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Hinterstocker

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[54] **ELECTRONIC COIN TESTING APPARATUS**

[76] Inventor: **Adolf Hinterstocker,** 28 Hirschbergstrasse, Roggersdorf near Holz Kirchen, Germany

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[52] **U.S. Cl.** .... **194/100 A,** 209/111.8

[51] **Int. Cl.** **G07f 3/02**

[58] **Field of Search** .... 194/100 R, 100 A; 73/163; 209/111.8

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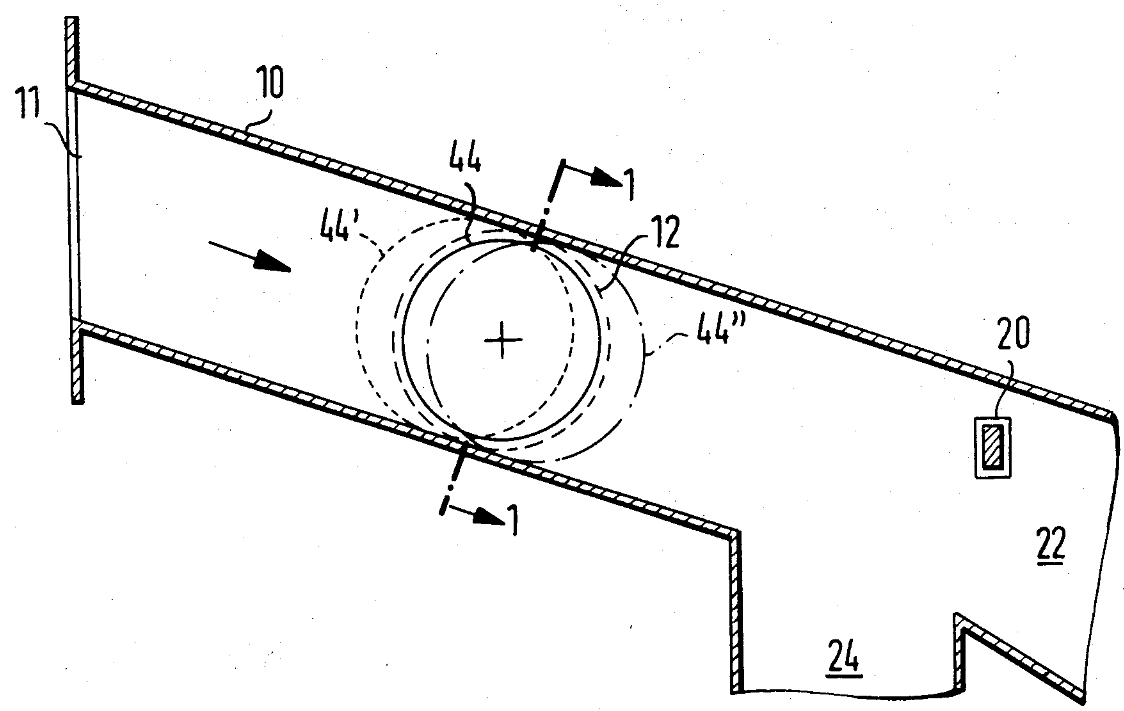
Primary Examiner—Robert B. Reeves
Assistant Examiner—David A. Scherbel
Attorney—Spencer & Kaye

[57] **ABSTRACT**

An electronic coin testing apparatus for comparing a coin travelling down a chute with a standard coin, of the type including means for producing a difference signal depending on the difference between the effect produced by the coin to be tested and that produced by the standard coin, the said difference signal decreasing from a predetermined value to zero and rising again as a coin identical with the standard coin passes a given position in the chute comprises a threshold device producing or not producing a predetermined threshold output signal depending on whether or not the difference signal exceeds a given value, a gate for separating accepted coins from rejected coins, and discriminating means for actuating the gate arranged to accept a coin only if there is a threshold output signal and it is not followed by a second such signal within a predetermined period of time.

