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Description

The present invention relates to electronic coin validators.

Known coin validators make use of certain coin characteristics such as diameter, material and surface embossment and shape in order to verify that the coin is genuine. In particular the apparatus disclosed in prior art document US patent No. 4,108,296 makes use of a succession of tests in order to verify each of these parameters sequentially. Whilst the above tests comprehensively validate the coin type, in practice fewer tests are necessary to validate a coin accurately. In particular a test relating to coin surface area and resistivity accurately validates the coin.

The present invention advantageously performs a single test which simultaneously carries out evaluation of the parameters related to coin face area and resistivity.

When a step change of magnetic flux is applied axially to a coin an eddy current is induced which flows in the periphery of the coin, the coin acting like a coil comprising a single shorted turn. The coin has an inductance Lc and an equivalent series resistance Rc, related to the resistivity of the coin. The eddy current induced in the coin is also related to the current step I in the transmit coil that produces the step change of magnetic flux and the mutual coupling Mc between the coil and coin.

The current can be used to give an electronic signature that defines the coin type.

According to the present invention there is provided an electronic coin validator including a transmit coil for creating a magnetic field, a receive coil for detecting changes in the magnetic field due to the presence of a coin adjacent to the coils and circuit means whereby the validator operates to perform a test on the coin, to give a first parameter which is a measure of the coin face area, and a second parameter which is a measure of the coin resistivity, said first and second parameters being used to establish the validity of the coin, characterised in that the transmit coil is driven by a current switch, and the receive coil drives an amplifier which is connected to an integrator and a peak detector, the integrator being connected to a comparator set at a percentage of the integrator maximum output voltage to provide a control signal; that the control signal controls a counter which is started when the transmit coil is activated, the control signal being used as a stop signal for the counter in which the count is indicative of a measured value relating to the second parameter of coin resistivity; and that the peak detector is connected to and drives a plurality of window circuits having respective thresholds adjusted for respective coin face areas, and which provide respective output signals, indicative of the first parameter of coin face area.

The invention will now be described with reference to the accompanying drawings wherein;

Figure 1 shows the circuit diagram of an electronic coin validator according to the present invention,

Figure 2 shows a set of waveforms which are produced at various points in the circuitry of Figure 1,

Figure 3 shows the output waveforms of the circuitry of Figure 1 for each coin denomination,

Referring to Figures 1, 2 and 3, an embodiment of the invention, an impulse test type validator, will now be described.

For impulse testing the magnetic field is larger than the largest coin to be tested and two parameters are measured, coin face area and coin resistivity. The receive coil current waveform is shown in Figure 2. If the open circuit voltage in the coil, is detected, the peak voltage is a measure of a coin face area and the integrated voltage waveform has a time constant related to the resistivity.

The circuit of Figure 1 produces the waveforms of Figure 2. It consists of a current switch CS which has a defined turn on time, and drives the transmit coil TC. The receive coil RC drives an amplifier A which is connected to an integrator I and a peak detector PD. A comparator set at 90% of the integrator maximum output voltage gives a signal that allows "t coin" to be measured, where the parameter "t coin" is the time taken for the integrator output voltage to rise to the 90% level.

A start pulse gates a 10 MHz clock into a counter chain CC via flip flop FFI when the transmit current step is applied, and the integrator output stops the count. The number in the counter is now a measure of the parameter "t coin" which relates to coin resistivity, and may be applied to a microprocessor µP for evaluation. The peak detector holds the peak impulse shown in Figure 2 and can produce the set of output voltages shown in Figure 3 for the different coins. The peak detector drives four window circuits WG, one of which is shown, whose thresholds are adjusted to each coin face area distribution. The window comparator outputs are gated into respective 'D' type flip-flops FF2 that are clocked 5 µS after the start of the coin test. This effectively produces a peak detector output sample at 5 µS, as shown in Figure 3. The output of each flip-flop FF2 may be applied to the microprocessor µP for evaluation. Alternatively, the peak detector voltage may be entered into an analog-to-digital converter and the output applied to a microprocessor for evaluation.

The theory of operation of the impulse test type coin validator is as follows:—

The voltage eoc induced by the direct flux linkage transmitted to the receive coil is represented by

$$-M\frac{dI}{dt}$$

where M is the mutual coupling which for a current step of

$$I,\ eoc(t)=-M.I.\frac{RT}{L}.e^{\frac{-RT}{L}L}$$

where Rt is a damping resistor across the receive coil and Rt≫Rx, where Rx is the coil resistance and where L is the inductance of the coil.

