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STANDARD SHEET		
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The invention relates to a rotor movement sensing system for use in a postage meter having a rotor for printing postage by cyclic rotation thereof.

In any electronic postage meter it is important that the electronic registers faithfully reflect the actual mechanical printing of postage by the print rotor. In nearly all instances of the printing of postage, electric power is available for the entirety of the print cycle and the processor, which controls and monitors printing of postage, is able to decrement and increment the descending and ascending registers accordingly.

Most of the time, when the rotor is not in motion (because it is not printing postage) the rotor is in or very near to a "home" position. It is standard to have a sensor that indicates to the processor that the rotor is in the home position. A typical sensor arrangement is to place a permanent magnet on a disk attached to the rotor shaft. A Hall-effect sensor is positioned so that the sensor is "on" when the rotor is in its home position. If a print cycle is in progress, the processor can confirm the completion of the

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cycle by sensing the return of the rotor to the home position.

It is also standard to have a ratchet or other mechanical arrangement coupled to the rotor shaft so that the rotor cannot be moved very far backwards. However, a number of design constraints limit how tightly the ratchet performs its task. For example, at the end of a print cycle, it is not uncommon that the rotor may reach the home position (as expected) but may also go slightly past the home position due to rotational inertia or due to drag from a large item being franked. If the meter is to be satisfactory to the user, the ratchet must permit the slight reverse rotation back to the home position.

The design of the meter must necessarily take into account, however, the prospect that power may fail unexpectedly. The processor may thus be in the situation of not having quite enough information to distinguish whether or not a print cycle has occurred. For example, one of the indications to the processor that a print cycle has begun is the home sensor turning off. This indicates that the rotor has moved from the home position. But if power is lost after the home sensor has turned off, then later when the processor again has power the processor may find that the home sensor is again on. This could have happened, however, due to either of two mechanical sequences.

On the one hand, the rotor may indeed have printed a print cycle, finished while processor power was absent. This would result in the home sensor again being on.

On the other hand, the rotor might merely have moved slightly past the home position, and then dropped backwards again to the home position, all while processor power was absent. This, too, would result in the home



sensor again being on. This slight forward-and-back movement could, as described above, arise due to a slight overrun of a previous print cycle.

The difficulty, however, is that without more
5 information the processor is not capable of distinguishing which mechanical sequence actually occurred. There is the difficulty, then that the meter designer would not know whether or not to program the processor to increment and decrement the ascending and descending registers in the face
10 of such sensor inputs. This presents the possible problem that the amount of postage actually printed may fail to correspond perfectly with the information in the descending and ascending registers.

One prior-art approach to this problem is that
15 found in U.S. Pat. No. 4,253,015 to McFiggans et al. ("the '015 patent"). As described in Figs. 1 and 3 of that patent, there is provided a counter gear 61 that is twice as large as a gear 60 on the rotor shaft; the counter gear 61 has an angular velocity at all times half that of the rotor
20 (also called a "drum" in this patent). Depending on whether the rotor has finished an even-numbered or odd-numbered printing cycle, the counter gear 61 will be in one of two orientations. Two holes 62 and 63, located at different radii on the counter gear 61, will trigger one of two
25 sensors 67 or 66 respectively, permitting the processor 120 to know whether the print cycle just finished was an odd-numbered one or an even-numbered one.

This approach has a number of drawbacks, chief among them that it requires a large counter gear which takes
30 up space in the meter, which adds to the count of moving parts, and which adds to the inertial moment that must accelerate and decelerate with each print cycle. The



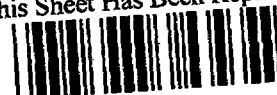
approach degrades the mechanical reliability of the meter, adds to the parts and assembly cost, and adds to wear due to use.

It would thus be desirable to have a way of
5 providing sensor information to the processor to resolve ambiguities regarding rotor movement during times when the processor has been unpowered, all without unduly degrading reliability and increasing parts and assembly cost.

The invention is defined in claim 1 and preferred
10 features are recited in the claims dependent thereon.

In summary, the new rotor sensing concept employs changes to hardware and software of the meter.

In hardware, an additional sensor is provided to sense the magnet on the disk when the rotor is substantially
15 past the home position. This additional sensor is positioned far enough past the home position that the above-mentioned ratchet will have ensured that the rotor must continue forward to completion of a print cycle. It would not, however, be workable simply to use a second
20 Hall-effect sensor at this location, with the second sensor (like the home sensor) continuously monitored by the processor. The reason is that the time interval required for mechanical movement of the rotor to the second sensor would be long enough that power failure might render the
25 processor incapable of detecting the output of the second sensor. To make the second sensor useful for its intended purpose, the second sensor is selected to be a so-called magnetic memory element ("MME") sensor. The MME sensor has a magnetic memory element with substantial magnetic
30 hysteresis. When the disk magnet passes near the memory element, the memory element is magnetized. The magnetization of the memory element persists long after the



permanent magnet of the disk has passed. A Hall-effect sensor is positioned at the memory element so that it provides a signal to the processor indicative of the magnetization of the memory element. Preferably the signal
5 is provided to the processor both as a discrete (polled) input and also as an interrupt. A solenoidal winding is provided around the memory element. The processor has an output which, when asserted, causes a substantial current to flow through the winding, whereby the memory element is
10 demagnetized.

In another embodiment of the invention, a reed switch is employed to sense movement of the rotor past a particular angular position. A flip-flop provides a bistable means backed up by a lithium cell or other reliable
15 source of power, and the output of the flip-flop provides a datum for the processor.

Several changes are made in software to effect the new rotor sensing concept. An interrupt routine is provided responsive to the signal from the second sensor, so
20 that during a routine franking cycle the processor responds to the interrupt, makes record in nonvolatile memory of the occurrence of the printing cycle, and energizes the winding. This interrupt routine is executed for each franking cycle when power is continuously available, which is the normal
25 and expected situation.

Of course, the remaining situation to be provided for in software is the application of power to the processor under circumstances where there is reason to suspect that a print cycle took place during a power outage. The power-up
30 routine of the software, then, has a step of noting whether the second sensor is on. If it is, then the processor assumes (and this assumption is one in which the designer



has high confidence) that a printing cycle did take place. The processor then clears the memory element by energizing the winding, and makes record of the printing cycle in nonvolatile memory.

5

The invention can be put into practice in various ways an embodiment of which will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 shows the rotor shaft, disk, and the home
10 and MME sensors;

Fig. 2 shows the home sensor;

Fig. 3 shows the MME sensor;

Fig. 4 is a timing diagram for signals to and from
the sensors;

15 Fig. 5 shows a symbolic equivalent for the MME
sensor;

Figs. 6-9 are flowcharts showing various software
provisions relating to the MME sensor;

Fig. 10 shows an overall processor system
20 configuration;

Fig. 11 shows a reed-switch embodiment of the
invention in side view;

Fig. 12 is a schematic diagram of the reed-switch
embodiment; and

25 Fig. 13 is a timing diagram for the reed-switch
embodiment.

An overview of the postage meter in accordance
30 with the invention is shown in Fig. 10. Processor 70
controls nearly all functions of the meter, responding to
user inputs at keyboard 72 and providing information to the



user at display 71. The processor 70 is operatively coupled to the keyboard and display by digital bus 79, which also provides operative coupling to memory 73, I/O ports 74, and other devices omitted for clarity from Fig. 10. Postage is
5 printed by a rotation of print drum or rotor 77, which contains print wheels settable under processor control by setting means, not shown in Fig. 10 for clarity. Mechanical locking, also omitted for clarity from Fig. 10, is provided so that when the rotor 77 moves away from the home position
10 the print wheels are locked into place. As a result, if a print cycle is found to have occurred during a time of loss of power, due to the locking there is little doubt about the position of the print wheels, and thus little doubt about the amount of postage that was printed. Ratchet means, also
15 omitted for clarity from Fig. 10, limits the extent to which rotor 77 may be moved in a direction other than that shown. The rotor turns on shaft 14, which is held by journal and thrust bearings, not shown.

In Fig. 10, disk 13 may be seen, preferably
20 positioned at the other end of shaft 14. Sensors 11 and 17 are disposed near the disk 13. Sensor 11, the "home" sensor about which more will be said below, gives a discrete input via line 75 to one of the input lines at the I/O ports 74. Sensor 17, the MME sensor about which more will be said
25 below, gives a discrete input via line 76 to one of the input lines at the I/O ports 74, and also preferably provides an interrupt to the processor 70.

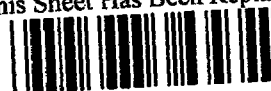
Turning now to Fig. 1, the disk 13 is seen in plan from a point of view at the rotor 77 (not shown in Fig. 1).
30 It will be appreciated that due to the change in point of view, the normal direction of rotation for disk 13 as shown in Fig. 1 is counterclockwise. Shaft 14 is shown in cross



section. Hall-effect sensor 11 defines a "home" position on disk 13, and permanent magnet 10 is located on disk 13 proximate to sensor 11. A second sensor 17, the MME sensor, is positioned as shown.

5 Fig. 2 shows sensor 11 in a section taken through disk 13. Sensor 11, which as mentioned above is preferably a Hall-effect sensor, is preferably mounted to a printed circuit board 15 and, when the rotor is in the home position, permanent magnet 10 is quite nearby. Fig. 3 shows
10 sensor 17 in a section parallel to but displaced from the section of Fig. 2. Sensor 17 is likewise preferably mounted to the same printed circuit board 15. In this figure disk 13 is shown having rotated so that magnet 10 is nearby to sensor 17; it will be appreciated that Figs. 2 and 3 show
15 things that do not happen simultaneously since magnet 10 cannot simultaneously be adjacent to both sensors 11 and 17.

 The second sensor 17 differs from home sensor 11 not only in its location but also in provision of the magnetic memory element (MME) 16, which has substantial
20 magnetic hysteresis. When the disk magnet 10 passes near the memory element 16, the memory element 16 is magnetized. The magnetization of the memory element 16 persists long after the permanent magnet 10 of the disk 13 has passed. The Hall-effect sensor 17 is positioned at the memory
25 element 16 so that it provides a signal to the processor 70 (not shown in Fig. 3) indicative of the magnetization of the memory element 16. In Fig. 3 may also be seen a solenoidal winding 18 around the memory element 16. The processor 70 has an output 80 (shown in Fig. 10) which, when asserted,
30 causes a substantial current to flow through the winding 18, whereby the memory element 16 is demagnetized.



It will be appreciated by those skilled in the art that design considerations may prompt any of a number of locations for the sensors 11, 17 and magnet 10. Cost is reduced if a circuit board 15 is already nearby, so that the sensors 11, 17 may be mounted directly to that circuit board 15, providing both mechanical mounting and electrical connections. This also prompts placing the sensors 11, 17 in a plane parallel to a main plane of the chassis of the meter, so that both may be placed on a single circuit board 15 rather than on two separate circuit boards. The elevation of the single circuit board 15 and the diameter of the disk 13 are chosen so as to make angle 91, shown in Fig. 1, as large as desired. Angle 91 is selected to satisfy a number of constraints including that the angle be great enough that the ratchet does not permit a backwards movement of the rotor 77 back to the home position.

Turning now to Fig. 4, there is shown a timing diagram for various of the signals of the rotor sensing concept. The top line shows the output of sensor 11, which is high when the rotor begins in a home position, and is again high when the rotor has returned to a home position at 22. The duration of one complete print cycle is thus seen to correspond to interval 20. Those skilled in the art will appreciate that the high output of sensor 11 may persist for a long time if a long time passes between franking cycles, as will sometimes happen during the course of a day. Those skilled in the art will also appreciate that the rise and fall of the signal from sensor 11 do not coincide precisely with the rotor's being in the home position. Rather, to allow for some variation in the magnet, the Hall-effect sensor, and their geometric relationship, the system is set up so that the rise of the signal precedes the arrival of



the rotor at the home position, and so that the fall of the signal follows the departure of the rotor from the home position.

The next line shows the output of the sensor 17.

5 At 21, the output rises, which means the rotor has moved by approximately the angle 91 so as to bring magnet 10 nearby to sensor 17. In the normal course of events (that is, in the absence of loss of power) the processor 70 will receive an interrupt at time 21. Then, at time 23, processor 70
10 generates the current pulse to winding 18 (see Fig. 3) via line 80 (see Fig. 10). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be
15 an interval determined by the downgoing transition 25 as detected by the processor.

Fig. 5 shows in functional block form an equivalent circuit for the sensor shown in Fig. 3. The sensor is not, of course, a counter because it does not
20 distinguish between successive print cycles. If it were to indicate a high level, the high level would only indicate that at least one print cycle had occurred but would not provide any count of print cycles. The sensor may be thought of as a D-type flip-flop which is set at 10', reset
25 by 18', and providing an output at 17'. The block 16' is comparable to the memory element 16 with its hysteresis which gives rise to bistability.

Those skilled in the art will readily appreciate that numerous variations could be devised to embody the
30 invention without deviating from it. For example, instead of a using a magnet and a magnetic memory element, one could use a mechanical latch that is triggered by rotor movement

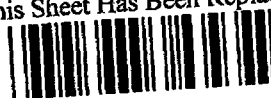


through angle 91. The latch would be coupled to a switch. Triggering of the mechanical latch would give rise to a switch signal like that of sensor 17. The mechanical latch would be made so as to be resettable, as by energizing a solenoid to move the mechanical latch back to its reset position. Generally, one skilled in the art could employ any bistable device that is set by movement of the rotor past a predetermined angle, and that is capable of being reset by an electrical signal.

10 It will also be appreciated that while the sensor is depicted herein as coupled directly with the rotor, it would be possible to couple the sensor in any of a range of indirect means, including coupling to any indicator of rotor movement. Other means that are thought inferior to the disclosed embodiment but nonetheless within the scope of the invention would include: coupling the sensor to rollers elsewhere in the envelope feed path; coupling the sensor to movement sensing means elsewhere in the feed path; and coupling the sensor to mechanical elements that are in turn
15 coupled to the rotor.
20

The software of the rotor sensing system, stored in memory 73 shown in Fig. 10, will now be discussed.

Fig. 6 shows in block diagram form the main routine that is being executed most of the time when the meter is powered. As will be appreciated, the main routine repeats itself over and over again. Loss of repetition of the main routine is preferably detected and remedied by a watchdog circuit, not shown. Dashed line 51 portrays the shift in program flow that occurs if an interrupt is
25 received at the processor 70 via line 76 from sensor 17. At 52 a nonvolatile record is made of the occurrence of the franking cycle. At 53 the processor energizes the winding
30



18, after which execution returns to the main routine 50 where it was interrupted.

Those skilled in the art will appreciate the normal and standard steps taken in the interrupt service routine of blocks 52 and 53. The first instruction of the routine is preferably disabling interrupts, followed by a masking of selected interrupts including the sensor-17 interrupt, followed by a re-enabling of interrupts. After the winding 18 has been energized, the sensor-17 signal is tested, and barring the unexpected persistence of the sensor-17 signal, the sensor-17 interrupt is again unmasked and/or re-enabled.

Those skilled in the art will also appreciate that nothing in the rotor sensing system requires that resetting of the MME 16 by energizing winding 18 take place prior to the end of the print cycle. While the resetting is so portrayed in Fig. 4 and in Fig. 6, the system could just as well permit these tasks to wait until after the rotor has again returned to its home position without deviating in any way from the system concept.

In contrast to the normal, fully-powered circumstance of Fig. 6, routines will now be described to provide for the possibility that at the time of power-up, a print cycle may have taken place. At Fig. 7, the meter's software with respect to powerup is shown in one embodiment. At 55, interrupts are disabled. At 54, the meter is initialized, preferably including a test of the print wheels of rotor 77 to determine what positions they were in. The print wheel positions are noted for later reference, and are compared with what the processor had noted the print wheel positions to be prior to the last previous loss of power. At 57, the processor 70 polls the condition of the MME



sensor 17 via line 76 (Fig. 10) and I/O port 74. At 58, a branch is made in the normal case, namely if no unaccounted-for print cycle has been detected, namely a jump to block 56. If, however, an unaccounted-for print cycle has been detected (as indicated by MME sensor 17), then blocks 52 and 53 are executed analogously to like-numbered blocks of Fig. 6. (Those skilled in the art will also appreciate that it may be helpful for troubleshooting or maintenance to make a nonvolatile record of the occurrence of power-up together with the sensor 17 having been set.) Block 56 re-enables interrupts, and control passes to the main routine of Fig. 6.

Fig. 8 shows the software configuration if a different approach is taken than that of Fig. 7. In Fig. 8, no attempt is made to disable interrupts. Instead, the signal from sensor 17, which is present from the moment of power-up, causes an interrupt to occur quite early on in processor execution of the initialization routine 54. The interrupt branches via 51 and the interrupt servicing routine of blocks 52 and 53 takes place much as in Fig. 6. Eventually control returns to the initialization routine 54 and eventually passes to the main routine of Fig. 6.

Fig. 9 shows yet another software configuration if a different approach is taken than that of Figs. 7 and 8. In box 55 interrupts are disabled, and in box 54 the meter is initialized. In box 56 interrupts are re-enabled and control may pass to the main routine of Fig. 6. But if the signal from sensor 17, which may happen to be present from the moment of power-up, is present, then this causes an interrupt to occur right away after block 56, essentially at the start of the main routine of Fig. 6. There, the interrupt branches via 51 and the interrupt servicing



routine of blocks 52 and 53 takes place. Eventually control returns to the main routine of Fig. 6.

In an alternative embodiment of the invention, a reed switch is employed to sense movement of the rotor past a particular angular position. A flip-flop provides a bistable means backed up by a lithium cell, and the output of the flip-flop provides a datum for the processor. Fig. 11 shows the switch arrangement relative to the rotor 13, with magnet 10, Hall-effect switch 11, and reed switch 17, all mounted to a printed circuit board, omitted for clarity in Fig. 11. The elements of Fig. 11 correspond to those of Fig. 1 for the embodiment previously discussed.

Fig. 12 is a schematic diagram for the alternative embodiment. During normal operation the circuit is powered by the same +5V source 110 that powers the rest of the meter. Lithium cell 112, preferably a 3.4 V cell, can also power the circuit reliably; isolation is provided by diodes 111, 114 and the power is smoothed by electrolytic capacitor 115. Optionally lithium cell 112 may also provide data backup for RAM, not shown in Fig. 12, via line 113.

Capacitor 121, preferably a highly stable capacitor, is charged through resistor 117. If magnet 10 nears reed switch 17, capacitor 121 is discharged through resistor 120. This defines high and low outputs on line 124, which serves as a setting input to an RS flip-flop composed of nand gates 118, 119. Nand gates 118, 119 are powered by line 116. As a consequence, the state of the flip-flop is preserved despite any changes in the level of the +5V power supply at 110. The flip-flop, which is of course a bistable device, receives a reset input via line 80 from an output of the I/O port 74, part of which seen at the lower left of Fig. 12. The output of the flip-flop is



provided via line 76 to an input of the I/O port 74, another part of which is seen at the lower right of Fig. 12.

Hall-effect sensor 11 also provides an input via line 75 to an input of the I/O port 74.

5 It will be appreciated that in Fig. 12, the interrupt to the processor is not from the sensor 17 but rather from the sensor 11. This differs from the embodiment disclosed above, in which the interrupt comes from the sensor 17. Those skilled in the art will appreciate that
10 either embodiment could, in principle, use either sensor to provide an interrupt to the processor without deviating in any way from the invention.