7 Claims, 9 Drawing Figures



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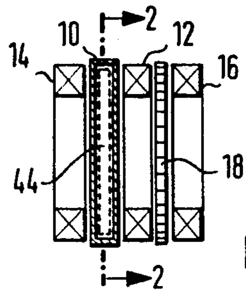


Fig.1

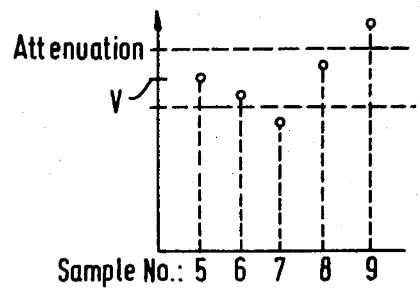


Fig.4

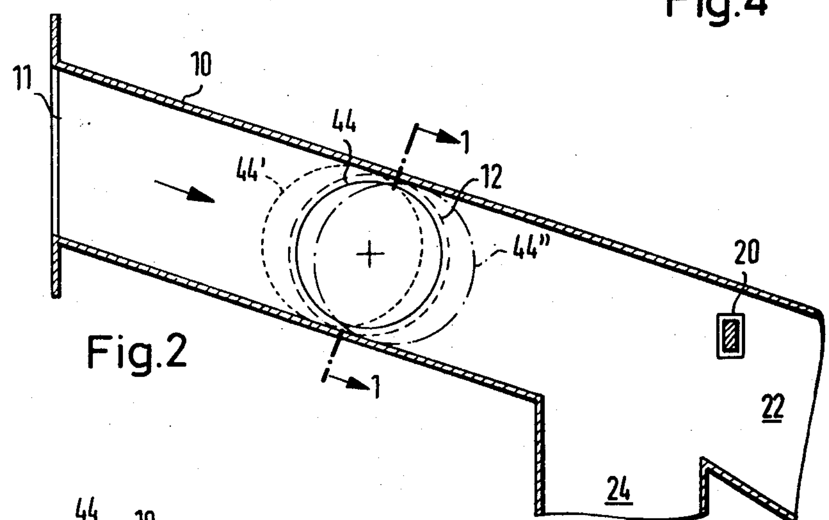


Fig.2

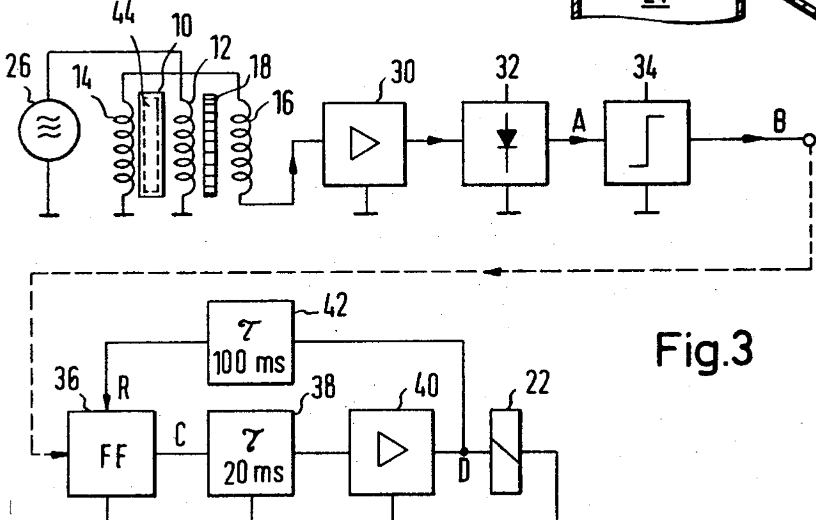


Fig.3

INVENTOR:
Adolf Hinterstocker

BY: Spencer & Kaye

ATTORNEYS

Fig.5

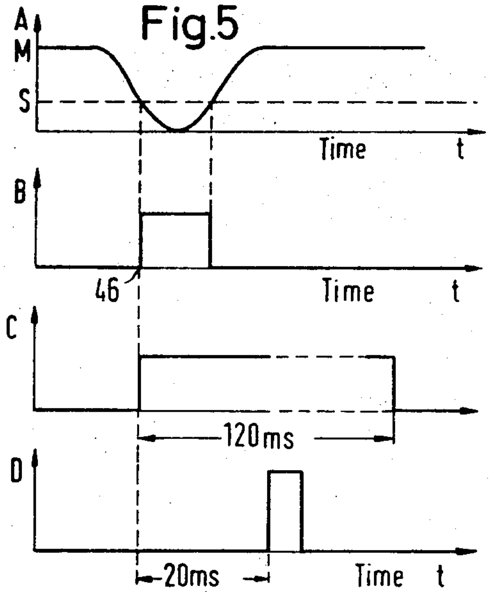


Fig.8

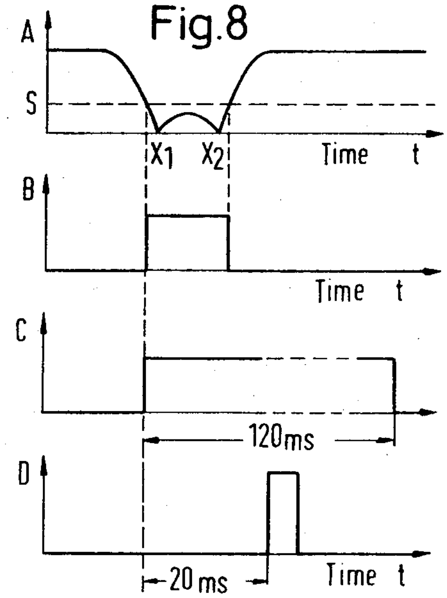


Fig.6

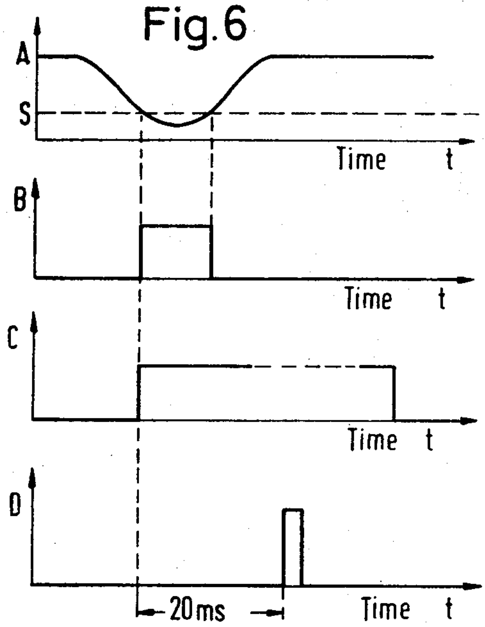
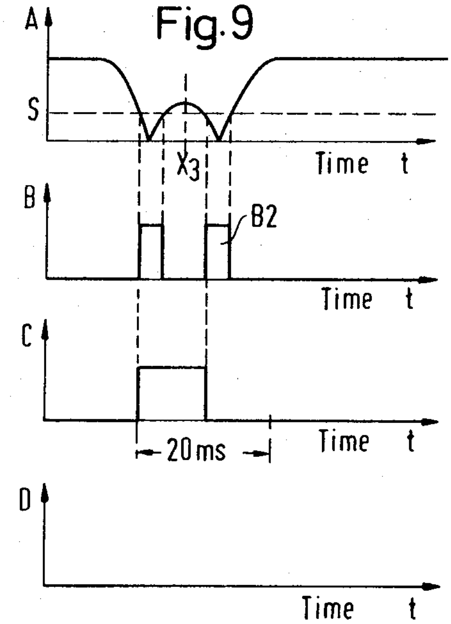


Fig.9



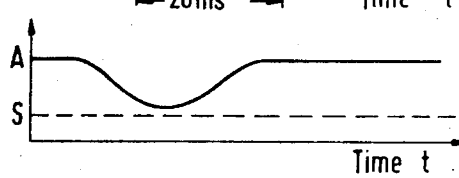


Fig.7

INVENTOR:
Adolf Hinterstocker

BY: Spencer & Kaye

ATTORNEYS.

ELECTRONIC COIN TESTING APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to electronic coin testing apparatus for comparing a coin travelling down a chute with a standard coin. In this type of testing apparatus a difference signal is produced which depends on the difference between the effect produced by the coin to be tested and that produced by the standard coin. This difference signal decreases from a predetermined initial value down to zero and then returns to its initial value as a coin identical with the standard coin passes a given position in the chute. A threshold device produces a predetermined threshold output signal the difference signal exceeds a given value. A gate separates accepted coins from the rejected coins. The gate is actuated by a discriminating means.

In one embodiment of the testing apparatus, the chute extends between a primary coil connected to a source of alternating current and a first secondary coil inductively coupled with the primary coil. The secondary coil is coupled to the gate, beyond the coils in the direction of travel of the coins. A second secondary coil is mounted on the side of the primary coil remote from the coin chute, and is inductively coupled with it, and is connected in series with the first secondary coil in such direction that the voltages induced by the primary coil in the two secondary coils are subtracted, with a device for holding a standard coin between the primary coil and the second secondary coil.