If the step is of rise time T, this is modified to:

$$eoc(t)=-M.\frac{I}{T}\left[1-f(t-T)-e^{\frac{-RT}{L}t}+ft-T).e^{\frac{-RT}{L}(t-T)}\right]$$

where f indicates that (t−T) is a function of a Laplace Transform.

It can be shown that if L is large and T small then the rise time variation does not have a great effect on the induced voltage eoc. The voltage in the receive coil due to the presence of the coin is modified to:

$$VT=\frac{-MR}{L}.\frac{Mc}{Lc}.I.\left[\frac{\frac{RT}{L}.e^{\frac{-RT}{L}.t}-\frac{-Rc}{L}.e^{\frac{-Rc}{Lc}.t}}{\frac{Rx}{L}-\frac{Rc}{Lc}}\right]$$

where Rc=equivalent series resistance of the coin related to its resistivity and resistance, MR=mutual coupling between the coin and the receiver coil, Mc=mutual coupling between the transmit coil and the coin, Lc=coin inductance and this has to be added to the voltage due to the direct flux in order to give the complete receive waveform. It can be seen from the equations that if a test impulse is applied when no coin is present then this can be used to provide a reference level providing compensation for the effects of drift etc. The coin validator verifies two parameters of a coin before it is passed as genuine. Any disc of the correct size will meet the size parameter, but then has to have a time "t coin" inside the correct time distribution to meet the second parameter and be recognised as genuine.

The validator uses identical transmit and receive coils wound on the outside of a ferrite vinkor. The area of the coil is quite critical and has to be such as to allow sufficient flux to pass around each coin and also produce an easily measurable t-coin period in excess of 10 μS.

Claims

1. An electronic coin validator including a transmit coil (TC) for creating a magnetic field, a receive coil (RC) for detecting changes in the magnetic field due to the presence of a coin adjacent to the coils and circuit means (CS, A, I, PD, C, WG, CC) whereby the validator operates to perform a test on the coin, to give a first parameter which is a measure of the coin face area, and a second parameter which is a measure of the coin resistivity, said first and second parameters being used to establish the validity of the coin, characterised in that the transmit coil (TC) is driven by a current switch (CS) and the receive coil (RC) drives an amplifier (A) which is connected to an integrator (I) and a peak detector (PD), the integrator (I) being connected to a comparator (C) set at a percentage of the integrator maximum output voltage to provide a control signal; that the control signal controls a counter (CC) which is started when the transmit coil (TC) is activated, the control signal being used as a stop signal for the counter (CC) in which the count is indicative of a measured value relating to the second coin parameter of coin resistivity; and that the peak detector (PD) is connected to and drives a plurality of window circuits (WG) having respective thresholds adjusted for respective coin face areas, and which provide respective output signals, indicative of the first parameter of the coin face area.

2. An electronic coin validator as claimed in claim 1 wherein the count value and the output signals are applied to a microprocessor for evaluation.