Fig. 13 shows a timing diagram for signals occurring during rotor rotation in the alternative
15 embodiment. The diagram corresponds in many ways to the timing diagram of Fig. 4 for the first embodiment. The top line shows the output of sensor 11, which is high when the rotor begins in a home position, and is again high when the rotor has returned to a home position at 22. The duration
20 of one complete print cycle is thus seen to correspond to interval 20.

The next line shows the output of the sensor 17. At 21, the output falls, which means the rotor has moved so as to bring magnet 10 nearby to reed switch 17. Then, at
25 time 23, processor 70 generates the reset signal via line 80 (see Fig. 12). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be an interval determined by
30 the downgoing transition 25 as detected by the processor.



If the system has the interrupt coming from the sensor 11 instead of the sensor 17, this changes in particular detail some of the software-driven activities of Figs. 6-9. In Fig. 6, the arrival of the interrupt at 51 prompts making a nonvolatile record that it was suspected a franking had occurred (to provide for the case where power fails while the rotor continues to move). If, while the software is in block 52, the second switch 17 is triggered, then the reset pulse of line 80 is generated in block 53, and the nonvolatile record is updated to show the normal and tidy progress of the franking activity.

If the software arrangement of Fig. 7 is considered, it will be seen that the polling of the flip-flop contents (block 57) suffices to determine that the sensor 17 must have been triggered at some time prior to the present instance of power having been applied. Thus it is assumed that franking took place, and the reset pulse of line 80 is generated in block 53.

In the case now being discussed where the output of the bistable device does not generate an interrupt, then the software arrangement of Figs. 8 and 9 is inapplicable.

Those skilled in the art will appreciate that while the circuit is shown using a reed switch and a Hall-effect switch, other sensing technologies could be used without departing from the invention. Likewise, numerous other bistable storage technologies could be employed other than the particular nand-gate flip-flop shown in Fig. 12.

Those skilled in the art will readily appreciate that while the steps described above are described as occurring in software that is executed by a processor, the steps could just as well be accomplished by random logic circuitry dedicated for that purpose.



CLAIMS

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1 1. A rotor movement sensing system for use in a
2 postage meter having a rotor for printing postage by cyclic
3 rotation thereof, and having a register relating to postage
4 printed by the rotor, the rotor position between postage
5 printing cycles defining a home position, the sensing system
6 comprising:

7 bistable means having an output, a setting
8 input and a resetting input, the setting input operatively
9 coupled to the rotor so as to set the bistable means upon
10 rotation of the rotor by a first predetermined angle past
11 the home position, and
12 means responsive to the output for changing
13 the register contents and for actuating the resetting input.

1 2. The rotor movement sensing system of claim 1
2 wherein:

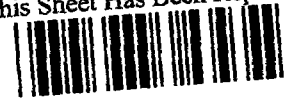
3 the bistable means comprise a magnetic
4 memory element, a Hall-effect sensor and a solenoid
5 adjacent the magnetic memory element,

6 the setting input comprises a permanent
7 magnet operatively coupled with the rotor,

8 the output comprises the output of the
9 Hall-effect sensor, and

10 the resetting input comprises leads of the
11 solenoid.





1 3. The rotor movement sensing system of claim 1
2 wherein:
3 the bistable means comprise a flip-flop with
4 a reliable source of power,
5 the setting input comprises a permanent
6 magnet operatively coupled with the rotor,
7 the output comprises the output of the
8 flip-flop, and
9 the resetting input comprises a signal to a
10 reset input of the flip-flop.

1 4. The rotor movement sensing system of claim 1,
2 2 or 3 wherein:
3 the means responsive to the output comprises
4 a microprocessor executing a stored program.

1 5. The rotor movement sensing system of claim 1,2,3 or 4
2 further comprising ratchet means operatively coupled with
3 the rotor whereby the rotor cannot move oppositely to the
4 direction for printing postage by more than a second
5 predetermined angle, and wherein the first predetermined
6 angle is selected to be greater than the second
7 predetermined angle.

1 6. The rotor movement sensing system of claim 4 or 5
2 wherein the output further comprises an interrupt to the
3 processor, and wherein the stored program further comprises
4 an interrupt routine.





7. A rotor movement sensing system of any of claims 1 to 6, further including means responsive to application of power to the meter for making record of the occurrence of the output being present upon the application of power.

8. A method for use in a postage meter having a rotor for printing postage by cyclic rotation thereof, and having a register relating to postage printed by the rotor, the rotor position between postage printing cycles defining a home position, the sensing system comprising bistable means having an output, a setting input and a resetting input, the setting input operatively coupled to the rotor so as to set the bistable means upon rotation of the rotor by a first predetermined angle past the home position, the method comprising the step of changing the register contents and actuating the resetting input.

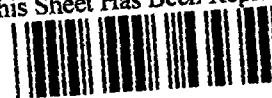
9. The method of claim 8 including applying power to the meter and determining the state of the output and if the output is present changing the register contents and actuating the resetting input.

10. The method of claim 8 or 9 wherein the bistable means comprises a magnetic memory element, and a Hall-effect sensor and a solenoid adjacent the magnetic memory element, the setting input comprises a permanent magnet operatively coupled with the rotor, and the output comprises the output of the Hall-effect sensor, the step of actuating the resetting input further comprising the step of applying current to the solenoid.



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1 11. The method of claim 8 or 9 wherein the bistable
2 means comprises a flip-flop with a reliable source of power,
3 the setting input comprises a permanent magnet operatively
4 coupled with the rotor, and the output comprises the output
5 of the flip-flop, the step of actuating the resetting input
6 further comprising the step of applying voltage to a reset
7 input of the flip-flop.

1 12. The method of any of claims 8 to 11 wherein the
2 determining step further comprises the step, if the output
3 is present, of making record of the occurrence of the output
4 being present upon the application of power.

1 13. The method of any of claims 8 to 12 wherein the meter
2 further comprises a processor, and the output further
3 comprises an interrupt to the processor, and wherein the
4 method further comprises responding to the interrupt.



ABSTRACTROTOR MOVEMENT SENSING SYSTEM

5 A rotor movement sensing system is provided for use
in a postage meter to permit detection of the printing of
postage even in the event that power is lost during the
printing cycle. A sensor is provided to sense the magnet
10 on a disk when the rotor is substantially past its home
position. When the disk magnet passes near a memory
element, the memory element is magnetized. A Hall-effect
sensor is positioned at the memory element so that it
provides a signal to the processor indicative of the
magnetization of the memory element. A solenoidal
15 winding is provided around the memory element. The
processor has an output which causes a current to flow
through the winding, whereby the memory element is
demagnetized. A flip-flop provides a bistable latch
backed up by a lithium cell, and the output of the flip-
20 flop provides a datum for the processor.

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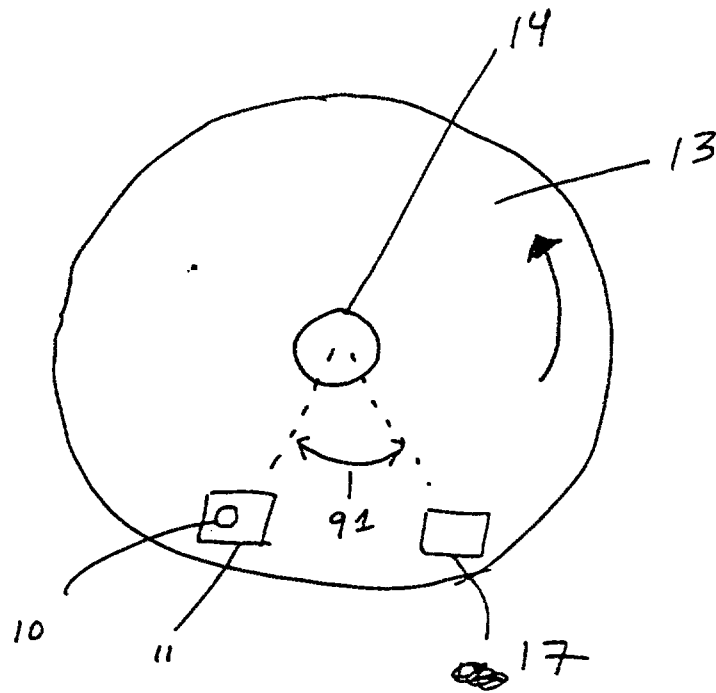


Fig. 1

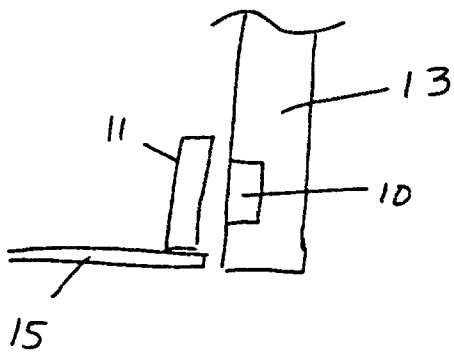


Fig. 2

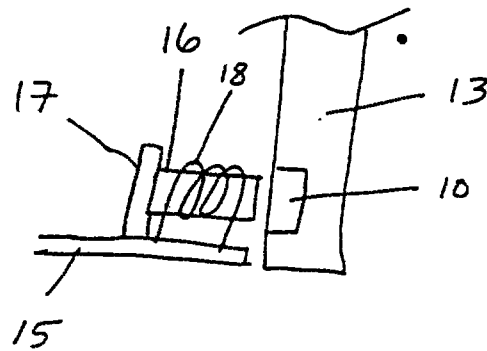


Fig. 3

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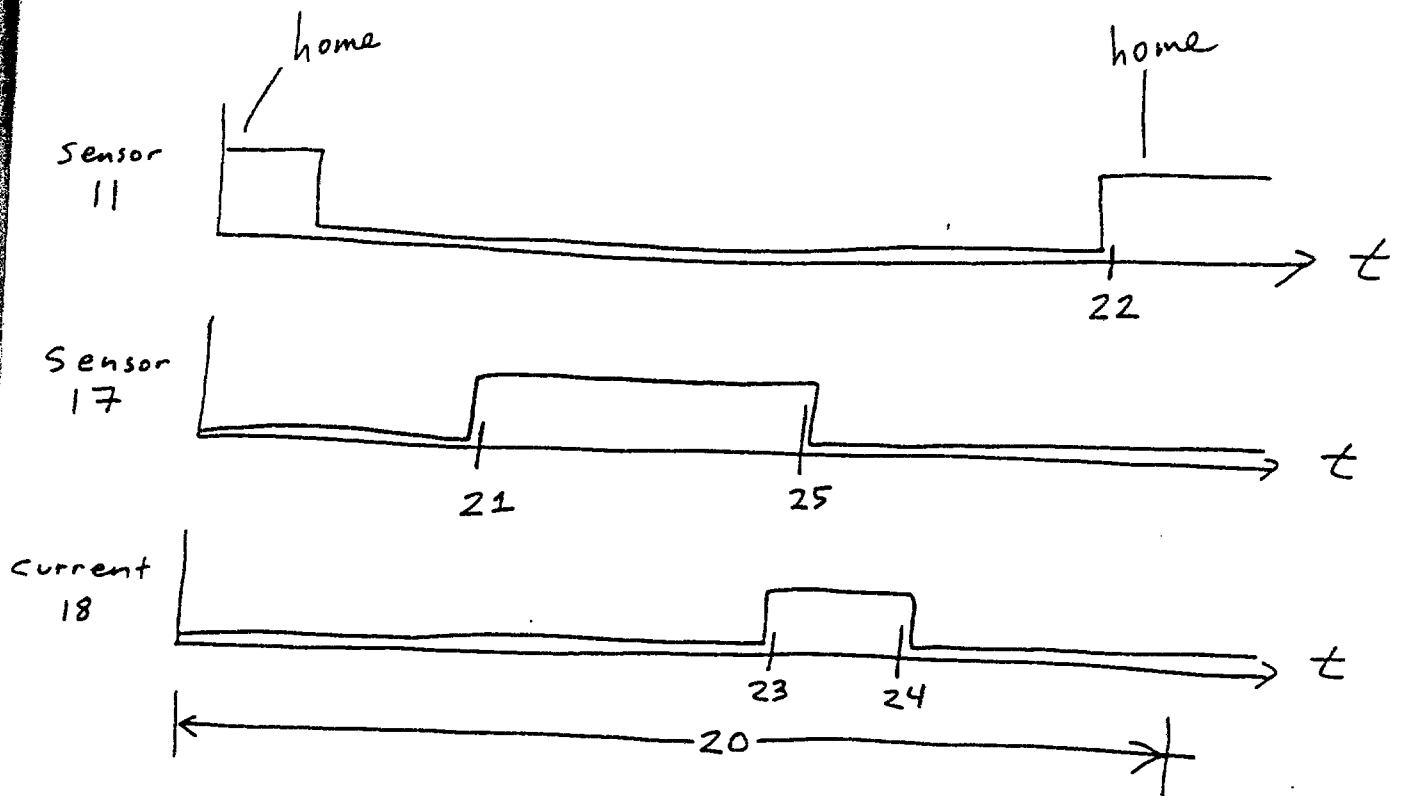