Such a coin testing device is described in my earlier patent application Ser. No. 852,531 filed 25 Aug. 1969, now U.S. Pat. No. 3,599,771. In this known coin testing device the testing must take place during a relatively short space of time, during which the coin to be tested (travelling down the chute) is situated exactly symmetrically with the "standard coin" For this purpose provision has been made for a switching device actuated by the coin to be tested, which device switches on the test circuit at the right moment and compares the coin to be tested, which must not move appreciably during the short "testing period."

Such switching devices, which test the coin passing through the coin chute at the moment when the coin is in the testing position between the primary coil and the secondary coil, give rise to certain problems. Mechanical switching devices, e.g. a rocker which is actuated by the coin to be tested, and on which a small magnet is mounted for the actuation of a reed contact, are sensitive, liable to interference and, with considerable use, wear relatively quickly. Contact-free switching devices, e.g. switching devices with capacitive and inductive sensors, are costly and also sensitive as well as susceptible to interference.

SUMMARY OF THE INVENTION

An object of the present invention is to provide such an electronic coin testing device in which it is not necessary to provide a coin-controlled switching device which limits the testing to a predetermined short space of time.

According to the invention discriminating means is provided for actuating the gate, arranged to accept a coin only if there is a threshold output signal and it is not followed by a second such signal within a predetermined period.

The discriminating means preferably include a bistable circuit arranged to be alternately set and reset by successive threshold output signals, to produce a flipflop output signal arranged to actuate the gate through a time constant circuit to accept a coin only if the flipflop output signal persists for a predetermined period. The time constant circuit conveniently includes an integrating operational amplifier, and may also include a level-responsive trigger device.

Resetting means may be provided for resetting the bistable circuit, if it is not already reset, after a second predetermined period, longer than the first predetermined period (in readiness for the next coin). Such resetting means may include a delay device connected between the output of the time constant circuit and a resetting input to the bistable device.

The invention may be put into practice in various ways but one specific embodiment will be described by way of example with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a simplified cross-sectional view through the coin chute and the measuring coils of an electronic coin-testing device, on the line 1—1 of FIG. 2;

FIG. 2 is a cross-section on the line 2—2 of FIG. 1;

FIG. 3 is a circuit diagram of an electronic coin-testing device according to the invention;

FIG. 4 is a graphic representation of the attenuation caused by various coins to be tested;

FIGS. 5 to 9 are diagrammatic graphs, relating respectively to the coins correspondingly numbered in FIG. 4, showing the time progress of signals at various points in the circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The present coin-testing device includes, as usual, a coin chute 10 of rectangular cross-section which starts at a coin input slot 11. The coin chute extends between a primary coil 12 and a first secondary coil 14 arranged coaxially with the primary coil. On the side of the primary coil 12 remote from the coin chute 10 there is a second secondary coil 16, the two secondary coils being mounted symmetrically with respect to the primary coil 12. Between the primary coil 12 and the second secondary coil 16 there is disposed a standard coin 18, i.e. a typical specimen of the coins to be tested.

In the direction of travel of the coins in the coin chute, beyond the coil arrangement 12, 14, 16, is a gate containing an abutment 20 which protrudes into the coin chute, and may be retracted by a magnet coil (FIG. 3). In the retracted state the gate allows the tested coin to enter a channel for accepted coins 22, while, when the magnet coil is not excited, the abutment 20 protrudes into the coin chute, so that the tested coin strikes against it and enters a reject channel 24.

The primary coil 12 is connected to an alternating current source 26 which may, for example, comprise a transistor oscillator, and which supplies an output voltage at a frequency in the range of approximately 10 to 100 kHz.

The two secondary coils 14, 16 are connected in series in such direction that the voltages induced in them by the primary coil 12 are subtracted from each other, to produce a difference signal which will be zero when between the primary coil 12 and the first secondary coil 14 there is a coin which corresponds exactly to the standard coin 18 and lies symmetrically with it.

The difference signal of the secondary coils 14, 16 is led via an amplifier 30 to a demodulator or rectifier 32 which supplies a difference signal A which corresponds to the envelope of the differential voltage produced by the series connected secondary coils 14, 16. The output signal A of the rectifier 32 is supplied to a level responsive trigger circuit 34, for example a Schmitt trigger circuit, which provides a threshold output signal B as long as the amplitude of the difference signal A lies below a predetermined threshold value S.

As described so far the arrangement is similar to that described in the specification referred to above.

