METHOD AND APPARATUS FOR USE IN AN INDUCTIVE SENSOR COIN SELECTOR

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Field of Search ..................... 209/111.6, 81 R, 81 A; 73/163; 194/97 R, 100 R, 100 A, 1 K, DIG. 15; 324/41 R

References Cited
UNITED STATES PATENTS
2,690,258 9/1954 Cox.............................. 209/111.6

ABSTRACT

A method and apparatus for use in an inductive sensor coin selector in which the acceptability of a coin is dependent upon a function of an examination of the output of an inductor in the absence of coins and an examination of the output of the inductor in the presence of the coin.

27 Claims, 4 Drawing Figures
METHOD AND APPARATUS FOR USE IN AN INDUCTIVE SENSOR COIN SELECTOR

We have found in discriminating between coins, tokens and the like in a coin selector by means of an inductive sensor that practical improvement in discrimination can be achieved by producing a function dependent upon both the information produced by the sensor in the presence of the coin and the information produced by the sensor at a slightly earlier or later time when no coin is in the presence of the sensor, and then comparing the value of this function with values for acceptable coins.

According to the method of our invention, the coin or other object to be tested is caused to pass along a known path past one or more poles of an inductor on the one side of the path. The method further comprises the steps of examining a characteristic of the inductor output signal in the absence of coins from the presence of the sensor, examining the same characteristic with a coin in the presence of the sensor, producing a signal which is a function of these two examinations, and producing a signal indicative of the acceptability of the coin tested. As a further development in our method, at the point where the coin is caused to pass the inductor on one side of the path, the coin is caused to pass between that inductor and an electrically conductive target on the other side of the path.

The method of our invention tends to minimize errors resulting from shifts in value of the reference standards upon which the coin examination depends, such as oscillator idling frequency, the duration of pulse counting periods and the like. The method employing the step of passing the coin between the sensor and a target is particularly useful in minimizing errors caused by variations in the physical position of the sensor relative to the passageway, as in apparatus, where the sensor is mounted on a moveable passageway sidewall. Our invention also comprises the combination of elements of a coin selector apparatus as described below.

In the drawings:

FIGS. 1 and 2 show a front schematic and a side schematic view (cutaway along line 2—2 of FIG. 1) of a portion of a coin selector apparatus according to our invention.

FIG. 3 is a block diagram of an embodiment of our invention.

FIG. 4 is a block diagram of another embodiment of our invention.

The figures are intended to be representational and are not necessarily drawn to scale.

Throughout this specification the term "coin" is intended to mean genuine coins, tokens, counterfeit coins, slugs, washers, and any other item which may be used by persons in an attempt to use coin-operated devices.

In the apparatus of FIG. 2, an inductor 20 having one or more pole pieces 22 is located on one side of a coin passageway 30. The passageway 30 is defined by two sidewalls 32 and 34, and a coin track 36 attached to a sidewall 34. Sidewall 32 is fixed to the rest of the coin discriminator apparatus and sidewall 34, on which inductor 20 is mounted, is attached to the remainder of the apparatus by a hinge 35. Sidewall 34 is movable, to permit cleaning the interior of the passageway 30 and removing of accidentally jammed coins or objects.

Opposite the inductor 20 embedded in or on the inner surface of the sidewall 32, on the other side of the passageway 30 from the inductor 20, is a conductive target 40 such as a thin disc of copper or other highly conductive material. In the absence of coins and other objects from the vicinity of the inductor 20 in the passageway 30, the signal across the inductor terminals is affected by the presence of target 40. If sidewall 34 varies in position with respect to sidewall 32, that signal will vary as a function of the relative locations of the inductor 20 and the target 40. Details regarding the choice of a suitable inductor 20 and a circuit in which such an inductor may be used may be found in British specifications 16538/71 and 8385/72, and U.S. Ser. No. 405,881, filed Oct. 12, 1973, now U.S. Pat. No. 3,870,137 which is a continuation of U.S. Ser. No. 255,814, filed May 22, 1972 assigned to the assignee of this patent, now abandoned.