Fig. 4

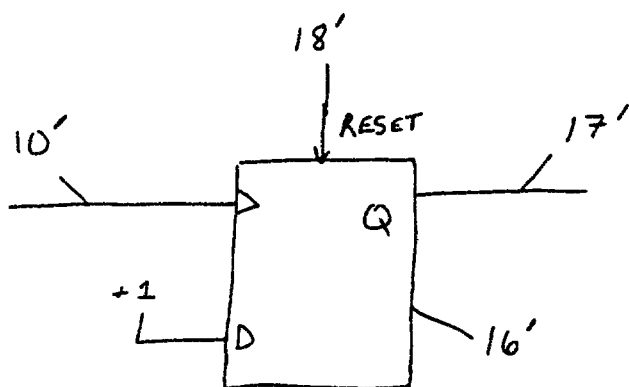


Fig. 5



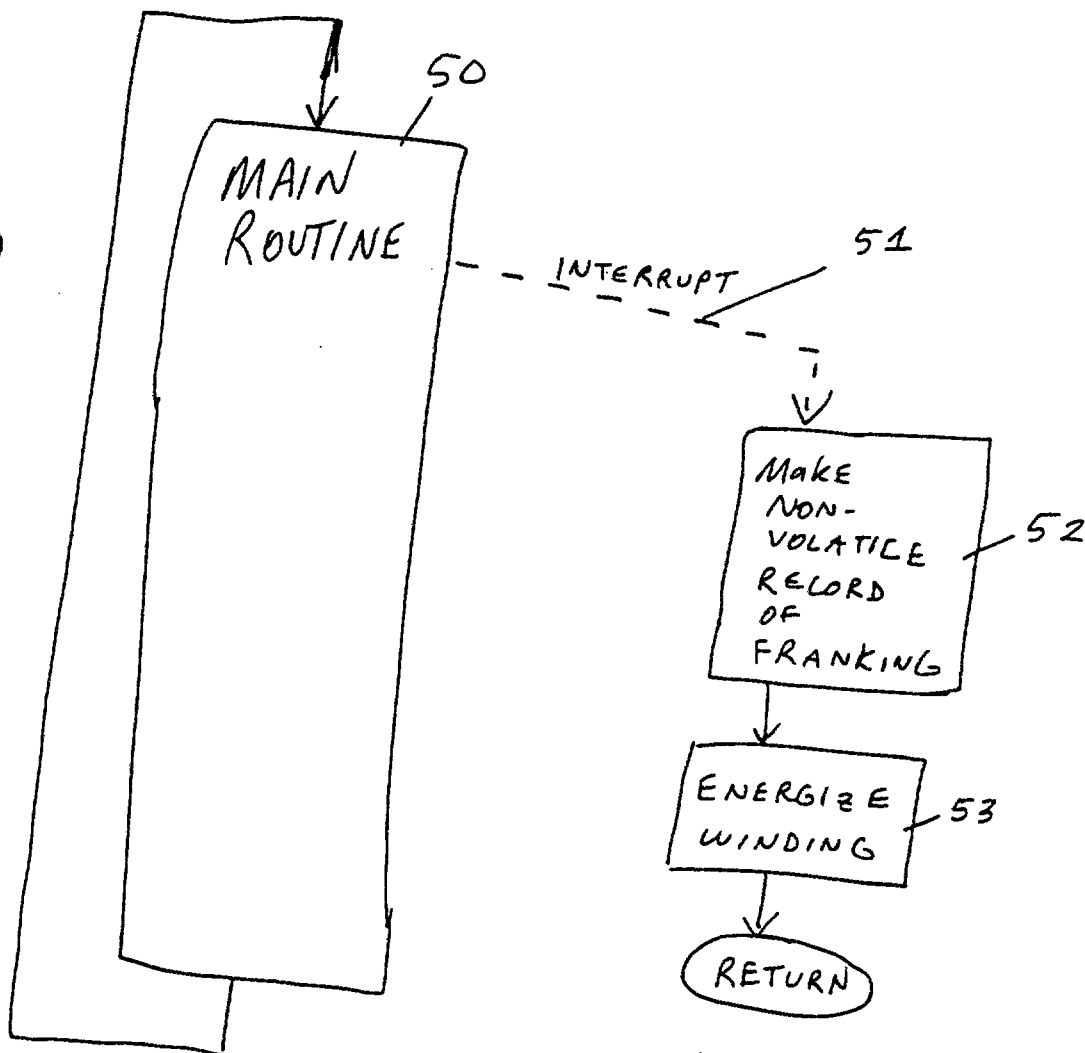


Fig. 6



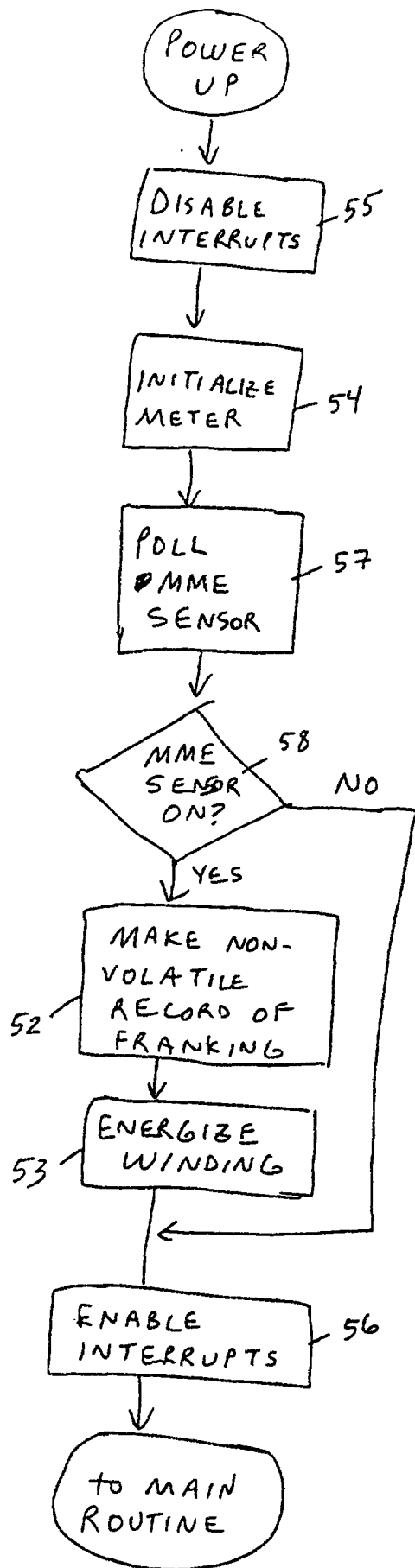


Fig. 7

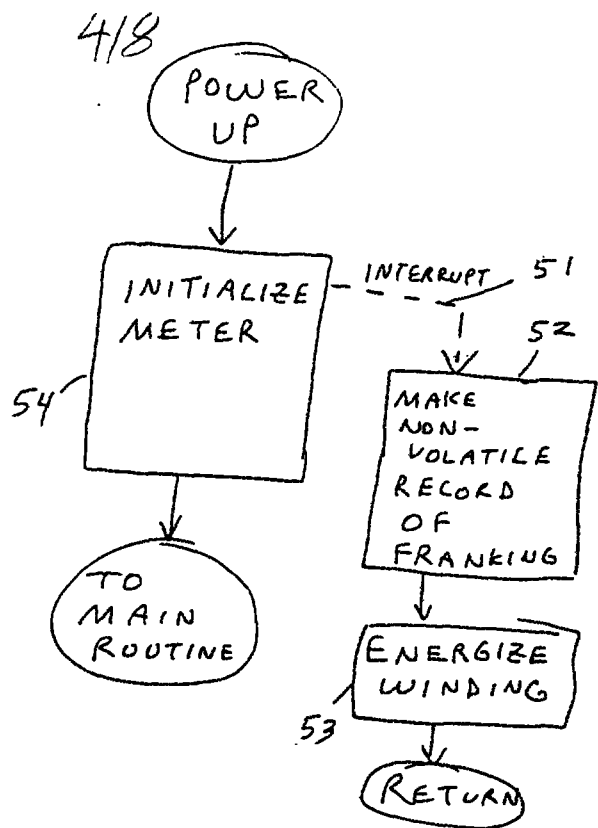


Fig. 8

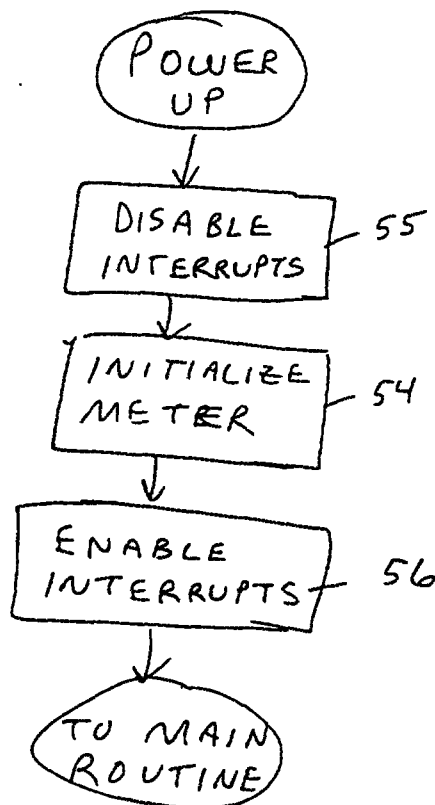


Fig. 9



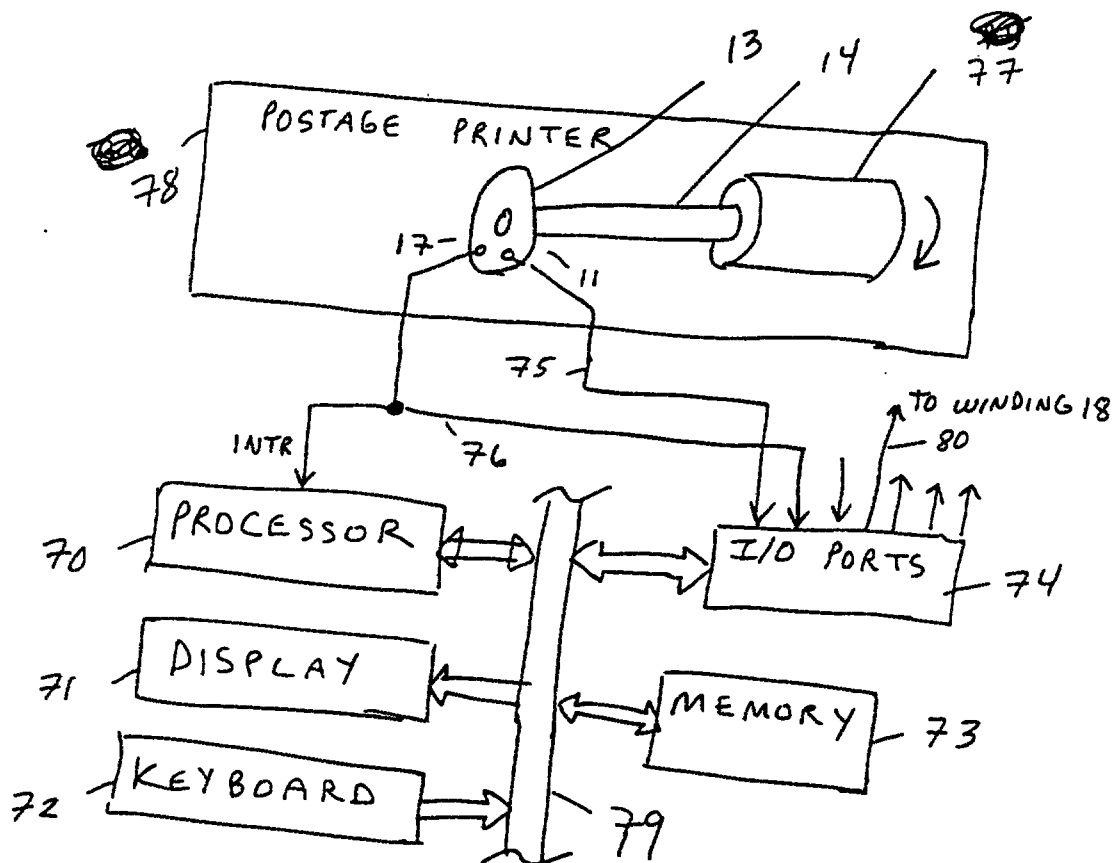


Fig. 10



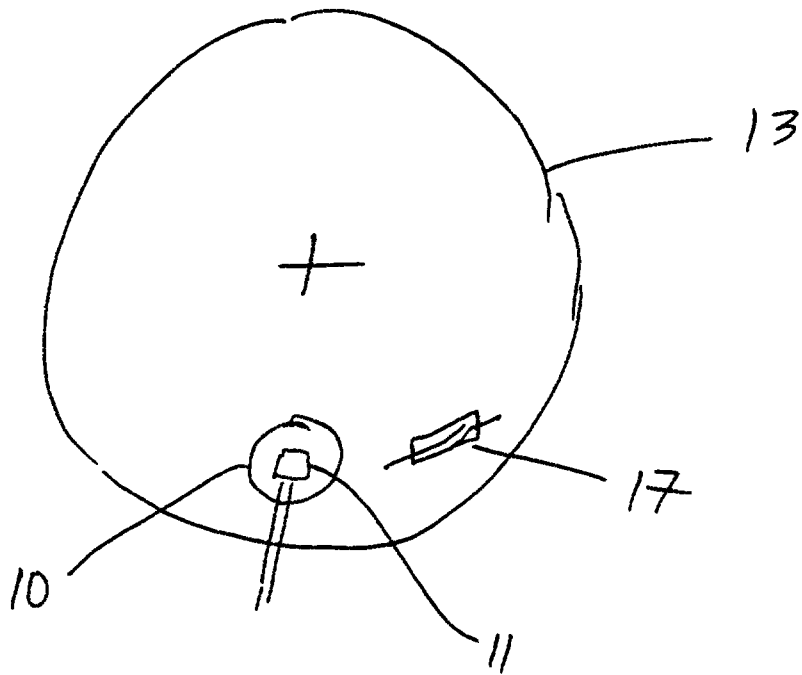


Fig. 11

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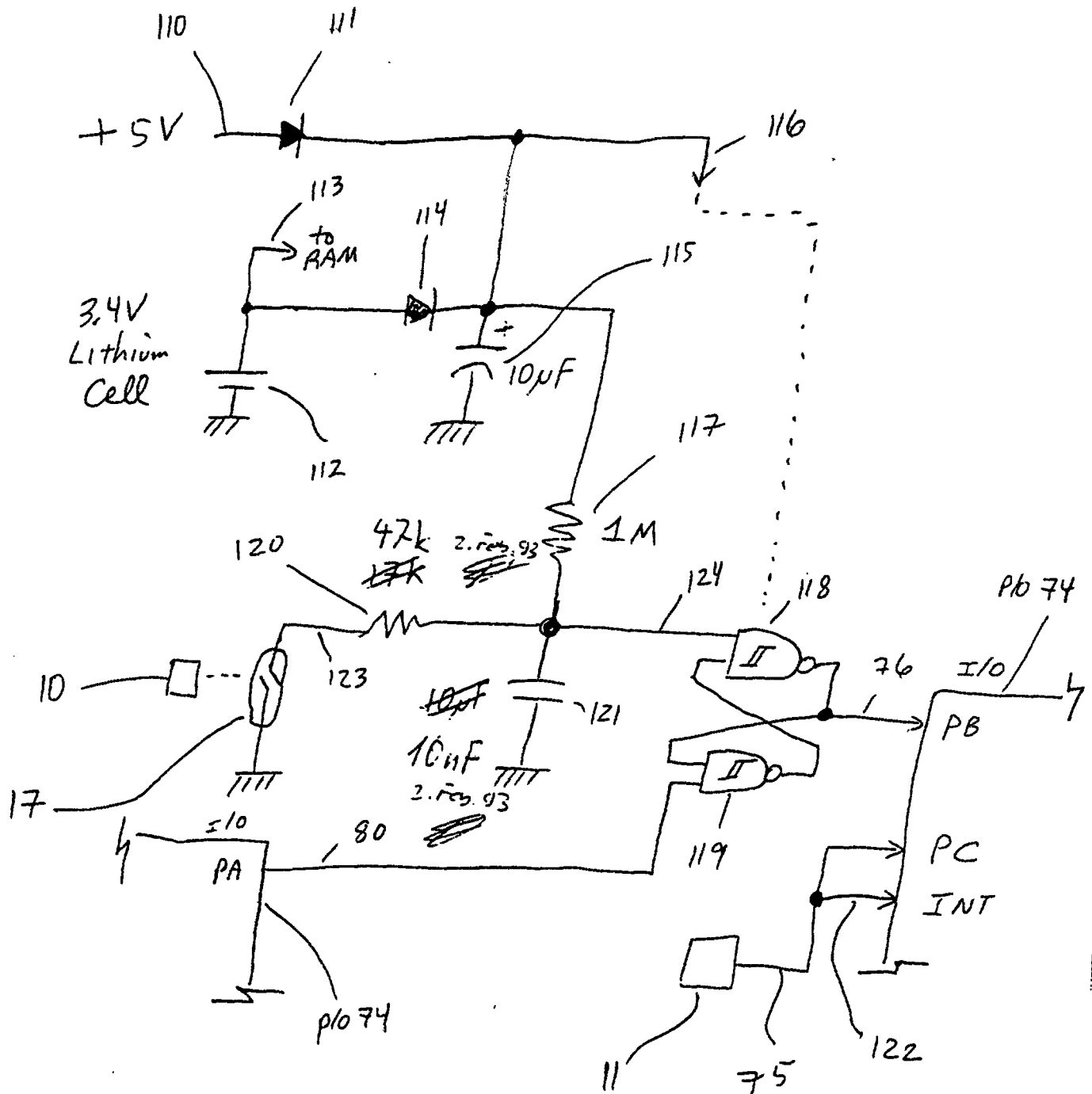


Fig. 12



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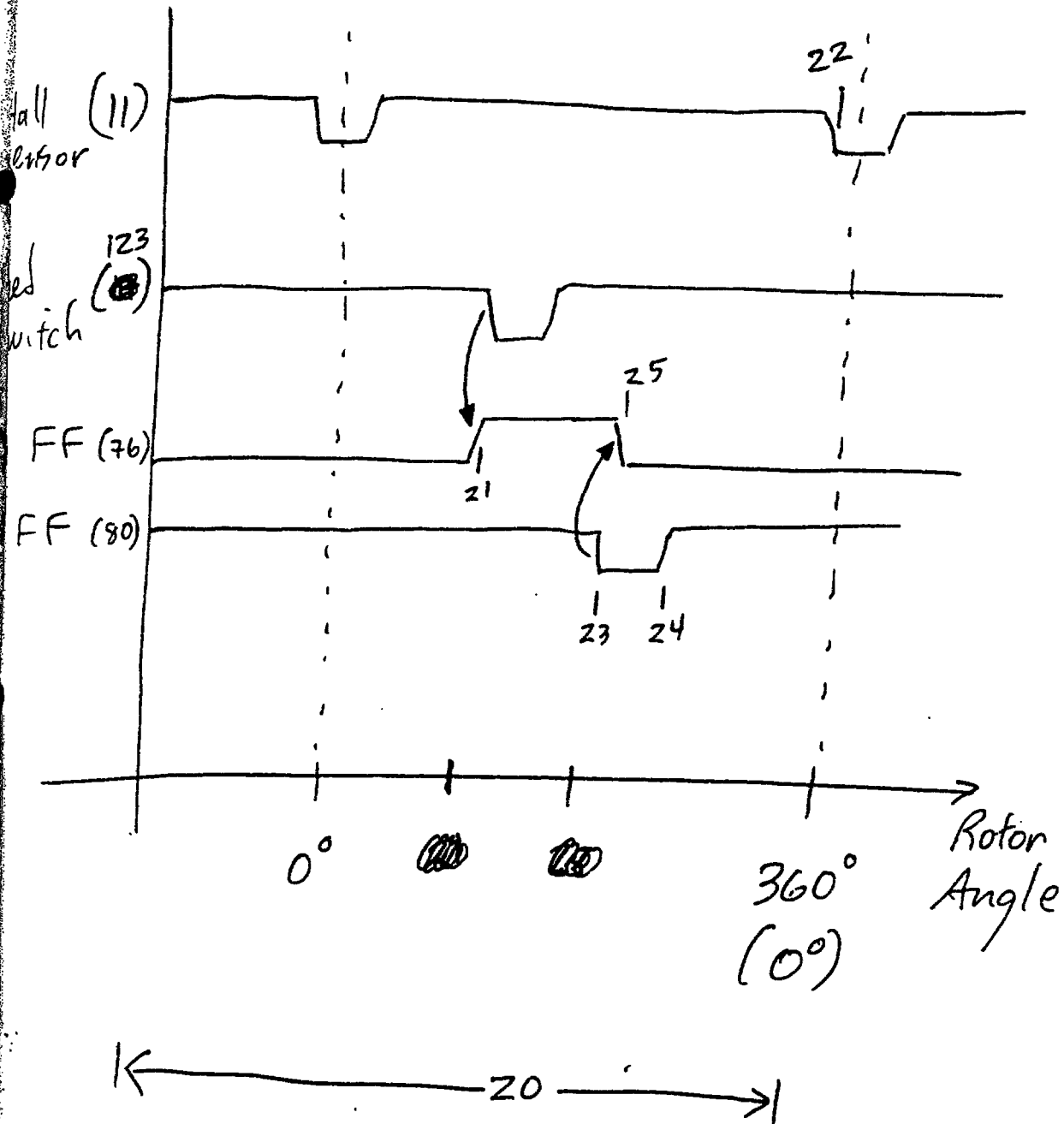


Fig. 13

A-415

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ROTOR MOVEMENT SENSING SYSTEM

REPLACED SHEETS	SG
☒ Description : paged ...1... to paged ...18...	
☒ Claim(s) : paged ...11... to paged ...22...	
☒ Drawing(s) : paged ...1/8... to paged ...9/8...	
☒ Abstract : paged ...23... to paged	

☒ Description : paged ...1... to paged ...18...	
☒ Claim(s) : paged ...11... to paged ...22...	
☒ Drawing(s) : paged ...1/8... to paged ...9/8...	
☒ Abstract : paged ...23... to paged	

Date: 5/12/96

The invention relates to a rotor movement sensing system for use in a postage meter having a rotor for printing postage by cyclic rotation thereof.

In any electronic postage meter it is important that the electronic registers faithfully reflect the actual mechanical printing of postage by the print rotor. In nearly all instances of the printing of postage, electric power is available for the entirety of the print cycle and the processor, which controls and monitors printing of postage, is able to decrement and increment the descending and ascending registers accordingly.

Most of the time, when the rotor is not in motion (because it is not printing postage) the rotor is in or very near to a "home" position. It is standard to have a sensor that indicates to the processor that the rotor is in the home position. A typical sensor arrangement is to place a permanent magnet on a disk attached to the rotor shaft. A Hall-effect sensor is positioned so that the sensor is "on" when the rotor is in its home position. If a print cycle is in progress, the processor can confirm the completion of the

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cycle by sensing the return of the rotor to the home position.

It is also standard to have a ratchet or other mechanical arrangement coupled to the rotor shaft so that the rotor cannot be moved very far backwards. However, a number of design constraints limit how tightly the ratchet performs its task. For example, at the end of a print cycle, it is not uncommon that the rotor may reach the home position (as expected) but may also go slightly past the home position due to rotational inertia or due to drag from a large item being franked. If the meter is to be satisfactory to the user, the ratchet must permit the slight reverse rotation back to the home position.

The design of the meter must necessarily take into account, however, the prospect that power may fail unexpectedly. The processor may thus be in the situation of not having quite enough information to distinguish whether or not a print cycle has occurred. For example, one of the indications to the processor that a print cycle has begun is the home sensor turning off. This indicates that the rotor has moved from the home position. But if power is lost after the home sensor has turned off, then later when the processor again has power the processor may find that the home sensor is again on. This could have happened, however, due to either of two mechanical sequences.

On the one hand, the rotor may indeed have printed a print cycle, finished while processor power was absent. This would result in the home sensor again being on.

On the other hand, the rotor might merely have moved slightly past the home position, and then dropped backwards again to the home position, all while processor power was absent. This, too, would result in the home

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sensor again being on. This slight forward-and-back movement could, as described above, arise due to a slight overrun of a previous print cycle.

The difficulty, however, is that without more information the processor is not capable of distinguishing which mechanical sequence actually occurred. There is the difficulty, then that the meter designer would not know whether or not to program the processor to increment and decrement the ascending and descending registers in the face of such sensor inputs. This presents the possible problem that the amount of postage actually printed may fail to correspond perfectly with the information in the descending and ascending registers.

One prior-art approach to this problem is that found in U.S. Pat. No. 4,253,015 to McFiggans et al. ("the '015 patent"). As described in Figs. 1 and 3 of that patent, there is provided a counter gear 61 that is twice as large as a gear 60 on the rotor shaft; the counter gear 61 has an angular velocity at all times half that of the rotor (also called a "drum" in this patent). Depending on whether the rotor has finished an even-numbered or odd-numbered printing cycle, the counter gear 61 will be in one of two orientations. Two holes 62 and 63, located at different radii on the counter gear 61, will trigger one of two sensors 67 or 66 respectively, permitting the processor 120 to know whether the print cycle just finished was an odd-numbered one or an even-numbered one.