Patentansprüche

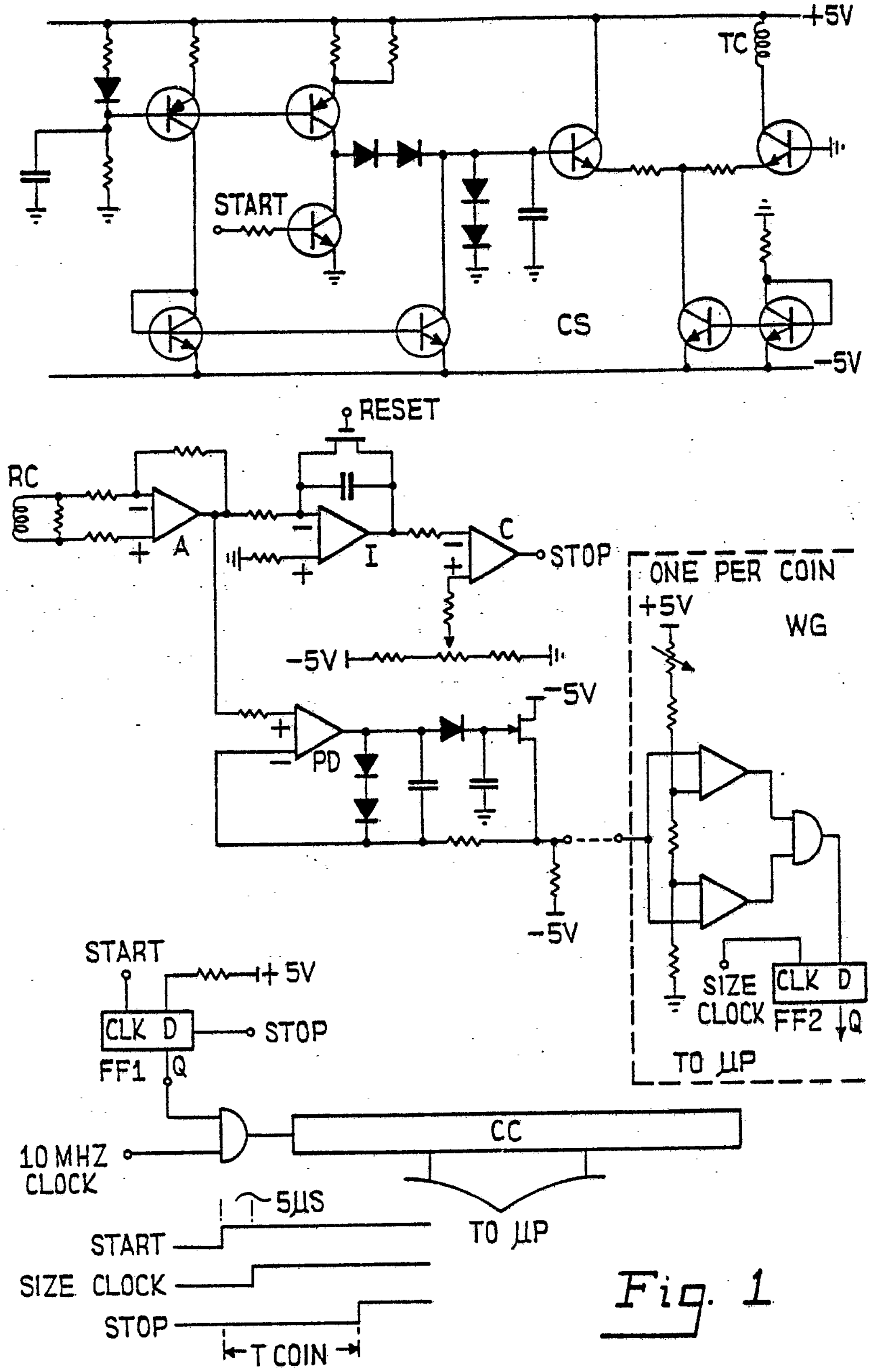
1. Elektronischer Münzprüfer mit Geberspule (TC) für die Erzeugung eines Magnetfeldes, Tastspule (RC) für das Abtasten von Änderungen im Magnetfeld aufgrund der Gegenwart einer Münze neben den Spulen und wobei Schalteinrichtung (CS, A, I, PD, C, WG, CC) vorgesehen sind, durch welche der Münzprüfer die Prüfung einer Münze durchführt, mit Vorgabe eines ersten Parameters als Maß für die Stirnfläche der Münze und eines zweiten Parameters für den Widerstand der Münze, wobei diese ersten und zweiten Parameter verwendet werden, um die Wertigkeit der Münze zu bestimmen, dadurch gekennzeichnet, daß die Geberspule (TC) durch einen Stromschalter (CS) getrieben wird und die Tastspule (RC) einen Verstärker (A) treibt, der an einen Integrator (I) und Spitzendetektor (PD) angeschlossen ist, wobei der Integrator (I) an einen Komparator (C) angeschlossen ist, der auf eine Prozentsatz der maximalen Ausgangsspannung des Integrators eingestellt ist, um ein Steuersignal abzugeben, wobei das Steuersignal einen Zähler (CC) steuert, der beim Erregen der Geberspule (TC) anläuft, wobei das Steuersignal als Haltsignal für den Zähler (CC) verwendet wird, dessen Zählwert dem Meßwert des zweiten Münzparameters des Münzenwiderstands entspricht, wobei der Spitzendetektor (PD) an eine Mehrzahl von Fensterkreisen (WG) angeschlossen ist und diese treibt, die auf entsprechende Schwellwerte für entsprechende Stirnflächen der Münzen eingestellt sind, und welche Ausgangssignale abgeben, die bezeichnend für den ersten Parameter der Münzenstirnfläche sind.

