearing per se is already well known to those skilled in the art, it will not be described in detail herein.

In accordance with a further aspect of this invention, an eccentric pin 30 is mounted through one of the sideplates and held by the return spring 21 for the purpose of adjusting the effective torque applied by the spring to the armature and pallet assembly. By simply turning this pin 30, which is readily accessible during assembly of the device, the spring torque can be readily adjusted to provide exactly the right amount of return movement (see FIGS. 6 and 7) to index the counter wheel one position for each cycle of oscillatory movement of the armature and pallet. This fine adjustment feature permits efficient and accurate adjustment of the counter in large production runs.

As can be seen from the foregoing detailed description, the present invention provides an improved events counter which is capable of efficiently converting a small electrical input to a mechanical output sufficient to drive a series of mechanical counter wheels. The inventive counter requires only a small number of parts, all of which can be economically manufactured and assembled. Moreover, the counter has a minimum magnetic leakage and, in the preferred form, includes a uniquely simple adjustment feature which permits efficient and accurate fine adjustment during manufacture.

We claim:

1. A counting device for counting repetitive events represented by electrical pulses, said counting device comprising the combination of an electrical coil for receiving the electrical pulses representing the repetitive events, a pair of magnetic pole pieces operatively associated with said coil for magnetization of the pole pieces in response to each of said pulses, a count display mechanism including a plurality of pallet pins, a magnetizable armature mounted for oscillatory movement in response to magnetization of said pole pieces, a pallet integrally mounted to said armature for oscillatory movement and operatively associated with said pallet pins for advancing said count display mechanism one position for each of said electrical pulses, and a pair of nonmagnetizable sideplates secured to opposite ends of said coil, said magnetic pole pieces having portions extending respectively from the opposite ends of said coil along the respective inner surfaces of said sideplates to a point adjacent said armature, at which point said portions include tabs bent inwardly along said armature for cooperation with the respective end faces of said armature.

2. A counting device as defined in claim 1 in which said armature is mounted for pivotal oscillatory movement and is substantially symmetrical about its pivot point to provide a balanced structure and said pallet also being generally balanced.

3. A counting device as defined in claim 1 in which said electrical coil has a magnetic core which provides support for said nonmagnetizable sideplates.

4. A counting device as defined in claim 1 which includes spring means for returning said armature to a retracted position and means for adjusting the effective torque applied by said spring means.

5. A counting device for counting repetitive events represented by electrical pulses, said counting device comprising the combination of an electrical coil for receiving the electrical pulses representing the repetitive events, a count display mechanism for displaying the number of events counted, a magnetoelectromechanical transducer operatively associated with said electrical coil and said count display mechanism for converting the electrical pulses applied to said coil to a mechanical output for driving said count display mechanism, said magnetoelectromechanical transducer including a balanced armature mounted for pivotal movement and having a pair of end faces at opposite ends thereof, a pallet integral with said armature for pivotal movement therewith, means for converting the pivotal movement of said pallet to unidirectional movement of said count display mechanism, and a pair of integral pole pieces operatively associated with said coil at one end and having bent tabs cooperating with said end faces on said armature at the other end for pivotally advancing said armature and said pallet in response to the electrical pulses applied to said coil, said pole pieces and said end faces being designed to be substantially flush with each other when said armature is in its advanced position.

6. A counting device as defined in claim 5 in which said pole pieces are adapted to magnetically attract the end faces of said armature in response to each electrical pulse to pivotally advance said armature, and which includes spring means for returning said armature to its retracted position.

7. A counting device as defined in claim 6 which includes means for adjusting the effective torque applied by said spring means.

8. A counting device for counting repetitive events represented by electrical pulses, said counting device comprising the combination of an electrical coil for receiving the electrical pulses representing the repetitive events, a count display mechanism for displaying the number of events counted, a magnetoelectromechanical transducer operatively associated with said electrical coil and said count display mechanism for converting the electrical pulses applied to said coil to a mechanical output for driving said count display mechanism, said magnetoelectromechanical transducer including a balanced armature mounted for pivotal movement and having a pair of end faces at opposite ends thereof, spring means for returning said armature to its retracted position, means for adjusting the effective torque applied by said spring means including an eccentric pin connected to said spring means whereby the torque can be adjusted to provide exactly the right amount of torque to return said armature to its retracted position, a pallet integral with said armature for pivotal movement therewith, means for converting the pivotal movement of said pallet to unidirectional movement of said count display mechanism, and a pair of integral pole pieces operatively associated with said coil at one end and having bent tabs cooperating with said
end faces on said armature at the other end for pivoting said armature and said pallet in response to the electric pulses applied to said coil.

9. A counting device as defined in claim 8 in which said pole pieces and said beveled end faces are designed to be substantially flush with each other when said armature is in its advanced position.