This approach has a number of drawbacks, chief among them that it requires a large counter gear which takes up space in the meter, which adds to the count of moving parts, and which adds to the inertial moment that must accelerate and decelerate with each print cycle. The

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approach degrades the mechanical reliability of the meter, adds to the parts and assembly cost, and adds to wear due to use.

It would thus be desirable to have a way of providing sensor information to the processor to resolve ambiguities regarding rotor movement during times when the processor has been unpowered, all without unduly degrading reliability and increasing parts and assembly cost.

The invention is defined in claim 1 and preferred features are recited in the claims dependent thereon.

In summary, the new rotor sensing concept employs changes to hardware and software of the meter.

In hardware, an additional sensor is provided to sense the magnet on the disk when the rotor is substantially past the home position. This additional sensor is positioned far enough past the home position that the above-mentioned ratchet will have ensured that the rotor must continue forward to completion of a print cycle. It would not, however, be workable simply to use a second Hall-effect sensor at this location, with the second sensor (like the home sensor) continuously monitored by the processor. The reason is that the time interval required for mechanical movement of the rotor to the second sensor would be long enough that power failure might render the processor incapable of detecting the output of the second sensor. To make the second sensor useful for its intended purpose, the second sensor is selected to be a so-called magnetic memory element ("MME") sensor. The MME sensor has a magnetic memory element with substantial magnetic hysteresis. When the disk magnet passes near the memory element, the memory element is magnetized. The magnetization of the memory element persists long after the

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permanent magnet of the disk has passed. A Hall-effect sensor is positioned at the memory element so that it provides a signal to the processor indicative of the magnetization of the memory element. Preferably the signal is provided to the processor both as a discrete (polled) input and also as an interrupt. A solenoidal winding is provided around the memory element. The processor has an output which, when asserted, causes a substantial current to flow through the winding, whereby the memory element is demagnetized.

In another embodiment of the invention, a reed switch is employed to sense movement of the rotor past a particular angular position. A flip-flop provides a bistable means backed up by a lithium cell or other reliable source of power, and the output of the flip-flop provides a datum for the processor.

Several changes are made in software to effect the new rotor sensing concept. An interrupt routine is provided responsive to the signal from the second sensor, so that during a routine franking cycle the processor responds to the interrupt, makes record in nonvolatile memory of the occurrence of the printing cycle, and energizes the winding. This interrupt routine is executed for each franking cycle when power is continuously available, which is the normal and expected situation.

Of course, the remaining situation to be provided for in software is the application of power to the processor under circumstances where there is reason to suspect that a print cycle took place during a power outage. The power-up routine of the software, then, has a step of noting whether the second sensor is on. If it is, then the processor assumes (and this assumption is one in which the designer



has high confidence) that a printing cycle did take place. The processor then clears the memory element by energizing the winding, and makes record of the printing cycle in nonvolatile memory.

The invention can be put into practice in various ways an embodiment of which will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 shows the rotor shaft, disk, and the home and MME sensors;

Fig. 2 shows the home sensor;

Fig. 3 shows the MME sensor;

Fig. 4 is a timing diagram for signals to and from the sensors;

Fig. 5 shows a symbolic equivalent for the MME sensor;

Figs. 6-9 are flowcharts showing various software provisions relating to the MME sensor;

Fig. 10 shows an overall processor system configuration;

Fig. 11 shows a reed-switch embodiment of the invention in side view;

Fig. 12 is a schematic diagram of the reed-switch embodiment; and

Fig. 13 is a timing diagram for the reed-switch embodiment.

An overview of the postage meter in accordance with the invention is shown in Fig. 10. Processor 70 controls nearly all functions of the meter, responding to user inputs at keyboard 72 and providing information to the





user at display 71. The processor 70 is operatively coupled to the keyboard and display by digital bus 79, which also provides operative coupling to memory 73, I/O ports 74, and other devices omitted for clarity from Fig. 10. Postage is printed by a rotation of print drum or rotor 77, which contains print wheels settable under processor control by setting means, not shown in Fig. 10 for clarity. Mechanical locking, also omitted for clarity from Fig. 10, is provided so that when the rotor 77 moves away from the home position the print wheels are locked into place. As a result, if a print cycle is found to have occurred during a time of loss of power, due to the locking there is little doubt about the position of the print wheels, and thus little doubt about the amount of postage that was printed. Ratchet means, also omitted for clarity from Fig. 10, limits the extent to which rotor 77 may be moved in a direction other than that shown. The rotor turns on shaft 14, which is held by journal and thrust bearings, not shown.

In Fig. 10, disk 13 may be seen, preferably positioned at the other end of shaft 14. Sensors 11 and 17 are disposed near the disk 13. Sensor 11, the "home" sensor about which more will be said below, gives a discrete input via line 75 to one of the input lines at the I/O ports 74. Sensor 17, the MME sensor about which more will be said below, gives a discrete input via line 76 to one of the input lines at the I/O ports 74, and also preferably provides an interrupt to the processor 70.

Turning now to Fig. 1, the disk 13 is seen in plan from a point of view at the rotor 77 (not shown in Fig. 1). It will be appreciated that due to the change in point of view, the normal direction of rotation for disk 13 as shown in Fig. 1 is counterclockwise. Shaft 14 is shown in cross

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section. Hall-effect sensor 11 defines a "home" position on disk 13, and permanent magnet 10 is located on disk 13 proximate to sensor 11. A second sensor 17, the MME sensor, is positioned as shown.

Fig. 2 shows sensor 11 in a section taken through disk 13. Sensor 11, which as mentioned above is preferably a Hall-effect sensor, is preferably mounted to a printed circuit board 15 and, when the rotor is in the home position, permanent magnet 10 is quite nearby. Fig. 3 shows sensor 17 in a section parallel to but displaced from the section of Fig. 2. Sensor 17 is likewise preferably mounted to the same printed circuit board 15. In this figure disk 13 is shown having rotated so that magnet 10 is nearby to sensor 17; it will be appreciated that Figs. 2 and 3 show things that do not happen simultaneously since magnet 10 cannot simultaneously be adjacent to both sensors 11 and 17.

The second sensor 17 differs from home sensor 11 not only in its location but also in provision of the magnetic memory element (MME) 16, which has substantial magnetic hysteresis. When the disk magnet 10 passes near the memory element 16, the memory element 16 is magnetized. The magnetization of the memory element 16 persists long after the permanent magnet 10 of the disk 13 has passed. The Hall-effect sensor 17 is positioned at the memory element 16 so that it provides a signal to the processor 70 (not shown in Fig. 3) indicative of the magnetization of the memory element 16. In Fig. 3 may also be seen a solenoidal winding 18 around the memory element 16. The processor 70 has an output 80 (shown in Fig. 10) which, when asserted, causes a substantial current to flow through the winding 18, whereby the memory element 16 is demagnetized.

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through angle 91. The latch would be coupled to a switch. Triggering of the mechanical latch would give rise to a switch signal like that of sensor 17. The mechanical latch would be made so as to be resettable, as by energizing a solenoid to move the mechanical latch back to its reset position. Generally, one skilled in the art could employ any bistable device that is set by movement of the rotor past a predetermined angle, and that is capable of being reset by an electrical signal.

It will also be appreciated that while the sensor is depicted herein as coupled directly with the rotor, it would be possible to couple the sensor in any of a range of indirect means, including coupling to any indicator of rotor movement. Other means that are thought inferior to the disclosed embodiment but nonetheless within the scope of the invention would include: coupling the sensor to rollers elsewhere in the envelope feed path; coupling the sensor to movement sensing means elsewhere in the feed path; and coupling the sensor to mechanical elements that are in turn coupled to the rotor.

The software of the rotor sensing system, stored in memory 73 shown in Fig. 10, will now be discussed.

Fig. 6 shows in block diagram form the main routine that is being executed most of the time when the meter is powered. As will be appreciated, the main routine repeats itself over and over again. Loss of repetition of the main routine is preferably detected and remedied by a watchdog circuit, not shown. Dashed line 51 portrays the shift in program flow that occurs if an interrupt is received at the processor 70 via line 76 from sensor 17. At 52 a nonvolatile record is made of the occurrence of the franking cycle. At 53 the processor energizes the winding



the rotor at the home position, and so that the fall of the signal follows the departure of the rotor from the home position.

The next line shows the output of the sensor 17. At 21, the output rises, which means the rotor has moved by approximately the angle 91 so as to bring magnet 10 nearby to sensor 17. In the normal course of events (that is, in the absence of loss of power) the processor 70 will receive an interrupt at time 21. Then, at time 23, processor 70 generates the current pulse to winding 18 (see Fig. 3) via line 80 (see Fig. 10). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be an interval determined by the downgoing transition 25 as detected by the processor.

Fig. 5 shows in functional block form an equivalent circuit for the sensor shown in Fig. 3. The sensor is not, of course, a counter because it does not distinguish between successive print cycles. If it were to indicate a high level, the high level would only indicate that at least one print cycle had occurred but would not provide any count of print cycles. The sensor may be thought of as a D-type flip-flop which is set at 10', reset by 18', and providing an output at 17'. The block 16' is comparable to the memory element 16 with its hysteresis which gives rise to bistability.

Those skilled in the art will readily appreciate that numerous variations could be devised to embody the invention without deviating from it. For example, instead of a using a magnet and a magnetic memory element, one could use a mechanical latch that is triggered by rotor movement

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It will be appreciated by those skilled in the art that design considerations may prompt any of a number of locations for the sensors 11, 17 and magnet 10. Cost is reduced if a circuit board 15 is already nearby, so that the sensors 11, 17 may be mounted directly to that circuit board 15, providing both mechanical mounting and electrical connections. This also prompts placing the sensors 11, 17 in a plane parallel to a main plane of the chassis of the meter, so that both may be placed on a single circuit board 15 rather than on two separate circuit boards. The elevation of the single circuit board 15 and the diameter of the disk 13 are chosen so as to make angle 91, shown in Fig. 1, as large as desired. Angle 91 is selected to satisfy a number of constraints including that the angle be great enough that the ratchet does not permit a backwards movement of the rotor 77 back to the home position.

Turning now to Fig. 4, there is shown a timing diagram for various of the signals of the rotor sensing concept. The top line shows the output of sensor 11, which is high when the rotor begins in a home position, and is again high when the rotor has returned to a home position at 22. The duration of one complete print cycle is thus seen to correspond to interval 20. Those skilled in the art will appreciate that the high output of sensor 11 may persist for a long time if a long time passes between franking cycles, as will sometimes happen during the course of a day. Those skilled in the art will also appreciate that the rise and fall of the signal from sensor 11 do not coincide precisely with the rotor's being in the home position. Rather, to allow for some variation in the magnet, the Hall-effect sensor, and their geometric relationship, the system is set up so that the rise of the signal precedes the arrival of



the rotor at the home position, and so that the fall of the signal follows the departure of the rotor from the home position.

The next line shows the output of the sensor 17. At 21, the output rises, which means the rotor has moved by approximately the angle 91 so as to bring magnet 10 nearby to sensor 17. In the normal course of events (that is, in the absence of loss of power) the processor 70 will receive an interrupt at time 21. Then, at time 23, processor 70 generates the current pulse to winding 18 (see Fig. 3) via line 80 (see Fig. 10). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be an interval determined by the downgoing transition 25 as detected by the processor.

Fig. 5 shows in functional block form an equivalent circuit for the sensor shown in Fig. 3. The sensor is not, of course, a counter because it does not distinguish between successive print cycles. If it were to indicate a high level, the high level would only indicate that at least one print cycle had occurred but would not provide any count of print cycles. The sensor may be thought of as a D-type flip-flop which is set at 10', reset by 18', and providing an output at 17'. The block 16' is comparable to the memory element 16 with its hysteresis which gives rise to bistability.

Those skilled in the art will readily appreciate that numerous variations could be devised to embody the invention without deviating from it. For example, instead of a using a magnet and a magnetic memory element, one could use a mechanical latch that is triggered by rotor movement

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through angle 91. The latch would be coupled to a switch. Triggering of the mechanical latch would give rise to a switch signal like that of sensor 17. The mechanical latch would be made so as to be resettable, as by energizing a solenoid to move the mechanical latch back to its reset position. Generally, one skilled in the art could employ any bistable device that is set by movement of the rotor past a predetermined angle, and that is capable of being reset by an electrical signal.

It will also be appreciated that while the sensor is depicted herein as coupled directly with the rotor, it would be possible to couple the sensor in any of a range of indirect means, including coupling to any indicator of rotor movement. Other means that are thought inferior to the disclosed embodiment but nonetheless within the scope of the invention would include: coupling the sensor to rollers elsewhere in the envelope feed path; coupling the sensor to movement sensing means elsewhere in the feed path; and coupling the sensor to mechanical elements that are in turn coupled to the rotor.

The software of the rotor sensing system, stored in memory 73 shown in Fig. 10, will now be discussed.

Fig. 6 shows in block diagram form the main routine that is being executed most of the time when the meter is powered. As will be appreciated, the main routine repeats itself over and over again. Loss of repetition of the main routine is preferably detected and remedied by a watchdog circuit, not shown. Dashed line 51 portrays the shift in program flow that occurs if an interrupt is received at the processor 70 via line 76 from sensor 17. At 52 a nonvolatile record is made of the occurrence of the franking cycle. At 53 the processor energizes the winding

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18, after which execution returns to the main routine 50 where it was interrupted.

Those skilled in the art will appreciate the normal and standard steps taken in the interrupt service routine of blocks 52 and 53. The first instruction of the routine is preferably disabling interrupts, followed by a masking of selected interrupts including the sensor-17 interrupt, followed by a re-enabling of interrupts. After the winding 18 has been energized, the sensor-17 signal is tested, and barring the unexpected persistence of the sensor-17 signal, the sensor-17 interrupt is again unmasked and/or re-enabled.

Those skilled in the art will also appreciate that nothing in the rotor sensing system requires that resetting of the MME 16 by energizing winding 18 take place prior to the end of the print cycle. While the resetting is so portrayed in Fig. 4 and in Fig. 6, the system could just as well permit these tasks to wait until after the rotor has again returned to its home position without deviating in any way from the system concept.

In contrast to the normal, fully-powered circumstance of Fig. 6, routines will now be described to provide for the possibility that at the time of power-up, a print cycle may have taken place. At Fig. 7, the meter's software with respect to powerup is shown in one embodiment. At 55, interrupts are disabled. At 54, the meter is initialized, preferably including a test of the print wheels of rotor 77 to determine what positions they were in. The print wheel positions are noted for later reference, and are compared with what the processor had noted the print wheel positions to be prior to the last previous loss of power. At 57, the processor 70 polls the condition of the MME

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sensor 17 via line 76 (Fig. 10) and I/O port 74. At 58, a branch is made in the normal case, namely if no unaccounted-for print cycle has been detected, namely a jump to block 56. If, however, an unaccounted-for print cycle has been detected (as indicated by MME sensor 17), then blocks 52 and 53 are executed analogously to like-numbered blocks of Fig. 6. (Those skilled in the art will also appreciate that it may be helpful for troubleshooting or maintenance to make a nonvolatile record of the occurrence of power-up together with the sensor 17 having been set.) Block 56 re-enables interrupts, and control passes to the main routine of Fig. 6.

Fig. 8 shows the software configuration if a different approach is taken than that of Fig. 7. In Fig. 8, no attempt is made to disable interrupts. Instead, the signal from sensor 17, which is present from the moment of power-up, causes an interrupt to occur quite early on in processor execution of the initialization routine 54. The interrupt branches via 51 and the interrupt servicing routine of blocks 52 and 53 takes place much as in Fig. 6. Eventually control returns to the initialization routine 54 and eventually passes to the main routine of Fig. 6.

Fig. 9 shows yet another software configuration if a different approach is taken than that of Figs. 7 and 8. In box 55 interrupts are disabled, and in box 54 the meter is initialized. In box 56 interrupts are re-enabled and control may pass to the main routine of Fig. 6. But if the signal from sensor 17, which may happen to be present from the moment of power-up, is present, then this causes an interrupt to occur right away after block 56, essentially at the start of the main routine of Fig. 6. There, the interrupt branches via 51 and the interrupt servicing

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routine of blocks 52 and 53 takes place. Eventually control returns to the main routine of Fig. 6.

In an alternative embodiment of the invention, a reed switch is employed to sense movement of the rotor past a particular angular position. A flip-flop provides a bistable means backed up by a lithium cell, and the output of the flip-flop provides a datum for the processor. Fig. 11 shows the switch arrangement relative to the rotor 13, with magnet 10, Hall-effect switch 11, and reed switch 17, all mounted to a printed circuit board, omitted for clarity in Fig. 11. The elements of Fig. 11 correspond to those of Fig. 1 for the embodiment previously discussed.

Fig. 12 is a schematic diagram for the alternative embodiment. During normal operation the circuit is powered by the same +5V source 110 that powers the rest of the meter. Lithium cell 112, preferably a 3.4 V cell, can also power the circuit reliably; isolation is provided by diodes 111, 114 and the power is smoothed by electrolytic capacitor 115. Optionally lithium cell 112 may also provide data backup for RAM, not shown in Fig. 12, via line 113.

Capacitor 121, preferably a highly stable capacitor, is charged through resistor 117. If magnet 10 nears reed switch 17, capacitor 121 is discharged through resistor 120. This defines high and low outputs on line 124, which serves as a setting input to an RS flip-flop composed of nand gates 118, 119. Nand gates 118, 119 are powered by line 116. As a consequence, the state of the flip-flop is preserved despite any changes in the level of the +5V power supply at 110. The flip-flop, which is of course a bistable device, receives a reset input via line 80 from an output of the I/O port 74, part of which seen at the lower left of Fig. 12. The output of the flip-flop is

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provided via line 76 to an input of the I/O port 74, another part of which is seen at the lower right of Fig. 12.

Hall-effect sensor 11 also provides an input via line 75 to an input of the I/O port 74.

It will be appreciated that in Fig. 12, the interrupt to the processor is not from the sensor 17 but rather from the sensor 11. This differs from the embodiment disclosed above, in which the interrupt comes from the sensor 17. Those skilled in the art will appreciate that either embodiment could, in principle, use either sensor to provide an interrupt to the processor without deviating in any way from the invention.

Fig. 13 shows a timing diagram for signals occurring during rotor rotation in the alternative embodiment. The diagram corresponds in many ways to the timing diagram of Fig. 4 for the first embodiment. The top line shows the output of sensor 11, which is high when the rotor begins in a home position, and is again high when the rotor has returned to a home position at 22. The duration of one complete print cycle is thus seen to correspond to interval 20.

The next line shows the output of the sensor 17. At 21, the output falls, which means the rotor has moved so as to bring magnet 10 nearby to reed switch 17. Then, at time 23, processor 70 generates the reset signal via line 80 (see Fig. 12). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be an interval determined by the downgoing transition 25 as detected by the processor.

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If the system has the interrupt coming from the sensor 11 instead of the sensor 17, this changes in particular detail some of the software-driven activities of Figs. 6-9. In Fig. 6, the arrival of the interrupt at 51 prompts making a nonvolatile record that it was suspected a franking had occurred (to provide for the case where power fails while the rotor continues to move). If, while the software is in block 52, the second switch 17 is triggered, then the reset pulse of line 80 is generated in block 53, and the nonvolatile record is updated to show the normal and tidy progress of the franking activity.

If the software arrangement of Fig. 7 is considered, it will be seen that the polling of the flip-flop contents (block 57) suffices to determine that the sensor 17 must have been triggered at some time prior to the present instance of power having been applied. Thus it is assumed that franking took place, and the reset pulse of line 80 is generated in block 53.