2. Elektronischer Münzprüfer nach Anspruch 1, in welchem der Zählwert und die Ausgangssignale an einen Mikroprozessor zwecks Auswertung angelegt werden.

Revendications

1. Un validateur électronique de pièce de monnaie, comprenant une bobine de transmission (TC) pour la création d'un champ magnétique, d'une bobine de réception (RC) pour la détection de modifications dans le champ magnétique dues à la présence de la pièce près des bobines et des circuits (CS, A, I, PD, C, WG, CC) est fourni selon lequel le validateur fonctionne pour effectuer un test sur la pièce, pour donner un premier paramètre qui est la mesure de la surface de la face de la pièce et un second paramètre qui est la mesure de la résistivité de la pièce, ces deux paramètres étant utilisés pour établir la validité de la pièce, caractérisés en cela que la bobine de transmission (TC) est entrainée par un commutateur de courant (CS) et la bobine de réception (RC) entraine un amplificateur (A) qui est raccordé à un intégrateur (I) et un détecteur de pointe (PD), l'intégrateur (I) étant raccordé à un comparateur (C) réglé à un pourcentage de la tension de sortie maximale de l'intégrateur pour fournir un signal de commande, ce signal de commande régissant un compteur (CC) qui démarre lorsque la bobine de transmission (TC) est actionnée, le signal de commande étant utilisé comme signal d'arrêt pour le compteur (CC) dans lequel le compte indique la valeur mesurée relative au deuxième paramètre de pièce, la résistivité, dans lequel le détecteur de pointe (PF) est raccordé à plusieurs circuits de fenêtre (WG) qu'il entraine, ces circuits ayant un seuil respectif réglé pour une surface de face de pièce respective et fournissant des signaux de sortie respectifs, indiquant le premier paramètre, la surface de face de la pièce.

2. Un validateur de pièce électronique comme revendiqué dans la revendication 1 dans lequel les signaux de sortie et de valeur de compte sont appliqués à un micro-processeur pour évaluation.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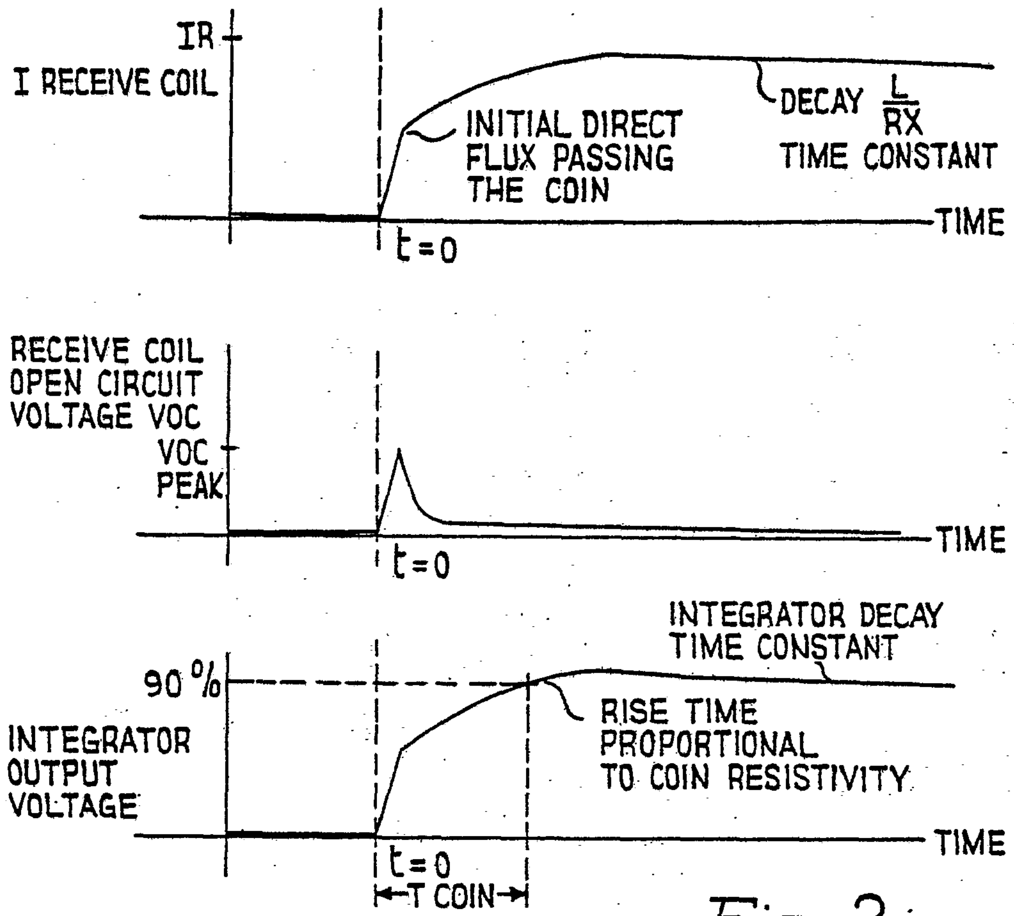
TC
START
CS
-5V
RESET
RC
A
I
C
STOP
ONE PER COIN
+5V
WG
-5V
-5V
PD
-5V
START
+ 5V
CLK D
STOP
FF1
Q
SIZE
CLOCK
CLK D
FF2
Q
TO μP
CC
10 MHZ
CLOCK
5μS
START
SIZE CLOCK
STOP
TO μP
T COIN