In FIG. 3, the inductor 320 is connected to an examining station circuit 350 in such a manner that the output of the station 350 is a function of material in the field of the inductor 320. When a target 340 is located across the passageway 330 from the inductor 320, the output of the station 350 is modified in an amount dependent upon the relative positions of the sidewalls 332 and 334. The target 340 need not be included in the apparatus if dependence upon relative side wall positions is not desired. The output of the station 350 is applied to both switching means 362 and 364, as is a sequence of time pulses from time pulse generator 360. When a coin examination is in progress, and at all other times except when the Q output of monostable 361 is producing a pulse, switching means 362 is enabled by the Q output of monostable 361; causing the output of station 350 to be directed to register 371 for the duration of the time pulse. Function circuit 385 produces a value which is a function of the test value which is stored in the register 371 and of the reference value which is stored in the register 370 as representative of the output of station 350 when no coin was present in the apparatus. That signal from the function circuit 383, which may for example be the arithmetic difference between counts stored in registers 370 and 371, is transmitted to the comparison and memory circuit 390. The comparison and memory circuit 390 contains information regarding values for valid coins and means for comparing such values with the values received from the function circuit 383. If the comparison and memory circuit 390 determines that such a received value is within the range for an acceptable coin, it produces a signal indicative of the fact that the coin being tested has passed the particular test. Further information about comparison and memory circuits suitable for use according to this invention may be found in an application Ser. No. 405,927 filed Oct. 12, 1973 and assigned to the assignee of this patent.

The reference value stored in register 370 is entered in the same manner as a test value is entered into register 371. The reference value is entered into register 370 at different times under control of the housekeeping circuit 365, OR gate 366, AND gate 367 and monostable 361. The housekeeping circuit 365 produces signals which are transmitted via the OR gate 366 and the AND gate 367 to trigger the monostable 361 as follows: when power is first applied to the coin selector each time a signal is received that the machine associated with the coin selector has been instructed to
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3 vend, and every one second. AND gate 367, however, receives a signal for the duration of the period from when the coin selector first senses the presence of a coin (arrival) to the departure of the coin, which inhibits the flow of triggering signals during that period. As a result, the reference value stored in register 370 will not include values influenced by the presence of a coin in the vicinity of a sensor. In a variation of this embodiment which is presently preferred, the reference value is stored when the housekeeping circuit 365 produces signals either approximately 300 milliseconds after power is first applied to the coin selector or approximately 300 milliseconds after an acceptable signal with respect to any denomination is received from a portion of the coin selector not dependent upon the reference value (e.g., a low frequency examination), followed by the absence of a coin accept signal (i.e.: a high frequency reject). The delay, which may be produced by the use of a counter within the housekeeping circuitry 365 to count pulses from the time pulse generator 360, assures a sharp, relatively noise-free pulse from the monostable 361 and, in the second case, assures that the coin leaves the system before the new reference value is entered. As a result, the reference value stored in register 370 will not include values influenced by the presence of a coin in the vicinity of a sensor.

In the event that a linear correction such as the one described above does not provide a satisfactory correction, for example, for variations in oscillator frequency due to variations in the relative position of the sidewalk 334 with respect to sidewalk 332 or other perturbations of the system, the value stored in the register 371 can be modified by a different mathematical function dependent upon the count stored in the register 370.

In one form of this embodiment implemented entirely with digital circuitry, the presence of conductive objects in the field of the inductor 420 causes a shift in the frequency of an oscillator comprising the station 350. Such an oscillator circuit is discussed in U.S. Pat. No. 3,870,137. The oscillator frequency is measured by use of precise duration time pulses from the time pulse generator 360 to gate pulses to digital counters comprising the registers 370 and 371. AND gates are employed for the switching means 362 and 364. The reference pulse which is stored is the difference (f-f0) between the peak frequency in the presence of a coin and the frequency in the absence of coins.

In another form of this embodiment, analog circuits can be used to perform at least some of the functions. For example, when the output of a coin examining station 350 which is indicative of the coin characteristic of interest is a variable amplitude voltage, the registers 370 and 371 may each comprise capacitor means for storing a peak voltage. The information may be converted to digital form at the output of the registers 370 and 371 or, as may be preferable in applying a complex function, the logic circuit 383 can be an analog circuit and its output can be converted to a digital signal for transmission to a digital memory system 390.