In the case now being discussed where the output of the bistable device does not generate an interrupt, then the software arrangement of Figs. 8 and 9 is inapplicable.

Those skilled in the art will appreciate that while the circuit is shown using a reed switch and a Hall-effect switch, other sensing technologies could be used without departing from the invention. Likewise, numerous other bistable storage technologies could be employed other than the particular nand-gate flip-flop shown in Fig. 12.

Those skilled in the art will readily appreciate that while the steps described above are described as occurring in software that is executed by a processor, the steps could just as well be accomplished by random logic circuitry dedicated for that purpose.

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CLAIMS

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1. A rotor movement sensing system for use in a postage meter having a rotor for printing postage by cyclic rotation thereof, and having a register relating to postage printed by the rotor, the rotor position between postage printing cycles defining a home position, the sensing system comprising:

bistable means having an output, a setting input and a resetting input, the setting input operatively coupled to the rotor so as to set the bistable means upon rotation of the rotor by a first predetermined angle past the home position, and

means responsive to the output for changing the register contents and for actuating the resetting input.

2. The rotor movement sensing system of claim 1 wherein:

the bistable means comprise a magnetic memory element, a Hall-effect sensor and a solenoid adjacent the magnetic memory element,

the setting input comprises a permanent magnet operatively coupled with the rotor,

the output comprises the output of the Hall-effect sensor, and

the resetting input comprises leads of the solenoid.



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3. The rotor movement sensing system of claim 1 wherein:

the bistable means comprise a flip-flop with a reliable source of power,

the setting input comprises a permanent magnet operatively coupled with the rotor,

the output comprises the output of the flip-flop, and

the resetting input comprises a signal to a reset input of the flip-flop.

4. The rotor movement sensing system of claim 1, 2 or 3 wherein:

the means responsive to the output comprises a microprocessor executing a stored program.

5. The rotor movement sensing system of claim 1,2,3 or 4 further comprising ratchet means operatively coupled with the rotor whereby the rotor cannot move oppositely to the direction for printing postage by more than a second predetermined angle, and wherein the first predetermined angle is selected to be greater than the second predetermined angle.

6. The rotor movement sensing system of claim 4 or 5 wherein the output further comprises an interrupt to the processor, and wherein the stored program further comprises an interrupt routine.



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7. A rotor movement sensing system of any of claims 1 to 6, further including means responsive to application of power to the meter for making record of the occurrence of the output being present upon the application of power.

8. A method for use in a postage meter having a rotor for printing postage by cyclic rotation thereof, and having a register relating to postage printed by the rotor, the rotor position between postage printing cycles defining a home position, the sensing system comprising bistable means having an output, a setting input and a resetting input, the setting input operatively coupled to the rotor so as to set the bistable means upon rotation of the rotor by a first predetermined angle past the home position, the method comprising the step of changing the register contents and actuating the resetting input.

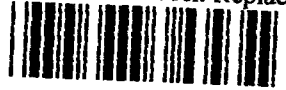
9. The method of claim 8 including applying power to the meter and determining the state of the output and if the output is present changing the register contents and actuating the resetting input.

10. The method of claim 8 or 9 wherein the bistable means comprises a magnetic memory element, and a Hall-effect sensor and a solenoid adjacent the magnetic memory element, the setting input comprises a permanent magnet operatively coupled with the rotor, and the output comprises the output of the Hall-effect sensor, the step of actuating the resetting input further comprising the step of applying current to the solenoid.

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11. The method of claim 8 or 9 wherein the bistable means comprises a flip-flop with a reliable source of power, the setting input comprises a permanent magnet operatively coupled with the rotor, and the output comprises the output of the flip-flop, the step of actuating the resetting input further comprising the step of applying voltage to a reset input of the flip-flop.

12. The method of any of claims 8 to 11 wherein the determining step further comprises the step, if the output is present, of making record of the occurrence of the output being present upon the application of power.

13. The method of any of claims 8 to 12 wherein the meter further comprises a processor, and the output further comprises an interrupt to the processor, and wherein the method further comprises responding to the interrupt.



ABSTRACT

ROTOR MOVEMENT SENSING SYSTEM

A rotor movement sensing system is provided for use in a postage meter to permit detection of the printing of postage even in the event that power is lost during the printing cycle. A sensor is provided to sense the magnet on a disk when the rotor is substantially past its home position. When the disk magnet passes near a memory element, the memory element is magnetized. A Hall-effect sensor is positioned at the memory element so that it provides a signal to the processor indicative of the magnetization of the memory element. A solenoidal winding is provided around the memory element. The processor has an output which causes a current to flow through the winding, whereby the memory element is demagnetized. A flip-flop provides a bistable latch backed up by a lithium cell, and the output of the flip-flop provides a datum for the processor.

FIGURE 10

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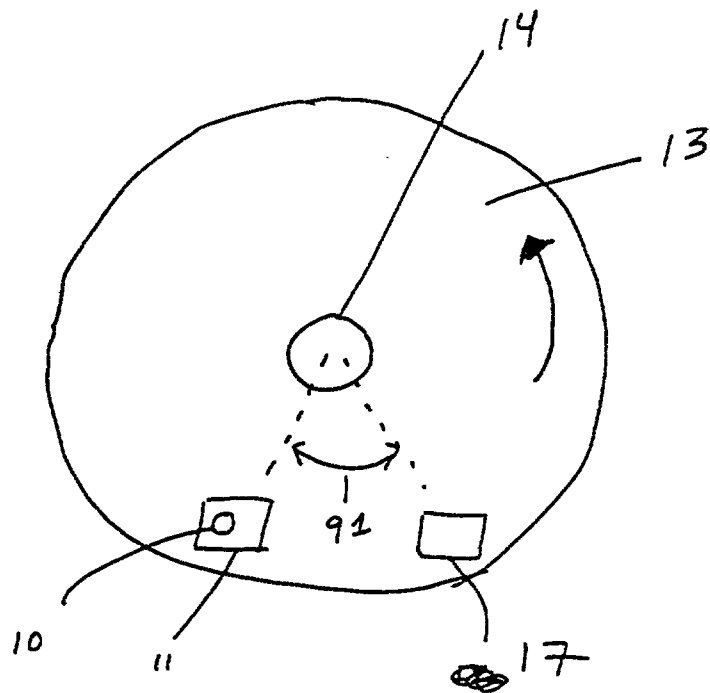


Fig. 1

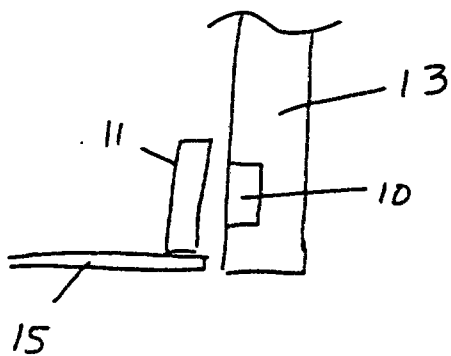


Fig. 2

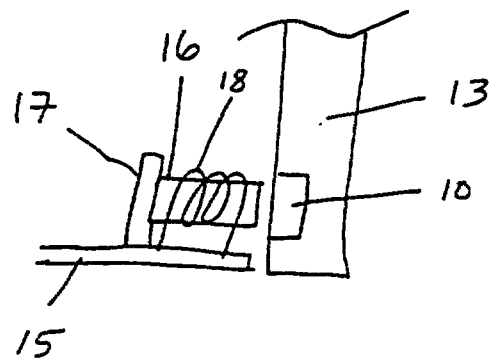


Fig. 3

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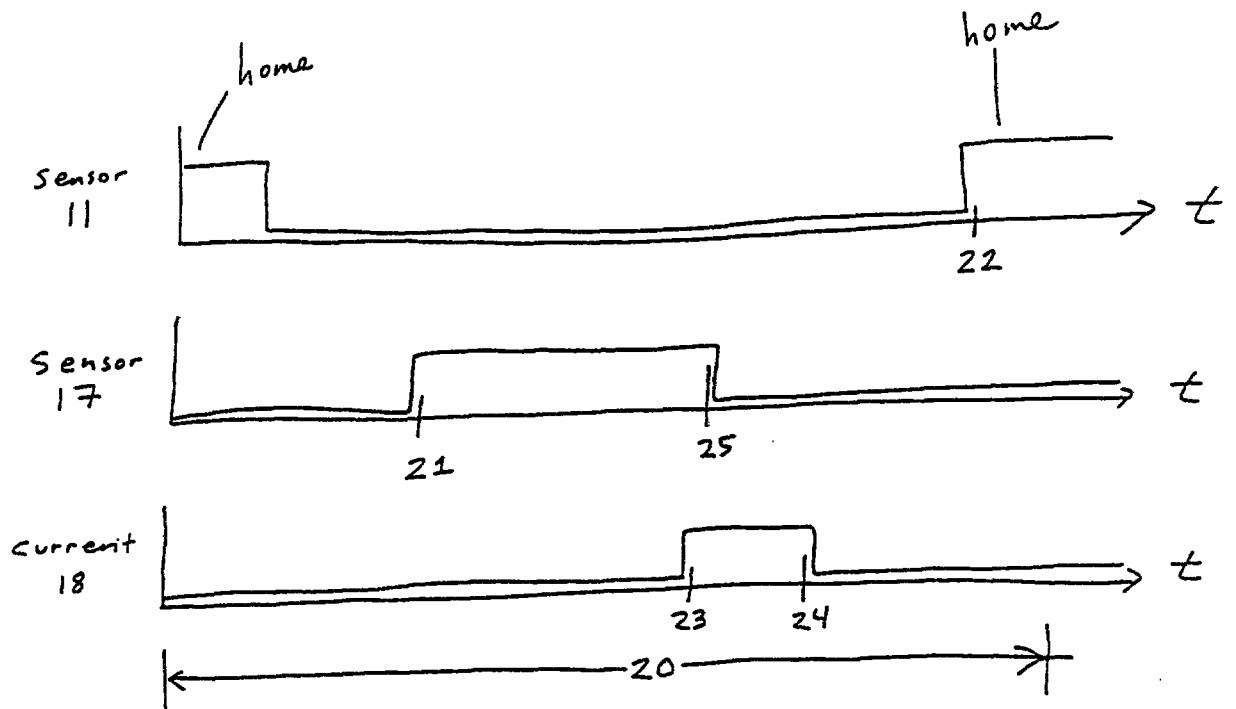


Fig. 4

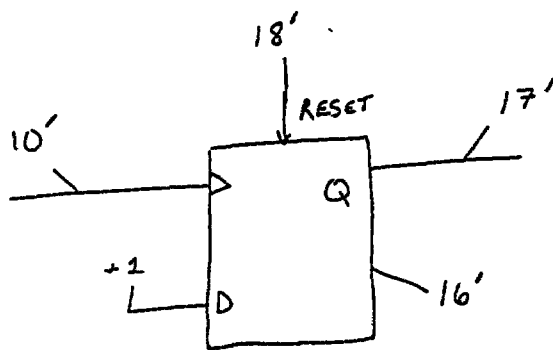


Fig. 5

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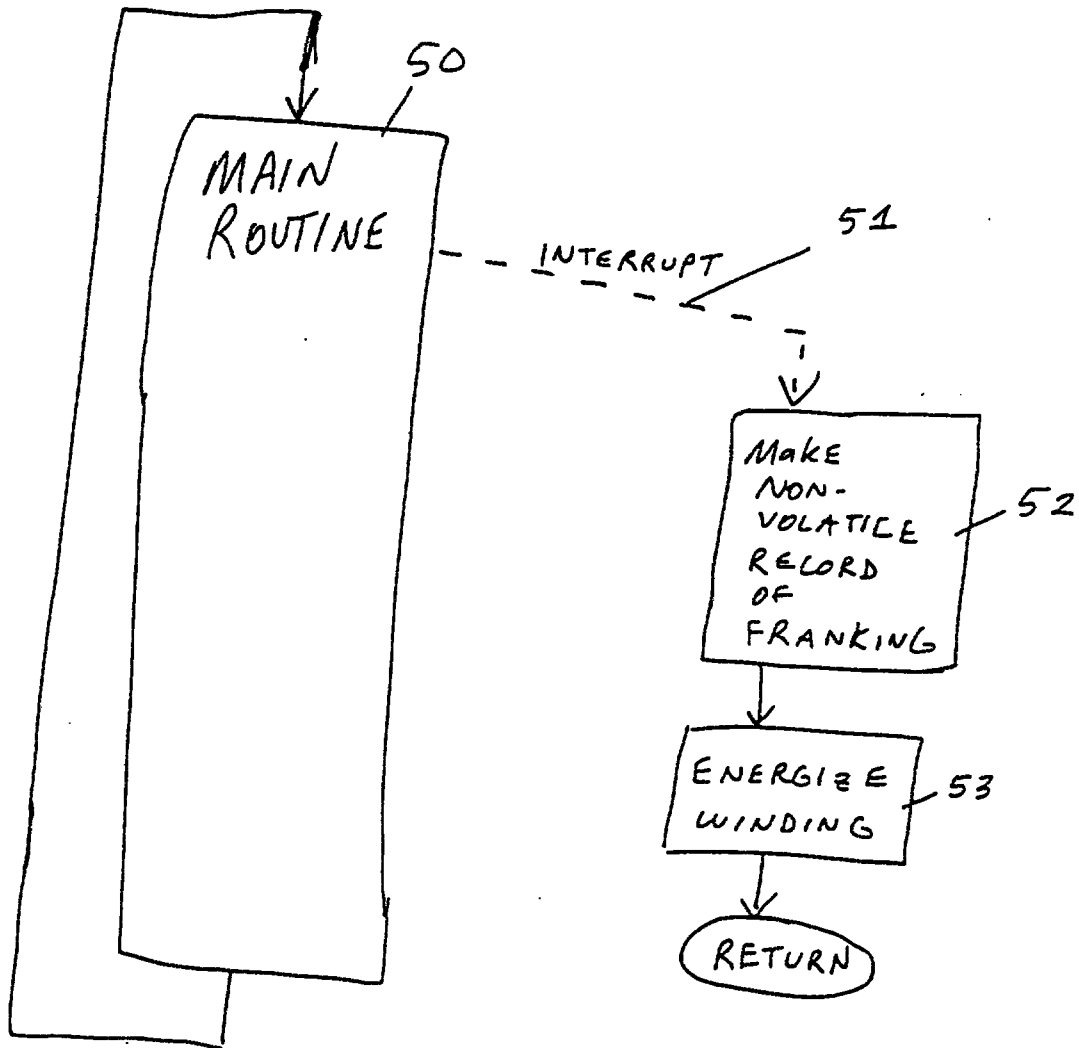


Fig. 6

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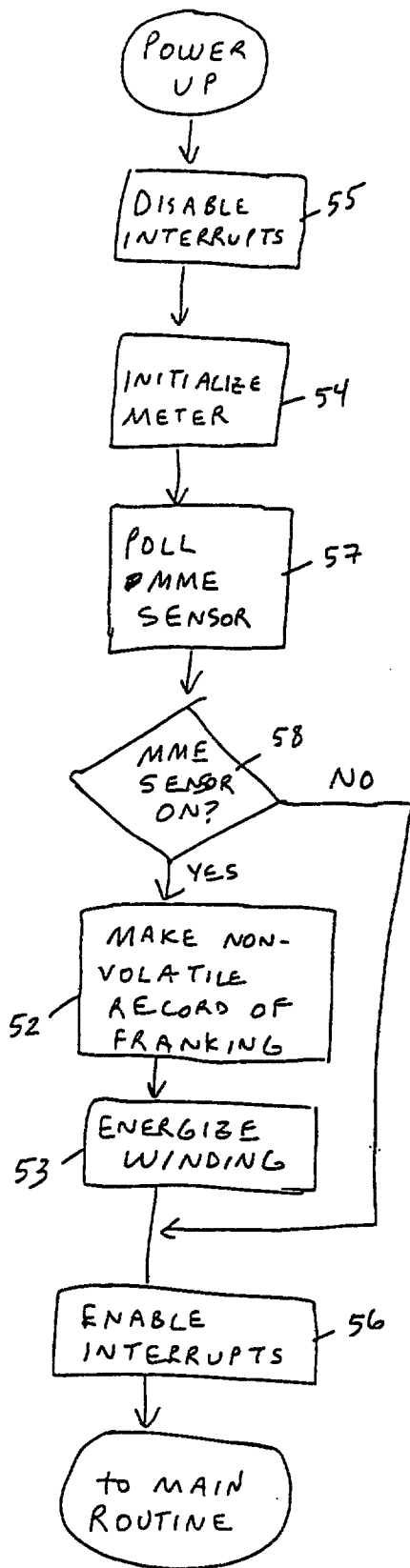


Fig. 7

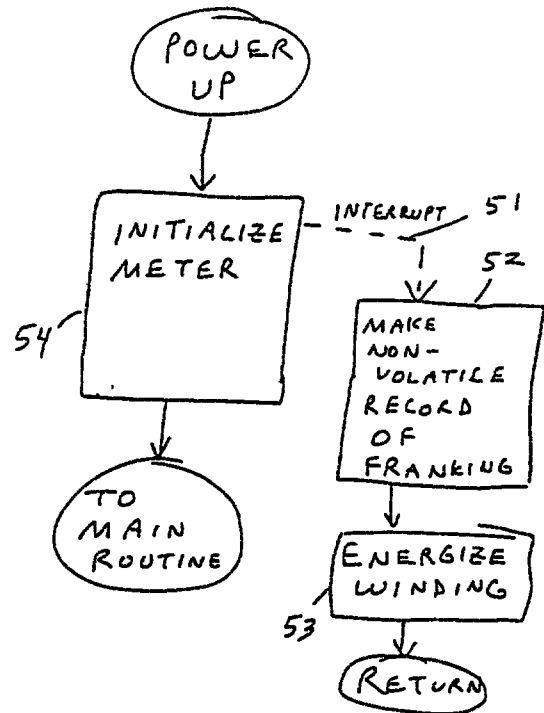


Fig. 8

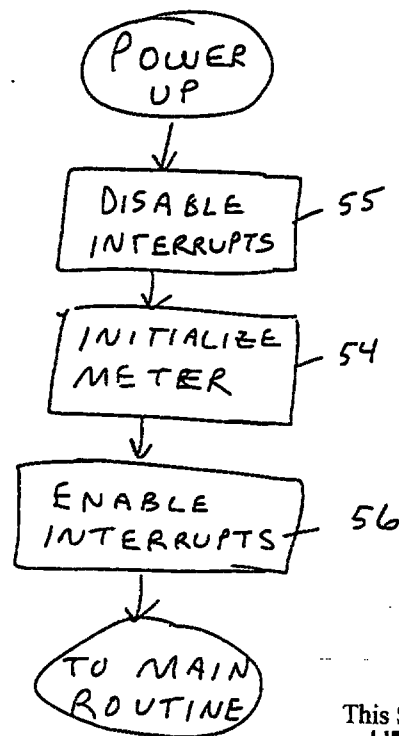


Fig. 9

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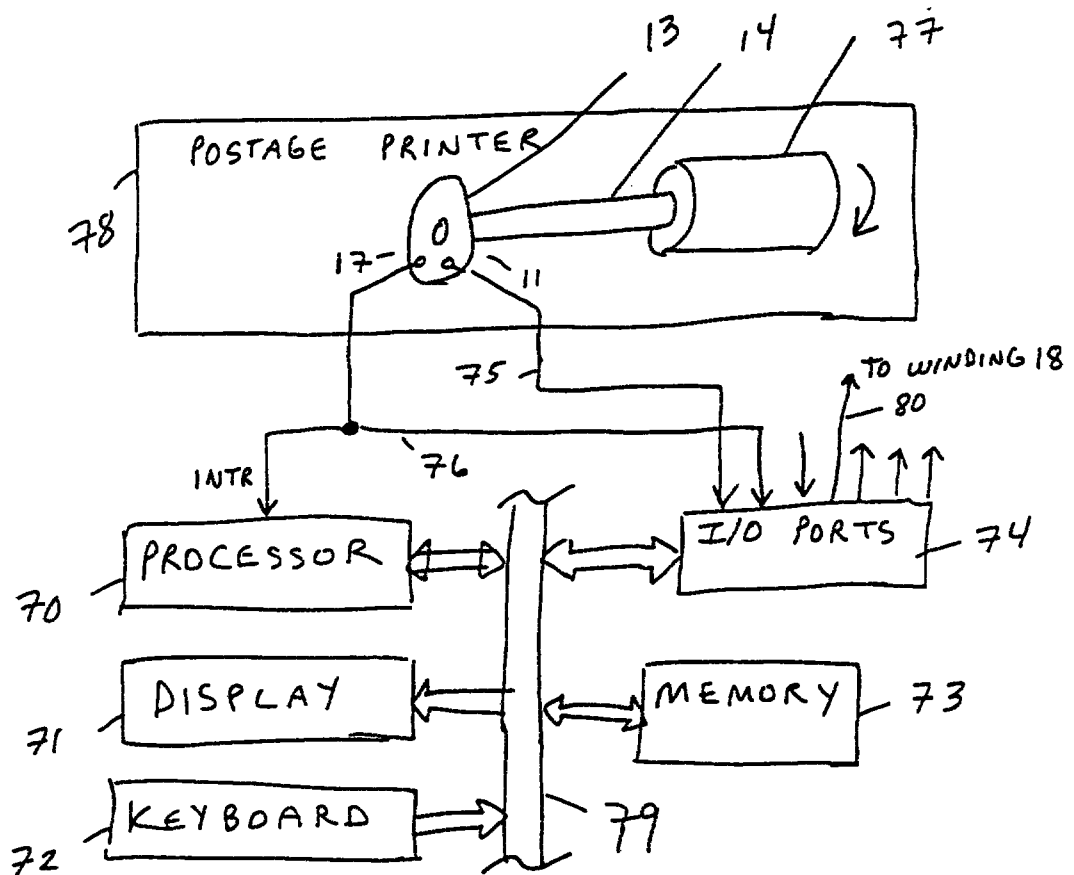


Fig. 10

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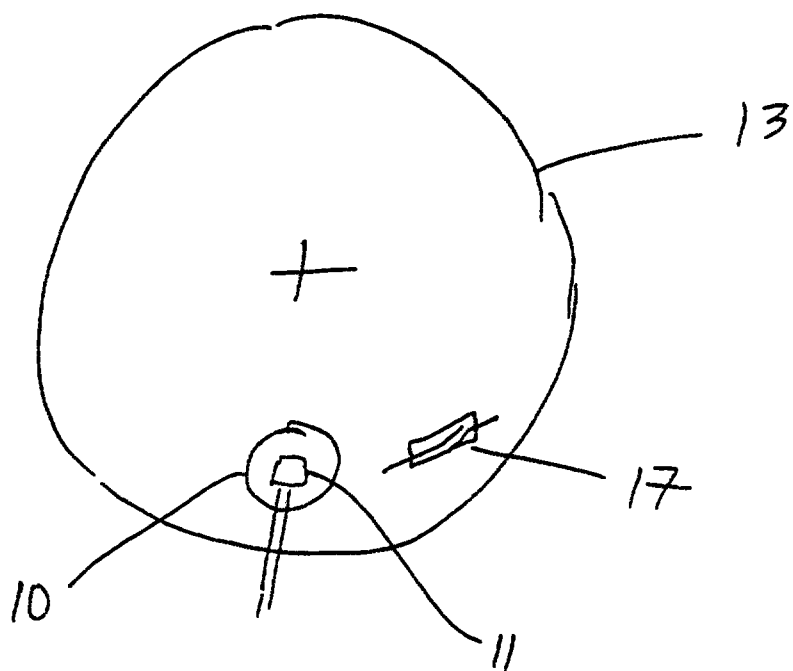


Fig. 11

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Fig. 12

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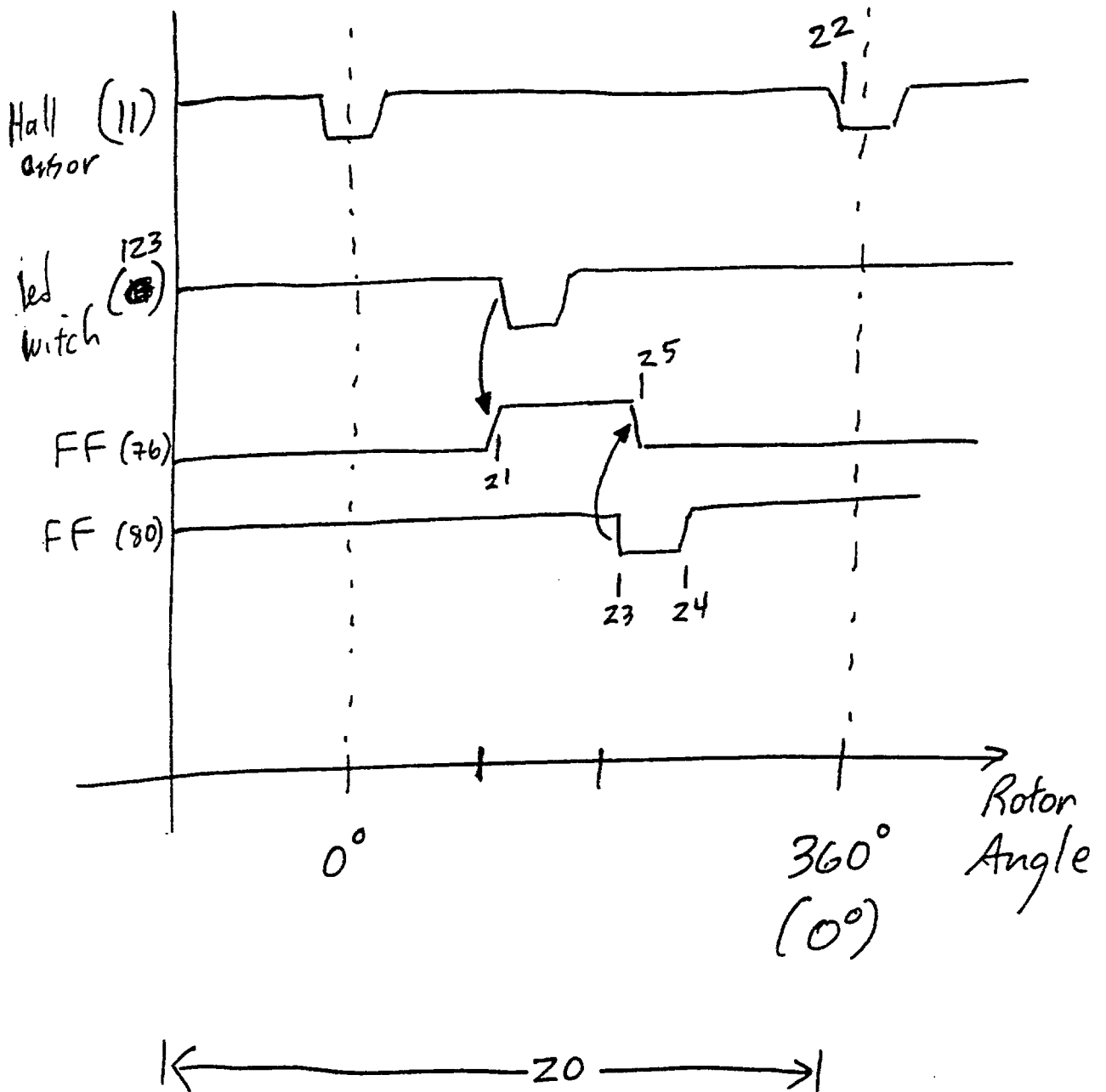


Fig. 13

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ROTOR MOVEMENT SENSING SYSTEM

✓	Page 1.1 to 1.14
✓	Page 1.17 to 1.28
✓	Page 1.31 to 1.37
✓	Page 1.40 to 1.41
DATE: 5/8/98	

The invention relates to a rotor movement sensing system and method adapted for use in a postage meter having a rotor for printing postage by cyclic rotation thereof.

In any electronic postage meter it is important that the electronic registers faithfully reflect the actual mechanical printing of postage by the print rotor. In nearly all instances of the printing of postage, electric power is available for the entirety of the print cycle and the processor, which controls and monitors printing of postage, is able to decrement and increment the descending and ascending registers accordingly.

Most of the time, when the rotor is not in motion (because it is not printing postage) the rotor is in or very near to a "home" position. It is standard to have a sensor that indicates to the processor that the rotor is in the home position. A typical sensor arrangement is to place a permanent magnet on a disk attached to the rotor shaft. A Hall-effect sensor is positioned so that the sensor is "on" when the rotor is in its home position. If a print cycle is in progress, the processor can confirm the completion of the

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cycle by sensing the return of the rotor to the home position.

It is also standard to have a ratchet or other mechanical arrangement coupled to the rotor shaft so that the rotor cannot be moved very far backwards. However, a number of design constraints limit how tightly the ratchet performs its task. For example, at the end of a print cycle, it is not uncommon that the rotor may reach the home position (as expected) but may also go slightly past the home position due to rotational inertia or due to drag from a large item being franked. If the meter is to be satisfactory to the user, the ratchet must permit the slight reverse rotation back to the home position.

The design of the meter must necessarily take into account, however, the prospect that power may fail unexpectedly. The processor may thus be in the situation of not having quite enough information to distinguish whether or not a print cycle has occurred. For example, one of the indications to the processor that a print cycle has begun is the home sensor turning off. This indicates that the rotor has moved from the home position. But if power is lost after the home sensor has turned off, then later when the processor again has power the processor may find that the home sensor is again on. This could have happened, however, due to either of two mechanical sequences.

On the one hand, the rotor may indeed have printed a print cycle, finished while processor power was absent. This would result in the home sensor again being on.

On the other hand, the rotor might merely have moved slightly past the home position, and then dropped backwards again to the home position, all while processor power was absent. This, too, would result in the home

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sensor again being on. This slight forward-and-back movement could, as described above, arise due to a slight overrun of a previous print cycle.

The difficulty, however, is that without more information the processor is not capable of distinguishing which mechanical sequence actually occurred. There is the difficulty, then that the meter designer would not know whether or not to program the processor to increment and decrement the ascending and descending registers in the face of such sensor inputs. This presents the possible problem that the amount of postage actually printed may fail to correspond perfectly with the information in the descending and ascending registers.

One prior-art approach to this problem is that found in U.S. Pat. No. 4,253,015 to McFiggans et al. ("the '015 patent"). As described in Figs. 1 and 3 of that patent, there is provided a counter gear 61 that is twice as large as a gear 60 on the rotor shaft; the counter gear 61 has an angular velocity at all times half that of the rotor (also called a "drum" in this patent). Depending on whether the rotor has finished an even-numbered or odd-numbered printing cycle, the counter gear 61 will be in one of two orientations. Two holes 62 and 63, located at different radii on the counter gear 61, will trigger one of two sensors 67 or 66 respectively, permitting the processor 120 to know whether the print cycle just finished was an odd-numbered one or an even-numbered one.

This approach has a number of drawbacks, chief among them that it requires a large counter gear which takes up space in the meter, which adds to the count of moving parts, and which adds to the inertial moment that must accelerate and decelerate with each print cycle. The

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approach degrades the mechanical reliability of the meter, adds to the parts and assembly cost, and adds to wear due to use.

Another approach is found in EP-A-0499725 which discloses an incremental position encoder providing quadrature output signals which contain information of the actual, incremental position of a print wheel.

It would thus be desirable to have a way of providing sensor information to the processor to resolve ambiguities regarding rotor movement during times when the processor has been unpowered, all without unduly degrading reliability and increasing parts and assembly cost.

The invention is defined in claims 1 and 8 and preferred features are recited in the claims dependent thereon.

In summary, the new rotor sensing concept employs changes to hardware and software of the meter.

In hardware, an additional sensor is provided to sense the magnet on the disk when the rotor is substantially past the home position. This additional sensor is positioned far enough past the home position that the above-mentioned ratchet will have ensured that the rotor must continue forward to completion of a print cycle. It would not, however, be workable simply to use a second Hall-effect sensor at this location, with the second sensor (like the home sensor) continuously monitored by the processor. The reason is that the time interval required for mechanical movement of the rotor to the second sensor would be long enough that power failure might render the processor incapable of detecting the output of the second sensor. To make the second sensor useful for its intended purpose, the second sensor is selected to be a so-called magnetic memory element ("MME") sensor. The MME sensor has

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a magnetic memory element with substantial magnetic hysteresis. When the disk magnet passes near the memory element, the memory element is magnetized. The magnetization of the memory element persists long after the permanent magnet of the disk has passed. A Hall-effect sensor is positioned at the memory element so that it provides a signal to the processor indicative of the magnetization of the memory element. Preferably the signal is provided to the processor both as a discrete (polled) input and also as an interrupt. A solenoidal winding is provided around the memory element. The processor has an output which, when asserted, causes a substantial current to flow through the winding, whereby the memory element is demagnetized.

In another embodiment of the invention, a reed switch is employed to sense movement of the rotor past a particular angular position. A flip-flop provides a bistable means backed up by a lithium cell or other reliable source of power, and the output of the flip-flop provides a datum for the processor.

Several changes are made in software to effect the new rotor sensing concept. An interrupt routine is provided responsive to the signal from the second sensor, so that during a routine franking cycle the processor responds to the interrupt, makes record in nonvolatile memory of the occurrence of the printing cycle, and energizes the winding. This interrupt routine is executed for each franking cycle when power is continuously available, which is the normal and expected situation.

Of course, the remaining situation to be provided for in software is the application of power to the processor under circumstances where there is reason to suspect that a print cycle took place during a power outage. The power-up

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routine of the software, then, has a step of noting whether the second sensor is on. If it is, then the processor assumes (and this assumption is one in which the designer has high confidence) that a printing cycle did take place. The processor then clears the memory element by energizing the winding, and makes record of the printing cycle in nonvolatile memory.

The invention can be put into practice in various ways an embodiment of which will now be described by way of example with reference to the accompanying drawings, in which:

Fig. 1 shows the rotor shaft, disk, and the home and MME sensors;

Fig. 2 shows the home sensor;

Fig. 3 shows the MME sensor;

Fig. 4 is a timing diagram for signals to and from the sensors;

Fig. 5 shows a symbolic equivalent for the MME sensor;

Figs. 6-9 are flowcharts showing various software provisions relating to the MME sensor;

Fig. 10 shows an overall processor system configuration;

Fig. 11 shows a reed-switch embodiment of the invention in side view;

Fig. 12 is a schematic diagram of the reed-switch embodiment; and

Fig. 13 is a timing diagram for the reed-switch embodiment.

An overview of the postage meter in accordance with the invention is shown in Fig. 10. Processor 70

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controls nearly all functions of the meter, responding to user inputs at keyboard 72 and providing information to the user at display 71. The processor 70 is operatively coupled to the keyboard and display by digital bus 79, which also provides operative coupling to memory 73, I/O ports 74, and other devices omitted for clarity from Fig. 10. Postage is printed by a rotation of print drum or rotor 77, which contains print wheels settable under processor control by setting means, not shown in Fig. 10 for clarity. Mechanical locking, also omitted for clarity from Fig. 10, is provided so that when the rotor 77 moves away from the home position the print wheels are locked into place. As a result, if a print cycle is found to have occurred during a time of loss of power, due to the locking there is little doubt about the position of the print wheels, and thus little doubt about the amount of postage that was printed. Ratchet means, also omitted for clarity from Fig. 10, limits the extent to which rotor 77 may be moved in a direction other than that shown. The rotor turns on shaft 14, which is held by journal and thrust bearings, not shown.

In Fig. 10, disk 13 may be seen, preferably positioned at the other end of shaft 14. Sensors 11 and 17 are disposed near the disk 13. Sensor 11, the "home" sensor about which more will be said below, gives a discrete input via line 75 to one of the input lines at the I/O ports 74. Sensor 17, the MME sensor about which more will be said below, gives a discrete input via line 76 to one of the input lines at the I/O ports 74, and also preferably provides an interrupt to the processor 70.

Turning now to Fig. 1, the disk 13 is seen in plan from a point of view at the rotor 77 (not shown in Fig. 1). It will be appreciated that due to the change in point of view, the normal direction of rotation for disk 13 as shown in Fig. 1 is counterclockwise. Shaft 14 is shown in cross

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section. Hall-effect sensor 11 defines a "home" position on disk 13, and permanent magnet 10 is located on disk 13 proximate to sensor 11. A second sensor 17, the MME sensor, is positioned as shown.

Fig. 2 shows sensor 11 in a section taken through disk 13. Sensor 11, which as mentioned above is preferably a Hall-effect sensor, is preferably mounted to a printed circuit board 15 and, when the rotor is in the home position, permanent magnet 10 is quite nearby. Fig. 3 shows sensor 17 in a section parallel to but displaced from the section of Fig. 2. Sensor 17 is likewise preferably mounted to the same printed circuit board 15. In this figure disk 13 is shown having rotated so that magnet 10 is nearby to sensor 17; it will be appreciated that Figs. 2 and 3 show things that do not happen simultaneously since magnet 10 cannot simultaneously be adjacent to both sensors 11 and 17.

The second sensor 17 differs from home sensor 11 not only in its location but also in provision of the magnetic memory element (MME) 16, which has substantial magnetic hysteresis. When the disk magnet 10 passes near the memory element 16, the memory element 16 is magnetized. The magnetization of the memory element 16 persists long after the permanent magnet 10 of the disk 13 has passed. The Hall-effect sensor 17 is positioned at the memory element 16 so that it provides a signal to the processor 70 (not shown in Fig. 3) indicative of the magnetization of the memory element 16. In Fig. 3 may also be seen a solenoidal winding 18 around the memory element 16. The processor 70 has an output 80 (shown in Fig. 10) which, when asserted, causes a substantial current to flow through the winding 18, whereby the memory element 16 is demagnetized.

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It will be appreciated by those skilled in the art that design considerations may prompt any of a number of locations for the sensors 11, 17 and magnet 10. Cost is reduced if a circuit board 15 is already nearby, so that the sensors 11, 17 may be mounted directly to that circuit board 15, providing both mechanical mounting and electrical connections. This also prompts placing the sensors 11, 17 in a plane parallel to a main plane of the chassis of the meter, so that both may be placed on a single circuit board 15 rather than on two separate circuit boards. The elevation of the single circuit board 15 and the diameter of the disk 11 are chosen so as to make angle θ , shown in Fig. 1, as large as desired. Angle θ is selected to satisfy a number of constraints including that the angle be great enough that the ratchet does not permit a backwards movement of the rotor 77 back to the home position.