Fig. 1


IR
I RECEIVE COIL
INITIAL DIRECT
FLUX PASSING
THE COIN
DECAY L/RX
TIME CONSTANT
TIME
t=0
RECEIVE COIL
OPEN CIRCUIT
VOLTAGE VOC
VOC
PEAK
TIME
t=0
INTEGRATOR DECAY
TIME CONSTANT
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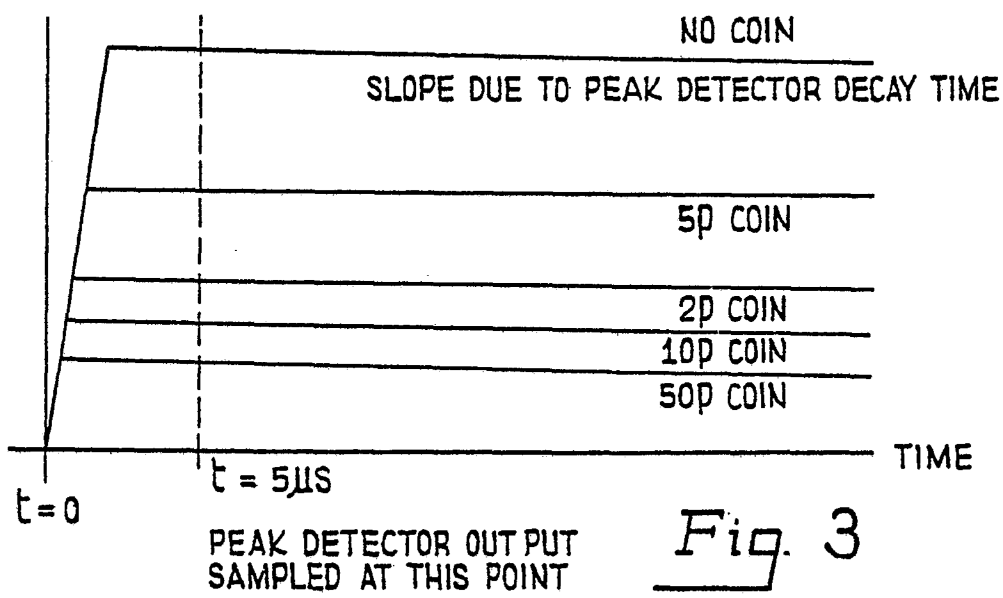
INTEGRATOR
OUTPUT
VOLTAGE
RISE TIME
PROPORTIONAL
TO COIN RESISTIVITY
TIME
t=0
T COIN

Fig. 2


NO COIN
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5p COIN
2p COIN
10p COIN
50p COIN
TIME
t = 5μs
t=0
PEAK DETECTOR OUT PUT
SAMPLED AT THIS POINT

Fig. 3