The output of the trigger ciruit 34 is connected to a switchover input of a bistable or flip-flop circuit 36, so that the latter will be alternately set and reset by successive threshold output signals B, and when set will supply an output signal C. This output signal C, which may be termed a "flip-flop" output signal is led via a time constant 38, e.g. an integrating operational amplifier with an input resistor and a feedback capacitor, and if required a further level-responsive trigger circuit, to an amplifier 40, the output of which actuates the magnetic coil 22 of the gate.

The time constant circuit 38 is so designed that the gate is actuated only when the duration of the flip-flop output signal C of the bistable circuit 36 exceeds a predetermined value, in practice about 20 ms.

The output signal of the amplifier 40 is furthermore led via a delay device 42, which may for example have a delay time of 100 ms, to a reset input R of the bistable circuit 36.

Before an explanation is given of the modus operandi of the present coin testing device a short examination will be made of the conditions present at the testing station (FIG. 1).

In coin testing devices of the present type the attenuation of the coupling between the primary coil 12 and the secondary coil 14 by a coin 44 to be tested, located between these coils, is compared with the attenuation which the standard coin 18 causes between the primary coil and the second secondary coil 16. Accepted as genuine are such coins as have an attenuation which falls within a predetermined range, which in FIG. 4 is delimited by the horizontal dashed lines. The attenuation of the standard coin corresponds to the value V at the center of this range.

If a coin, with respect to its attenuation qualities corresponds exactly to the standard coin 18, travels down the coin chute 10 between the coils 12 and 14, the threshold output signal A of the rectifier 32 (FIG. 3) alters as a function of time as represented in FIG. 5. As long as the coin has not yet entered the field of influence of the coils, the signal A has a definite rest value M. When the coin begins to enter the space between the coils 12 and 14, the amplitude of the signal A decreases until it finally becomes zero, when the coin is situated exactly between the coils 12 and 14, as is shown in FIG. 2 by the continuous circle 44. At this moment, in the known coin-testing devices, the testing of the coin for genuineness took place, i.e. at this moment the attenuations of the coin to be tested and the standard coin were compared. If the coin then travels further, the amplitude of the signal A rises again to the rest value M, as represented in the upper diagram of FIG. 5.

When the coin to be tested has an attenuation smaller than the attenuation of the standard coin, as is shown at 6 in FIG. 4, the output signal A develops according to the first diagram in FIG. 6. If the attenuation is still smaller and lies outside the tolerance range, as is shown at 7 in FIG. 4, the output signal develops according to Curve A in FIG. 7.

If the attenuation is slightly greater than that of the standard coin, as shown at 8 in FIG. 4, the form of the output signal A is as shown in FIG. 8. The attenuation effected by the coin to be tested is then indeed equal to the attenuation of the standard coin 18 before the coin to be tested finds itself in the centralised position 44 (FIG. 2). The output signal A has therefore a first zero position x_1, when the coin to be tested is situated in the position 44' (FIG. 2) shown doted. When the coin to be tested is located in the centre position 44, the output signal has a small intermediate maximum, and it again becomes zero at a position x_2, when the coin to be tested is in a position 44'' symmetrical with the position 44'. Then, the output signal increases again to the rest value. If the coin has an attenuation so great that it lies outside the tolerance range, as represented at 9 in FIG. 4, the development of the output signal A is as represented in FIG. 9, so that the intermediate maximum, at a point x_3, has a relatively high value.

The state of affairs depicted above as regards the development of the output signal of the rectifier 32 with coins of different attenuation is used in the present invention to discriminate between accepted and rejected coins, without the necessity for making the test within a definite interval of time.

In the circuit of FIG. 3 the trigger circuit 34 supplies a threshold output signal B as long as the amplitude of the difference signal A lies below the threshold value S (cf. the upper diagram of FIGS. 5 to 9). By the forward edge 46 of the threshold output signal B the bistable circuit 36 is set to supply the flip-flop output signal C. If the flip-flop output signal C lasts longer than 20 ms, the amplifier 40 supplies a switching signal D to the magnet coil 22, which then retracts the abutment 20 (FIG. 2) from the coin chute, so that the tested coin can continue to travel into the channel 22 for accepted coins.

This is possible with coins with attenuation values such as represented at 5, 6 and 8 in FIG. 4, as here the threshold circuit 34, as the coin passes between the coils 12 and 14, supplies only a single threshold output impulse B and the bistable circuit 36 is therefore set, and remains set until, after for example 120 ms, it is reset by the reset circuit with the delay device 42, as is represented by the curves C in FIGS. 5, 6 and 8.