FIG. 4 is a block diagram of a digital circuit embodiment of the present invention. The inductor 420 and oscillator 450 and coin passageway details (not shown) may correspond to those of the embodiment of FIG. 3.

A timing pulse generating means 460 drives a flipflop 461 with a precision duration pulse via AND gate 463. In the example shown, the flipflop 461 is triggered at the end of each precision pulse period.

In the initial idling frequency monitoring mode of operation the flipflop 461 directs the output of the oscillator alternately to counter 470 or counter 471 for the precision pulse period, for example 1 millisecond. AND gates 462 and 464 are employed to switch the oscillator output between the counters and AND gates 466 and 468 are used to define the duration of the counting periods.

When no coin is in the vicinity of the inductor 420, one of the counters 470 and 471 stores a value representative of the output frequency of the oscillator 450, while the other is measuring the oscillator output signal. When the coin selector apparatus detects the arrival of a coin within the apparatus by arrival/departure detecting means 455, the details of which are not a part of this invention, an arrival signal is directed to AND gate 463 to inhibit that gate and stop the alternation between counters of the oscillator output signal. Instead, one of the counters 470 or 471 remains connected to receive and count the oscillator output signal for the precision pulse period, while the other continues to store the last count value, stored prior to the arrival signal. This stored value is representative of the idling frequency of the oscillator 450 just prior to the coin examination which is to follow. Alternatively, the idling frequency can be determined in the manner described for the apparatus of FIG. 3.

When the coin enters the field of the inductor, the oscillator frequency increases. During each subsequent precision pulse period, the comparison means 473 sets the flipflop 485 as soon as the pulse count of the frequency increases above the pulse count stored as representative of the idling frequency, and thereby activates AND gate 489. All of the remaining pulses from the oscillator 450 during that period are transmitted via OR gate 487 and AND gate 489 to the memory system 490 for comparison with information stored there regarding acceptable coins.

Following the end of each precision pulse period, during a brief interlude prior to the start of the next precision pulse period, a reset pulse is produced on lead 479 from the pulse generating means 460. It resets flipflop 485 and appropriate elements in the memory system 490. The reset pulse is also applied to gates 476 and 478, one of which is enabled by a signal from the flipflop 461 which controls which of the counters 470 or 471 is to count in the next period, causing only that counter to be reset.

When the coin departs from the coin selector apparatus, the arrival signal from the arrival/departure sensing means 455 ceases, AND gate 463 is no longer inhibited and the apparatus returns to the idling frequency monitoring mode of operation.

We claim:

1. A method for examining coins with respect to authenticity including the steps of producing an alternating magnetic field, subjecting a coin to the field, producing a first signal having a quality representative of the degree of interaction of the coin with the field, determining a first value of said quality at a time when no coin is in the presence of the field, determining a second value of said quality at another time when the coin is in the presence of the field,
producing a second signal having a value representative of a function which is dependent upon both the first value and the second value, and comparing the value representative of the function for the coin with a value representative of the function for an acceptable coin.

2. The method of claim 1 wherein the value representative of the function is the arithmetic difference between the first and second values.

3. A method for examining coins with respect to authenticity including
   producing an alternating magnetic field,
   subjecting a coin to the field,
   producing a first signal having a quality representative of the degree of interaction of the coin with the field.

   determining a first value of said quality at a time when no coin is in the presence of the field,
   determining a second value of said quality at another time when the coin is in the presence of the field
   storing one of the values,
   producing a second signal having a value representative of a function which is dependent upon both the first value and the second value, and
   comparing the value representative of the function for the coin with a value representative of the function for an acceptable coin.

4. The method of claim 3 wherein the value representative of the function is the arithmetic difference between the first and second values.

5. The method of claim 4 wherein the quality representative of the degree of interaction is the frequency of the magnetic field.

6. The method of claim 5 wherein the first and second values of the quality are each produced by counting the pulses of the field frequency, further including the step of storing one of said values for use in producing the second signal.

7. The method of claim 6 wherein values representative of the function for the coin are produced throughout the period during which the coin is subjected to the field further including the step of determining whether the coin is acceptable only if the largest of said values is within predetermined limits for acceptable coins of a given denomination.