Turning now to Fig. 4, there is shown a timing diagram for various of the signals of the rotor sensing concept. The top line shows the output of sensor 11, which is high when the rotor begins in a home position, and is again high when the rotor has returned to a home position at 22. The duration of one complete print cycle is thus seen to correspond to interval 20. Those skilled in the art will appreciate that the high output of sensor 11 may persist for a long time if a long time passes between franking cycles, as will sometimes happen during the course of a day. Those skilled in the art will also appreciate that the rise and fall of the signal from sensor 11 do not coincide precisely with the rotor's being in the home position. Rather, to allow for some variation in the magnet, the Hall-effect sensor, and their geometric relationship, the system is set up so that the rise of the signal precedes the arrival of

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the rotor at the home position, and so that the fall of the signal follows the departure of the rotor from the home position.

The next line shows the output of the sensor 17. At 21, the output rises, which means the rotor has moved by approximately the angle 91 so as to bring magnet 10 nearby to sensor 17. In the normal course of events (that is, in the absence of loss of power) the processor 70 will receive an interrupt at time 21. Then, at time 23, processor 70 generates the current pulse to winding 18 (see Fig. 3) via line 80 (see Fig. 10). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be an interval determined by the downgoing transition 25 as detected by the processor.

Fig. 5 shows in functional block form an equivalent circuit for the sensor shown in Fig. 3. The sensor is not, of course, a counter because it does not distinguish between successive print cycles. If it were to indicate a high level, the high level would only indicate that at least one print cycle had occurred but would not provide any count of print cycles. The sensor may be thought of as a D-type flip-flop which is set at 10', reset by 18', and providing an output at 17'. The block 16' is comparable to the memory element 16 with its hysteresis which gives rise to bistability.

Those skilled in the art will readily appreciate that numerous variations could be devised to embody the invention without deviating from it. For example, instead of using a magnet and a magnetic memory element, one could use a mechanical latch that is triggered by rotor movement

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through angle 91. The latch would be coupled to a switch. Triggering of the mechanical latch would give rise to a switch signal like that of sensor 17. The mechanical latch would be made so as to be resettable, as by energizing a solenoid to move the mechanical latch back to its reset position. Generally, one skilled in the art could employ any bistable device that is set by movement of the rotor past a predetermined angle, and that is capable of being reset by an electrical signal.

It will also be appreciated that while the sensor is depicted herein as coupled directly with the rotor, it would be possible to couple the sensor in any of a range of indirect means, including coupling to any indicator of rotor movement. Other means that are thought inferior to the disclosed embodiment but nonetheless within the scope of the invention would include: coupling the sensor to rollers elsewhere in the envelope feed path; coupling the sensor to movement sensing means elsewhere in the feed path; and coupling the sensor to mechanical elements that are in turn coupled to the rotor.

The software of the rotor sensing system, stored in memory 73 shown in Fig. 10, will now be discussed.

Fig. 6 shows in block diagram form the main routine that is being executed most of the time when the meter is powered. As will be appreciated, the main routine repeats itself over and over again. Loss of repetition of the main routine is preferably detected and remedied by a watchdog circuit, not shown. Dashed line 51 portrays the shift in program flow that occurs if an interrupt is received at the processor 70 via line 76 from sensor 17. At 52 a nonvolatile record is made of the occurrence of the franking cycle. At 53 the processor energizes the winding

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18, after which execution returns to the main routine 50 where it was interrupted.

Those skilled in the art will appreciate the normal and standard steps taken in the interrupt service routine of blocks 52 and 53. The first instruction of the routine is preferably disabling interrupts, followed by a masking of selected interrupts including the sensor-17 interrupt, followed by a re-enabling of interrupts. After the winding 18 has been energized, the sensor-17 signal is tested, and barring the unexpected persistence of the sensor-17 signal, the sensor-17 interrupt is again unmasked and/or re-enabled.

Those skilled in the art will also appreciate that nothing in the rotor sensing system requires that resetting of the MME 16 by energizing winding 18 take place prior to the end of the print cycle. While the resetting is so portrayed in Fig. 4 and in Fig. 6, the system could just as well permit these tasks to wait until after the rotor has again returned to its home position without deviating in any way from the system concept.

In contrast to the normal, fully-powered circumstance of Fig. 6, routines will now be described to provide for the possibility that at the time of power-up, a print cycle may have taken place. At Fig. 7, the meter's software with respect to powerup is shown in one embodiment. At 55, interrupts are disabled. At 54, the meter is initialized, preferably including a test of the print wheels of rotor 77 to determine what positions they were in. The print wheel positions are noted for later reference, and are compared with what the processor had noted the print wheel positions to be prior to the last previous loss of power. At 57, the processor 70 polls the condition of the MME

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sensor 17 via line 76 (Fig. 10) and I/O port 74. At 58, a branch is made in the normal case, namely if no unaccounted-for print cycle has been detected, namely a jump to block 56. If, however, an unaccounted-for print cycle has been detected (as indicated by MME sensor 17), then blocks 52 and 53 are executed analogously to like-numbered blocks of Fig. 6. (Those skilled in the art will also appreciate that it may be helpful for troubleshooting or maintenance to make a nonvolatile record of the occurrence of power-up together with the sensor 17 having been set.) Block 56 re-enables interrupts, and control passes to the main routine of Fig. 6.

Fig. 8 shows the software configuration if a different approach is taken than that of Fig. 7. In Fig. 8, no attempt is made to disable interrupts. Instead, the signal from sensor 17, which is present from the moment of power-up, causes an interrupt to occur quite early on in processor execution of the initialization routine 54. The interrupt branches via 51 and the interrupt servicing routine of blocks 52 and 53 takes place much as in Fig. 6. Eventually control returns to the initialization routine 54 and eventually passes to the main routine of Fig. 6.

Fig. 9 shows yet another software configuration if a different approach is taken than that of Figs. 7 and 8. In box 55 interrupts are disabled, and in box 54 the meter is initialized. In box 56 interrupts are re-enabled and control may pass to the main routine of Fig. 6. But if the signal from sensor 17, which may happen to be present from the moment of power-up, is present, then this causes an interrupt to occur right away after block 56, essentially at the start of the main routine of Fig. 6. There, the interrupt branches via 51 and the interrupt servicing

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routine of blocks 52 and 53 takes place. Eventually control returns to the main routine of Fig. 6.

In an alternative embodiment of the invention, a reed switch is employed to sense movement of the rotor past a particular angular position. A flip-flop provides a bistable means backed up by a lithium cell, and the output of the flip-flop provides a datum for the processor. Fig. 11 shows the switch arrangement relative to the rotor 13, with magnet 10, Hall-effect switch 11, and reed switch 17, all mounted to a printed circuit board, omitted for clarity in Fig. 11. The elements of Fig. 11 correspond to those of Fig. 1 for the embodiment previously discussed.

Fig. 12 is a schematic diagram for the alternative embodiment. During normal operation the circuit is powered by the same +5V source 110 that powers the rest of the meter. Lithium cell 112, preferably a 3.4 V cell, can also power the circuit reliably; isolation is provided by diodes 111, 114 and the power is smoothed by electrolytic capacitor 115. Optionally lithium cell 112 may also provide data backup for RAM, not shown in Fig. 12, via line 113.

Capacitor 121, preferably a highly stable capacitor, is charged through resistor 117. If magnet 10 nears reed switch 17, capacitor 121 is discharged through resistor 120. This defines high and low outputs on line 124, which serves as a setting input to an RS flip-flop composed of nand gates 118, 119. Nand gates 118, 119 are powered by line 116. As a consequence, the state of the flip-flop is preserved despite any changes in the level of the +5V power supply at 110. The flip-flop, which is of course a bistable device, receives a reset input via line 80 from an output of the I/O port 74, part of which seen at the lower left of Fig. 12. The output of the flip-flop is

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provided via line 76 to an input of the I/O port 74, another part of which is seen at the lower right of Fig. 12. Hall-effect sensor 11 also provides an input via line 75 to an input of the I/O port 74.

It will be appreciated that in Fig. 12, the interrupt to the processor is not from the sensor 17 but rather from the sensor 11. This differs from the embodiment disclosed above, in which the interrupt comes from the sensor 17. Those skilled in the art will appreciate that either embodiment could, in principle, use either sensor to provide an interrupt to the processor without deviating in any way from the invention.

Fig. 13 shows a timing diagram for signals occurring during rotor rotation in the alternative embodiment. The diagram corresponds in many ways to the timing diagram of Fig. 4 for the first embodiment. The top line shows the output of sensor 11, which is high when the rotor begins in a home position, and is again high when the rotor has returned to a home position at 22. The duration of one complete print cycle is thus seen to correspond to interval 20.

The next line shows the output of the sensor 17. At 21, the output falls, which means the rotor has moved so as to bring magnet 10 nearby to reed switch 17. Then, at time 23, processor 70 generates the reset signal via line 80 (see Fig. 12). The interval between 21 and 23 is mostly a result of the latency time of the interrupt-handling routine of the processor. The pulse is held until time 24, which may be a fixed interval or may be an interval determined by the downgoing transition 25 as detected by the processor.

If the system has the interrupt coming from the sensor 11 instead of the sensor 17, this changes in particular detail some of the software-driven activities of Figs. 6-9. In Fig. 6, the arrival of the interrupt at 51 prompts making a nonvolatile record that it was suspected a franking had occurred (to provide for the case where power fails while the rotor continues to move). If, while the software is in block 52, the second switch 17 is triggered, then the reset pulse of line 80 is generated in block 53, and the nonvolatile record is updated to show the normal and tidy progress of the franking activity.

If the software arrangement of Fig. 7 is considered, it will be seen that the polling of the flip-flop contents (block 57) suffices to determine that the sensor 17 must have been triggered at some time prior to the present instance of power having been applied. Thus it is assumed that franking took place, and the reset pulse of line 80 is generated in block 53.

In the case now being discussed where the output of the bistable device does not generate an interrupt, then the software arrangement of Figs. 8 and 9 is inapplicable.

Those skilled in the art will appreciate that while the circuit is shown using a reed switch and a Hall-effect switch, other sensing technologies could be used without departing from the invention. Likewise, numerous other bistable storage technologies could be employed other than the particular nand-gate flip-flop shown in Fig. 12.

Those skilled in the art will readily appreciate that while the steps described above are described as occurring in software that is executed by a processor, the steps could just as well be accomplished by random logic circuitry dedicated for that purpose.

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CLAIMS

1. A rotor movement sensing system adapted for use in a postage meter having a rotor (77) for printing postage by cyclic rotation thereof, and having a register relating to postage printed by the rotor, the rotor position between postage printing cycles defining a home position, characterized in that the sensing system comprises:

bistable means (16, 16') having an output (Q) (17, 17'), a setting input (10, 10') and a resetting input (R) (18, 18'), the setting input operatively coupled to the rotor (77) so as to set the bistable means upon rotation of the rotor by a first predetermined angle past the home position, and

means responsive to the output of the bistable means (16, 16') for changing the register contents and for actuating the resetting input.

2. The rotor movement sensing system of claim 1 wherein:

the bistable means comprises a magnetic memory element (16), a Hall-effect sensor (17) and a solenoid (18) adjacent to the magnetic memory element,

the setting input comprises a permanent magnet (16) operatively coupled with the rotor,

the output comprises the output of the Hall-effect sensor (17), and

the resetting input comprises leads of the solenoid (18).

3. The rotor movement sensing system of claim 1 wherein:

the bistable means comprises a flip-flop (16'), with a reliable source of



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power,

the setting input comprises a permanent magnet (10') operatively coupled with the rotor,

the output comprises the output of the flip-flop (Q), and

the resetting input comprises a signal (18') to a reset input of the flip-flop

4. The rotor movement sensing system of claim 1, 2 or 3 wherein:

the means responsive to the output of the bistable means (16, 16')

comprises a microprocessor executing a stored program.

5. The rotor movement sensing system of claim 1,2,3 or 4 further comprising ratchet means operatively coupled with the rotor whereby the rotor cannot move oppositely to the direction for printing postage by more than a second predetermined angle, and wherein the first predetermined angle is selected to be greater than the second predetermined angle.

6. The rotor movement sensing system of claim 4 or 5 wherein the output further comprises an interrupt to the processor, and wherein the stored program further comprises an interrupt routine.



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7. A rotor movement sensing system of any of claims 1 to 6, further including means responsive to application of power to the meter for making record of the occurrence of the output being present upon the application of power.

8. A method adapted for use in a postage meter having a rotor (77) for printing postage by cyclic rotation thereof, and having a register relating to postage printed by the rotor, the rotor position between postage printing cycles defining a home position, characterized in that the sensing system comprises bistable means (16, 16') having an output (Q) (17, 17'), a setting input (10, 10') and a resetting input (R) (18, 18'), the setting input being operatively coupled to the rotor whereby the method comprises the step of setting the bistable means upon rotation of the rotor by a first predetermined angle past the home position, and further comprises the step of changing the register contents and actuating the resetting input in response to the output of the bistable means (Q) (16, 16').

9. The method of claim 8 including the further step of applying power to the meter and determining the state of the output and if the output is present changing the register contents and actuating the resetting input.

10. The method of claim 8 or 9 wherein the bistable means comprises a magnetic memory element, and a Hall-effect sensor and a solenoid adjacent the magnetic memory element, the setting input comprises a permanent magnet operatively coupled with the rotor, and the output comprises the output of the Hall-effect sensor, the step of actuating the resetting input further comprising the step of applying current to the solenoid.

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11. The method of claim 8 or 9 wherein the bistable means comprises a flip-flop with a reliable source of power, the setting input comprises a permanent magnet operatively coupled with the rotor, and the output comprises the output of the flip-flop, the step of actuating the resetting input further comprising the step of applying voltage to a reset input of the flip-flop.

12. The method of any of claims 8 to 11 wherein the determining step further comprises the step, if the output is present, of making record of the occurrence of the output being present upon the application of power.

13. The method of any of claims 8 to 12 wherein the meter further comprises a processor, and the output further comprises an interrupt to the processor, and wherein the method further comprises responding to the interrupt.



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ABSTRACT

ROTOR MOVEMENT SENSING SYSTEM

A rotor movement sensing system is provided for use in a postage meter to permit detection of the printing of postage even in the event that power is lost during the printing cycle. A sensor is provided to sense the magnet on a disk when the rotor is substantially past its home position. When the disk magnet passes near a memory element, the memory element is magnetized. A Hall-effect sensor is positioned at the memory element so that it provides a signal to the processor indicative of the magnetization of the memory element. A solenoidal winding is provided around the memory element. The processor has an output which causes a current to flow through the winding, whereby the memory element is demagnetized. A flip-flop provides a bistable latch backed up by a lithium cell, and the output of the flip-flop provides a datum for the processor.

FIGURE 10

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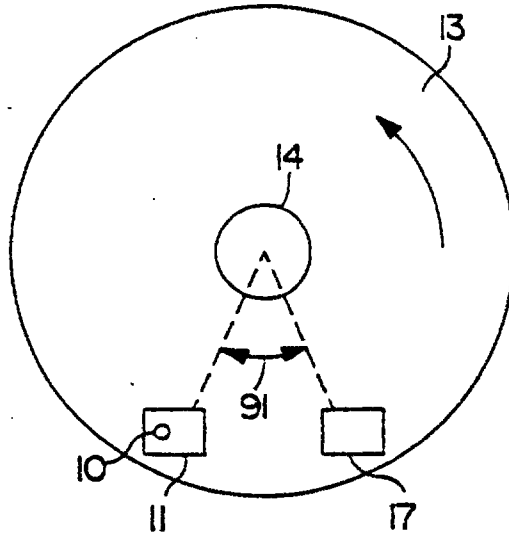


FIG. 1

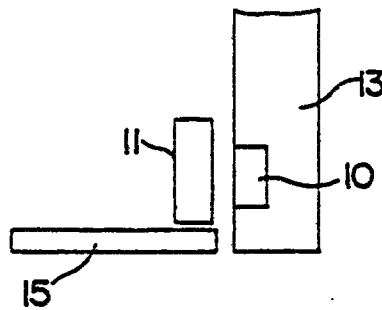


FIG. 2

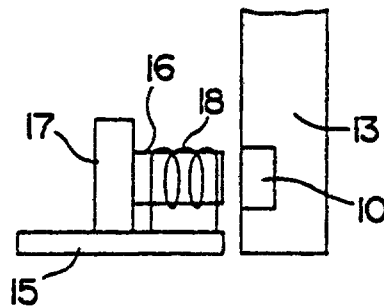


FIG. 3

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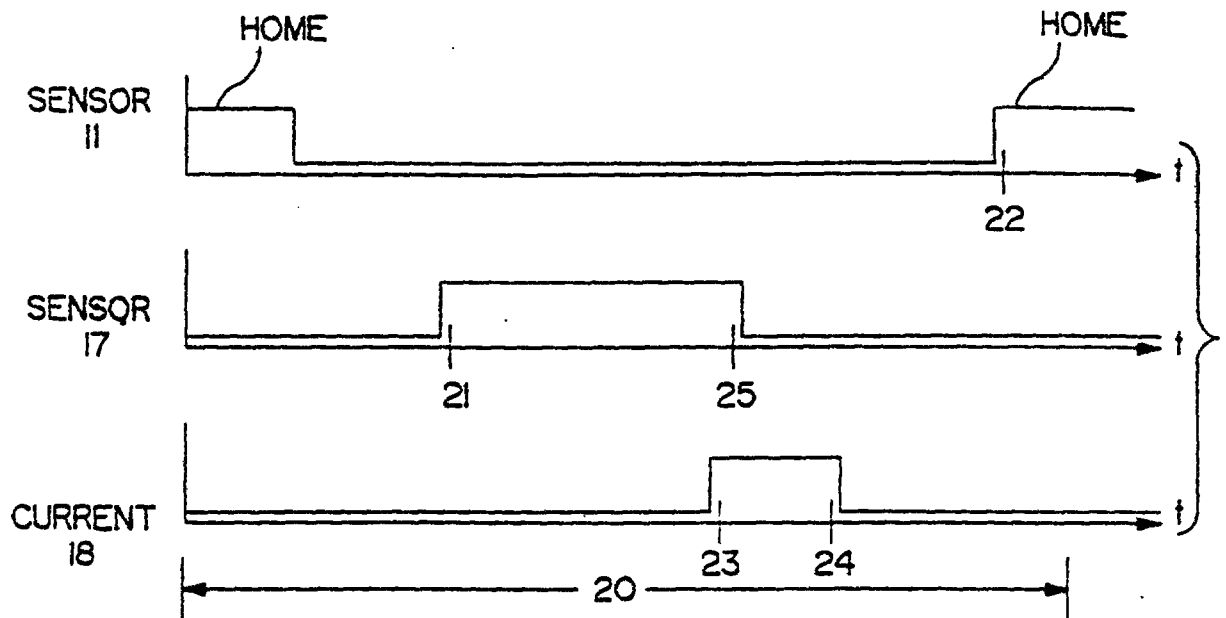


FIG. 4

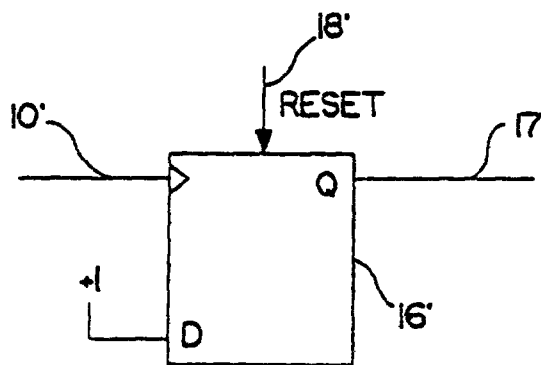


FIG. 5

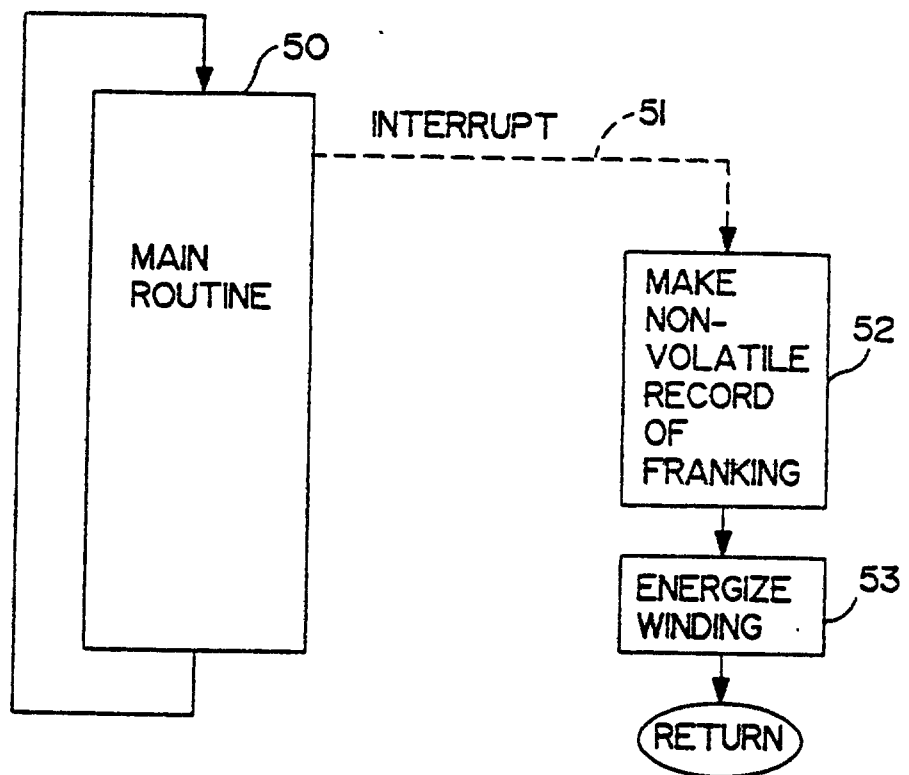


FIG. 6

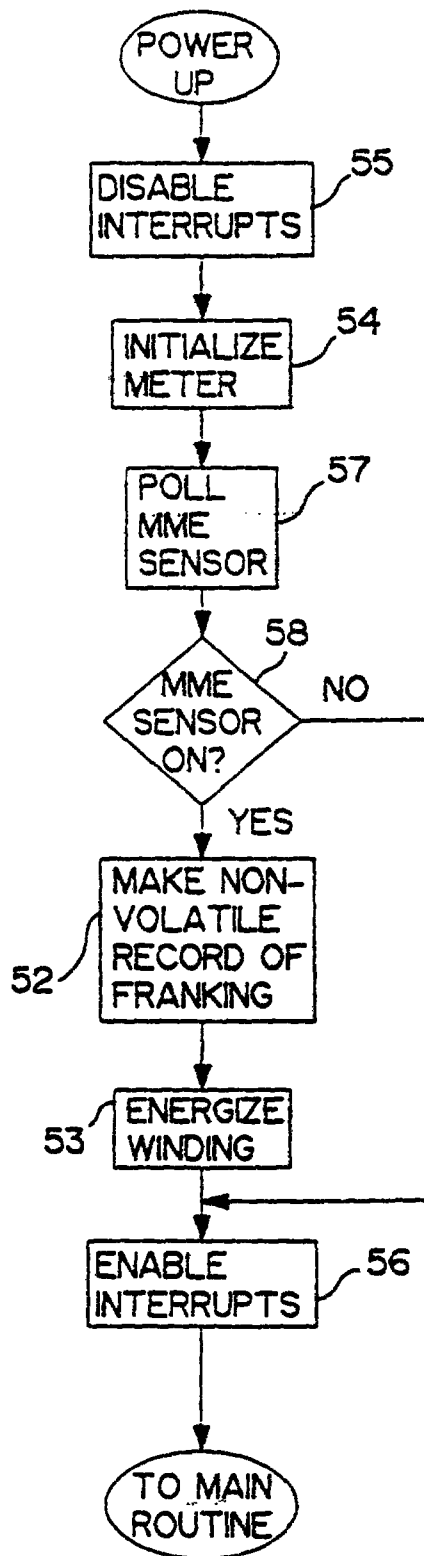


FIG. 7

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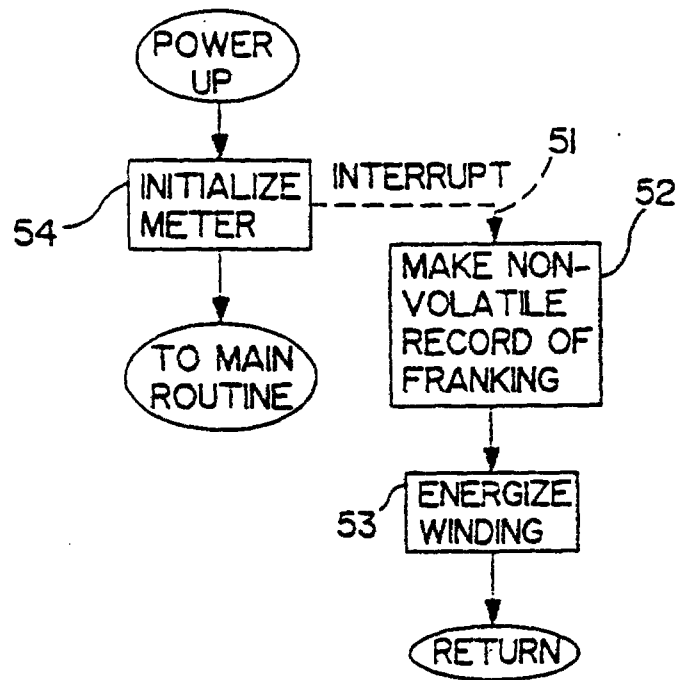


FIG. 8

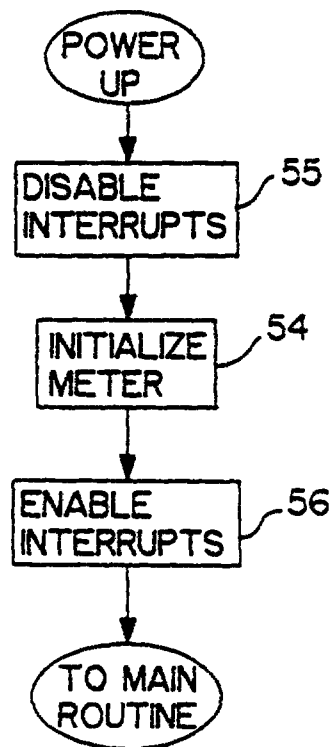


FIG. 9

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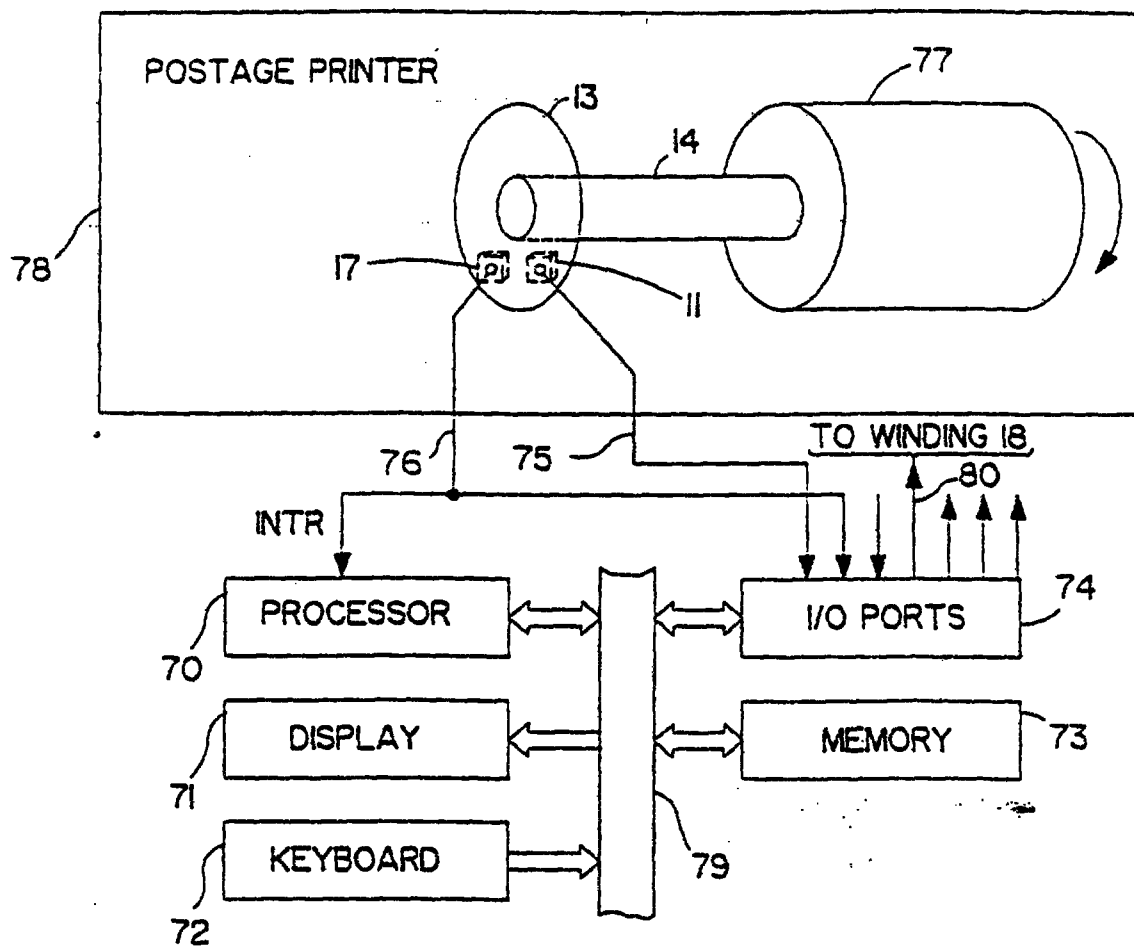


FIG. 10

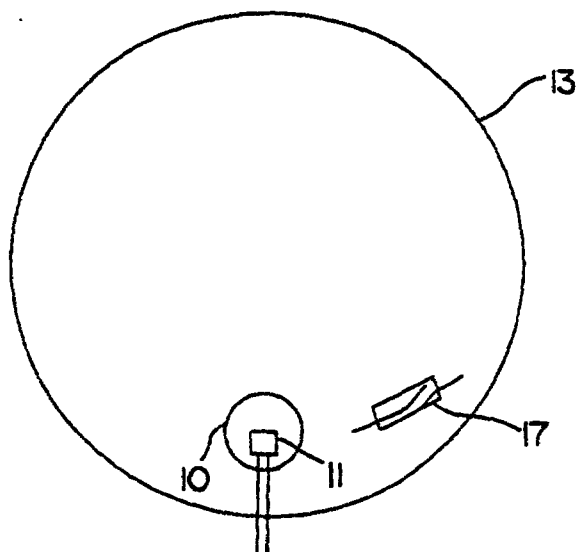


FIG. 11

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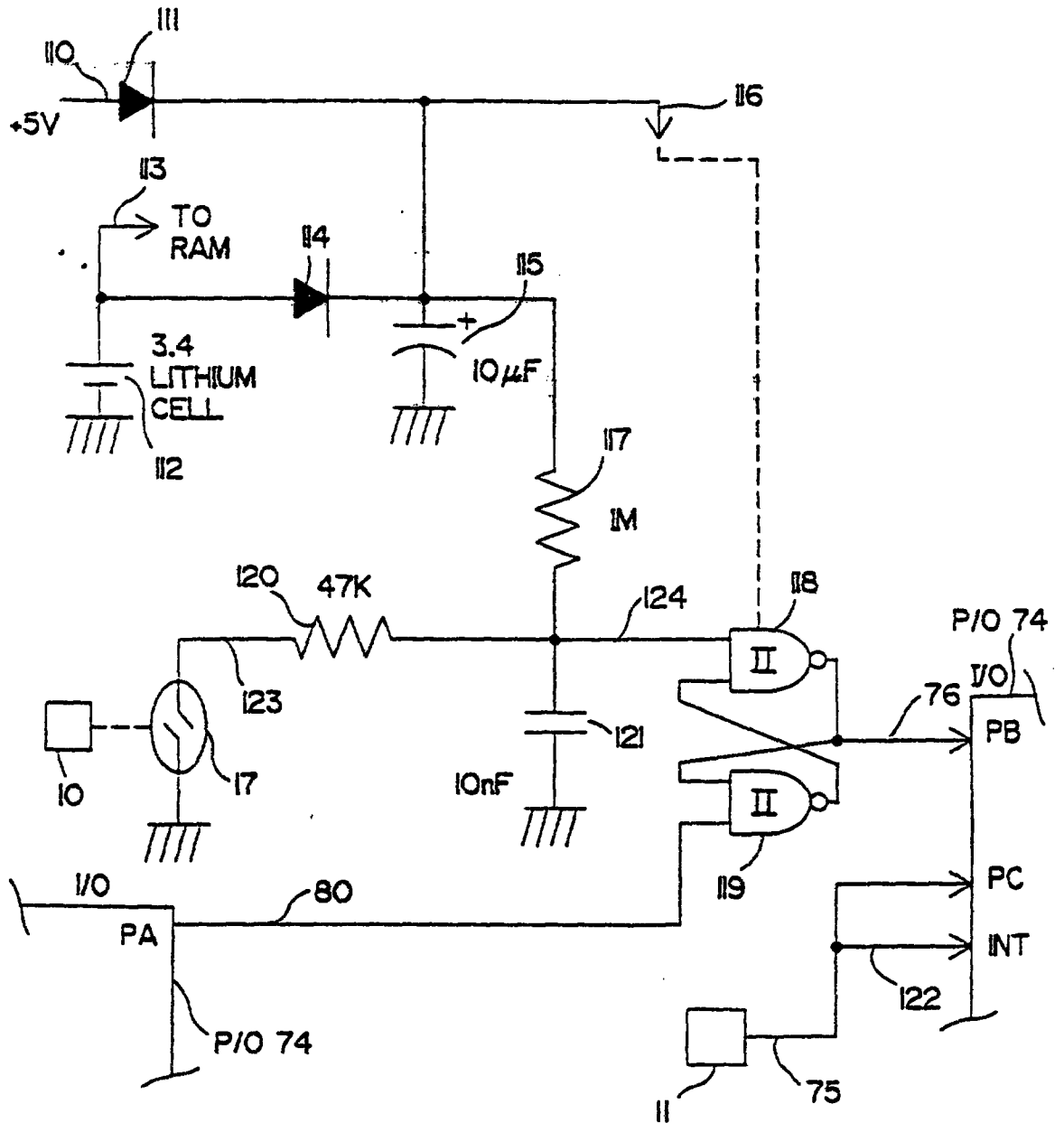


FIG. 12

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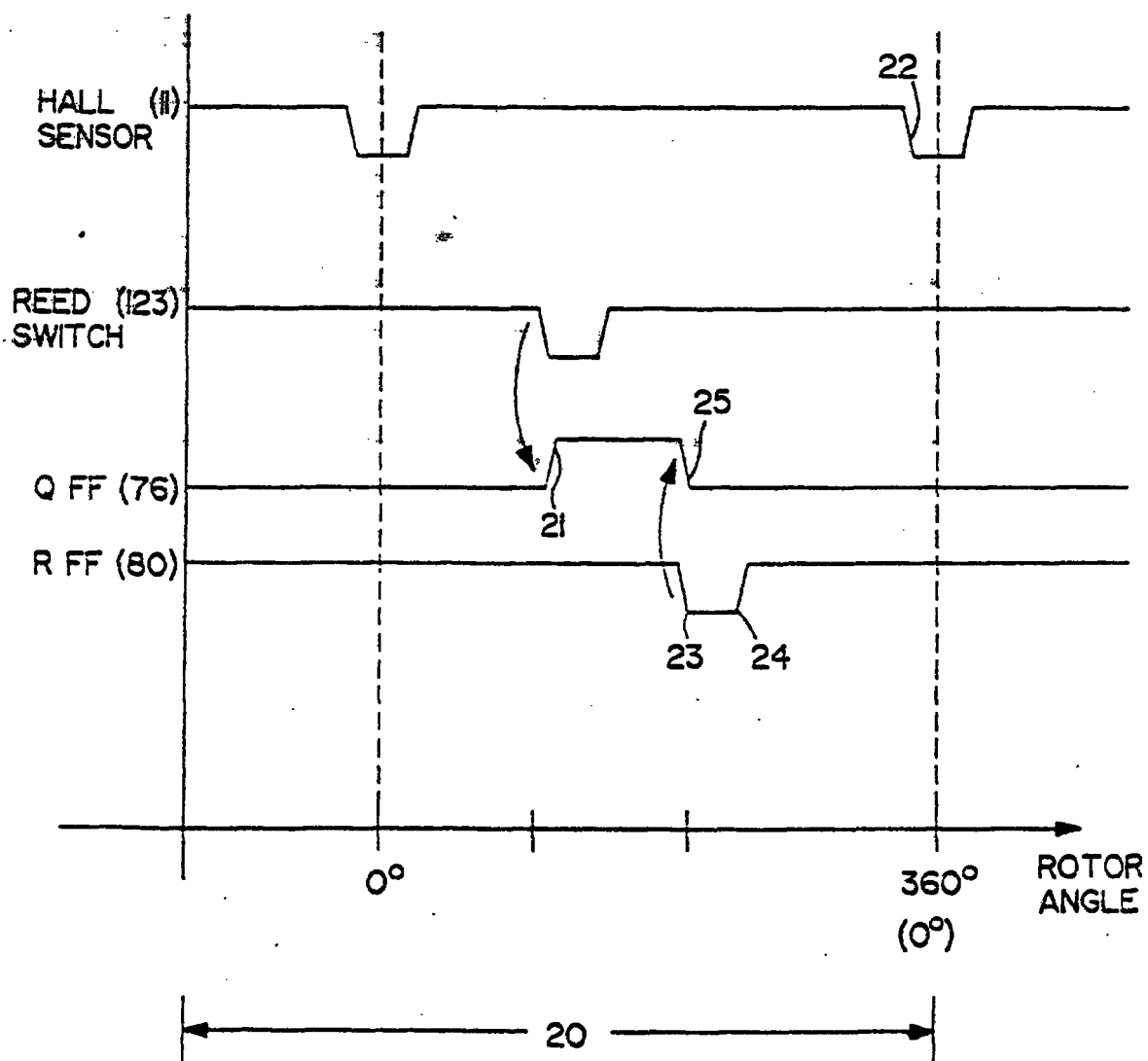


FIG. 13

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