When, however, the attenuation of the coin to be tested is as small as is represented at 7 in FIG. 4, the difference signal A (FIG. 7) does not fall below the threshold value S of the trigger circuit 34, the latter cannot supply any threshold output signal, the bistable circuit 36 is not set and therefore also no impulse can be produced for the actuation of the gate.

When, on the other hand, the attenuation of the coin to be tested lies above the upper tolerance limit, as represented at 9 in FIG. 4, two impulses occur in the threshold output signal B as will be easily seen from FIG. 9. The intermediate maximum at x_3 in this case actually exceeds the threshold value S, so that the trigger circuit **34** can for a short time reset before the difference signal A (FIG. **9**) becomes zero for the second time. The second impulse B_2 (FIG. **9**), however, then resets the bistable circuit **36** before the time constant member **38** and the amplifier **40** can respond, and the gate is therefore in this case also not actuated, so that the tested coin strikes on the abutment **20** and is directed into the rejected channel **24.**

In the circuit of FIG. **3** the entire testing circuit is therefore continuously operative when coins are to be tested. With mains-operated coin testing devices the oscillator **26** and the other stages can then be constantly in operation; with battery-operated coin testing devices provision can be made for a quite simple switching device actuated by the insertion of a coin, which switches on the arrangement for the duration of the test. As these switching processes need not be synchronised with the run of the coin through the testing station, this switching arrangement may be made very simple and cheap.

Instead of the bistable or flip-flop circuit **36** and of the reset circuit consisting in a delay circuit **42,** it is naturally possible to use also other known switching arrangements equivalent in effect.

The values given above for the delay times effected through the time constant circuit **38** and the delay circuit **42** are typical, and have proved themselves adequately in practice; however, they may be modified if desired. The retardation time of the time constant circuit must, however, be at least long enough to make possible resetting of the bistable circuit **36** by the second impulse B_2 (FIG. **9B**) to prevent actuation of the gate.

The delay circuit **42** must ensure that the abutment **20** of the gate remains retracted from the coin chute until a coin found to be acceptable as a result of the testing is able to enter the channel **22** for accepted coins.

The circuits mentioned above and shown in block form in the drawing are preferably transistorized circuits which may be of known construction.

As various changes could be made in the above disclosed embodiment without departing from the scope of invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What I claim is:

1. In an electronic coin testing apparatus including a signal generating means for producing a test signal in dependence on a coin to be tested in comparison to a standard coin and a control means for producing an acceptance signal only when the maximum value of the test signal falls within preselected boundaries, the improvement wherein the control means comprises, in combination: a rectifier means connected to said signal generating means for producing a rectified output of the test signal; threshold value means connected to said rectifier means for producing a threshold output signal each time the rectified output of the test signal is within a threshold area defined by the two preselected boundaries; a bistable means, receiving a plurality of signals and connected to said threshold value means, for producing a gating signal upon receipt of a first signal and turning off the gating signal upon receipt of a second signal; a time constant means connected to said bistable means for producing an acceptance pulse when the duration of the gating signal is longer than a first predetermined time period; and reset means providing a signal for resetting said bistable means after a second predetermined time period which is longer than the first predetermined time period.

2. Apparatus as defined in claim **1** wherein said time constant means includes an integrating operational amplifier.

3. Apparatus as defined in claim **2** wherein said time constant circuit further includes a level-responsive trigger device.

4. Apparatus as defined in claim **1** wherein said reset means includes a delay device connected between the output of said time constant means and a resetting input to said bistable means.

5. Apparatus as defined in claim **1** further comprising a chute along which the coin to be tested passes; and wherein said signal generating means includes: a source of alternating current; a primary coil connected to said current source and arranged on one side of said chute; a first secondary coil inductively coupled with said primary coil and arranged on the side of said chute opposite said primary coil, whereby the voltage induced in said first secondary coil by the current in said primary coil is affected by the coin passing along said chute; a second secondary coil inductively coupled with said primary coil and arranged on the side of said primary coil remote from said chute, whereby the voltage induced in said second secondary coil by the current in said primary coil is affected by a standard coin positioned between said primary coil and said second secondary coil; said first and second secondary coils being connected in such a manner that the voltages induced therein by said primary coil are subtracted.

6. Apparatus as defined in claim **1** wherein the first predetermined time period is selected such that the gating signal will only be of a longer duration than the first predetermined time period when the rectified output of the test signal only passes into the threshold area once.

7. Apparatus as defined in claim **1** wherein said threshold value means includes a Schmitt trigger circuit.

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