8. The method of claim 7 wherein the value representative of the function is the arithmetic difference between the first and second values.

9. The method of claim 3 wherein the quality representative of the degree of interaction is the frequency of the magnetic field.

10. The method of claim 9 wherein the first and second values of the quality are each produced by counting the pulses of the field frequency, further including the step of storing one of said values for use in producing the second signal.

11. The method of claim 10 wherein values representative of the function for the coin are produced throughout the period during which the coin is subjected to the field further including the step of determining whether the coin is acceptable only if the largest of said values is within predetermined limits for acceptable coins of a given denomination.

12. The method of claim 11 wherein the value representative of the function is the arithmetic difference between the first and second values.

13. The method of claim 3 wherein values representative of the function for the coin are produced throughout the period during which the coin is subjected to the field further including the step of determining whether the coin is acceptable only if the largest of said values is within predetermined limits for acceptable coins of a given denomination.

14. Apparatus for examining coins with respect to authenticity including
   inductor means for subjecting a coin to an alternating magnetic field,
   means for producing a first signal having a quality representative of the degree of interaction of the coin with the field,
   means for storing a first value of the quality of the first signal determined when no coin is in the presence of the field,
   function generator means connected to receive the first value and a second value of the first signal determined when the coin is in the presence of the field to produce a function of the first and second values, and
   comparator means connected to receive the output of the function generator means for comparing a value representative of the function of the coin with a value representative of the function of an acceptable coin.

15. The apparatus of claim 14 further including a coin passageway having non-conductive sidewalls between which coins to be examined pass along a predetermined path and a conductive target, wherein the inductor is located on one side of the path and the target is located on the other side of the path opposite the inductor.

16. The apparatus of claim 15 wherein the first signal producing means is an oscillator having the inductor as a frequency determining component.

17. The apparatus of claim 15 wherein the quality of the degree of interaction of the coin with the field is the frequency of the first signal.

18. The apparatus of claim 15 wherein the function generator means produces the arithmetic difference between the first and second values.

19. The apparatus of claim 14 further including a coin track along which coins to be examined are conducted through the field, a first non-conductive sidewall on one side of the track to which the inductor is mounted, a second non-conductive sidewall on the other side of the track to which a conductive target is mounted opposite the inductor, the sidewalls being relatively moveable.

20. The apparatus of claim 19 wherein the first signal producing means is an oscillator having the inductor as a frequency determining component.

21. The apparatus of claim 19 wherein the quality of the degree of interaction of the coin with the field is the frequency of the first signal.

22. The apparatus of claim 19 wherein the function generator means produces the arithmetic difference between the first and second values.

23. The apparatus of claim 14 wherein the first signal producing means is an oscillator having the inductor as a frequency determining component.

24. The apparatus of claim 14 wherein the quality of the degree of interaction of the coin with the field is the frequency of the first signal.
25. The apparatus of claim 14 wherein the function generator means produces the arithmetic difference between the first and second values.

26. Apparatus for examining coins with respect to authenticity including:

- a coin passageway along which a coin to be examined will pass on a predetermined path,
- an oscillator including an inductor within its frequency determining circuit which produces a first signal having a frequency representative of the degree of interaction of the magnetic field of the inductor with coins within the field,
- means for preserving a first value of the frequency of the first signal determined when no coin is in the field,
- function generator means for producing second signal having a value representative of the difference between the first value of the first signal and a second value of the frequency of the first signal determined when the coin is in the field, and
- a comparator arranged to compare the value of the second signal representative of the difference for the coin with a value representative of the difference for an acceptable coin.

27. The apparatus of claim 26 further including a conductive target located on the opposite side of the path from the inductor.

* * * *
UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 3,918,564
DATED : November 11, 1975
INVENTOR(S) : Fred P. Heiman and Gerhard Herzog

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Col. 1, line 49, "diaagram" should be --diagram--.

Col. 2, line 36 "385" should be --383--.

Col. 5, (claim 3) line 21, there should be a comma --,-- after "field".

Col. 5, line 22 should not be indented.

Signed and Sealed this Twentieth Day of July 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks