March 19, 1968 N. L. KUSTERS ET AL 3,373,856

METHOD AND APPARATUS FOR COIN SELECTION

Filed May 23, 1966 3 Sheets-Sheet 1

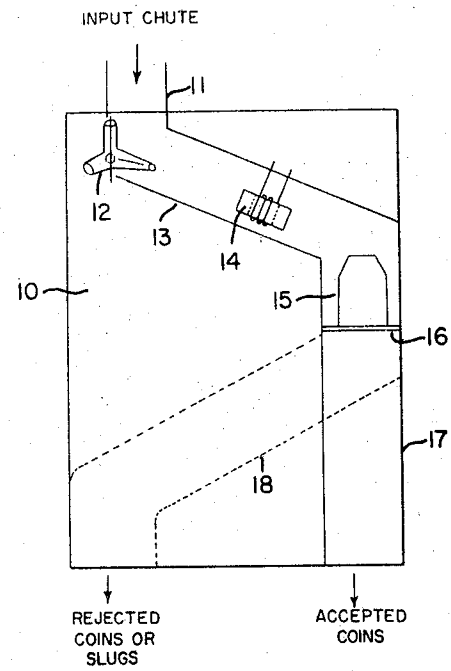

FIG. 1

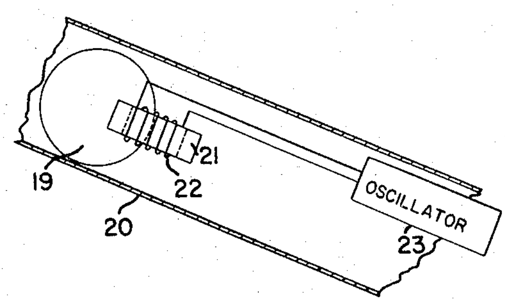

FIG. 2

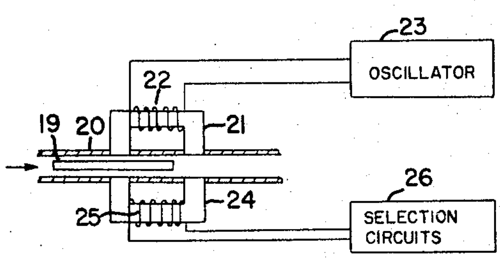

FIG. 3

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METHOD AND APPARATUS FOR COIN SELECTION

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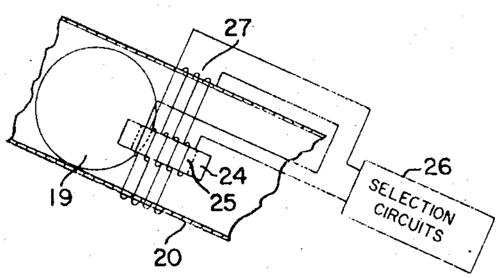

FIG. 4

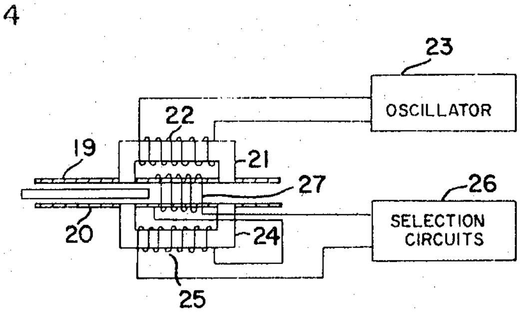

FIG. 5

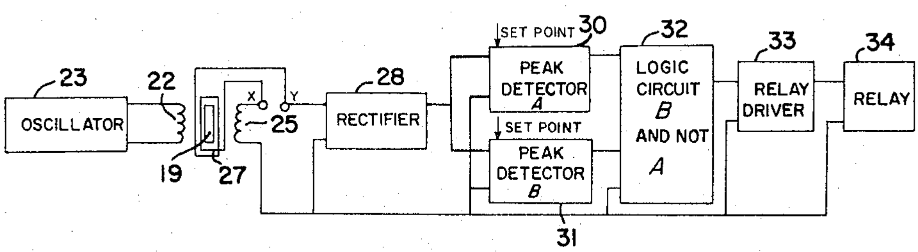

FIG. 6

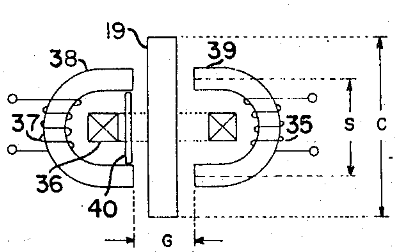

FIG. 7

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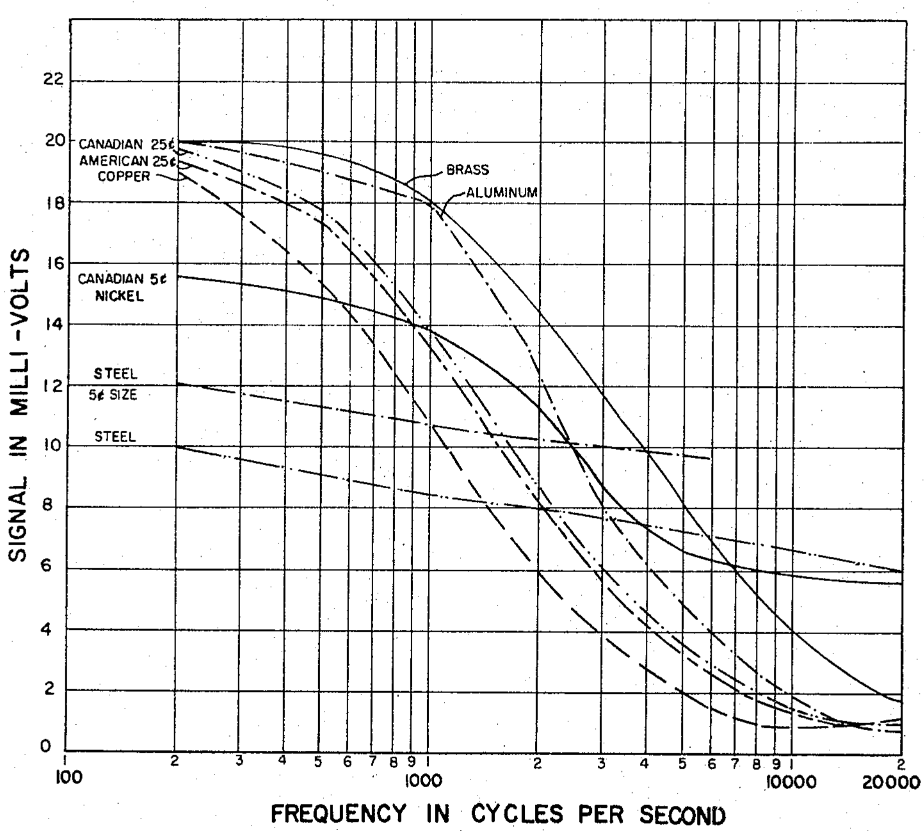

FIG. 8

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United States Patent Office 3,373,856
Patented Mar. 19, 1968

3,373,856
METHOD AND APPARATUS FOR COIN SELECTION

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Filed May 23, 1966, Ser. No. 551,992
Claims priority, application Canada, Jan. 18, 1966, 950,098
12 Claims. (Cl. 194—100)

This invention relates to coin selector mechanisms and more particularly to a method and apparatus capable of detecting and rejecting spurious or counterfeit coins or slugs and accepting as valid, coins that may be made of either a non-magnetic metal or alloy having known electrical characteristics or a magnetic metal or alloy having known electro-magnetic characteristics.

At the present time the coins of the larger denominations of most countries are made of a metal alloy the major constituent of which is silver. For example, the U.S. 25-cent piece is 90° silver and the Canadian 25-cent piece is 80% silver. These coins are used not only for ordinary money transactions but also quite widely in coin-operated vending machines. The coin-operated mechanisms of the more sophisticated type usually incorporate coin testing devices so that spurious coins, tokens, slugs, or other objects not conforming to a given specification will be rejected. The coin testing devices presently used normally test not only weight and size of the coins inserted but also an electrical characteristic such as resistance, capacitance, or the eddy-current braking action on the coin as it rolls past a permanent magnet. This latter method is used quite widely and is quite effective and satisfactory for testing coins made of non-magnetic material such as silver. If coins with ferromagnetic properties are inserted, they are strongly attracted to the permanent magnet and are rejected by the selector mechanism.

At the present time there is a world-wide shortage of silver and many countries are studying the desirability and possibility of issuing coins which contain either no or only a minor proportion of silver with the other proportion being of nickel, copper, iron, steel, or other metals. The United States Government has announced that they will begin issuing 25-cent pieces and 10-cent pieces using a sandwich style coin with the faces composed of a copper-nickel alloy plus a core of pure copper. It is claimed that these coins are completely compatible with the old silver coins in that they have the correct electrical properties to operate the large numbers of coin-operated vending machines.

Several countries including Canada would like to issue coins with a larger base metal content. Up until now there has been no known way of making these coins of solid metal or alloy with the correct electrical properties to make them compatible with the old silver coins in coin selector mechanisms. The sandwich type coin provides difficulties in manufacture and an undesirable appearance from the aesthetic point of view.

It is an object of the present invention to provide a coin testing method and apparatus that is capable of accepting as valid to a high degree of accuracy a coin of known properties and rejecting all others.

It is another object of the present invention to provide a coin testing method and apparatus that will accept as valid at least two different kinds of coins, for example, the silver coin now in use and a coin that would be made from a metal or alloy having ferromagnetic properties.

It is another object of the invention to provide a coin testing method and apparatus that will be readily adaptable to present coin operated vending machines and that

will be compatible in that it will accept coins presently in use and any new types of coins that might be decided upon by a country or state.

These and other objects of the invention are achieved by passing an alternating magnetic field through the coin and measuring the attenuation of the magnetic field caused by the coin.

Applicants have found that if a magnetic field is passed through a coin, the attenuation of the magnetic field caused by the coin can be measured and used as the criterion for the acceptance of the validity of the coin. It follows from this that a coin selector mechanism can be designed and built for accepting as valid a coin of known properties and discriminating against all others provided the parameters of the selector mechanism such as operating frequency and geometry of the magnetic circuitry are properly selected. In addition, applicants have found that the attenuation in a non-magnetic material varies with the frequency of the alternating magnetic field but in the case of a magnetic material it is nearly independent of frequency. It follows from this that if the operating frequency is properly chosen, the same attenuation can be obtained with the present silver coins and coins made of a material having some ferromagnetic properties.

According to the invention a coin testing mechanism is provided wherein the coin under test is inserted in the field generated by a magnetic device positioned on one side of the coin and the voltage induced in a suitable pick-up device positioned on the opposite side of the coin is measured. The frequency of input voltage to the magnetic circuit, and the positions of the driving device, pick-up device, and coin are chosen such that the variation of signal due to eddy currents in a coin made of non-magnetic material, e.g. silver would be or could be adjusted to be substantially equal to the variation of signal due to the presence of a coin made of magnetic material, e.g. nickel, stainless steel.

According to another more versatile aspect of the invention a coin testing apparatus is provided wherein the coin under test is inserted in the field induced by a magnetic driver device placed on one side of the coin so that it attenuates the voltage generated in a suitable pick-up device placed on the opposite side of the coin. In this case a pick-up coil surrounds the coin under test and has a voltage induced in it by the magnetic flux passing mainly through the coin and not across the coin to the pick-up device. The frequency of the input voltage, the positions of the driver device, the pick-up device, and the coil around the coin are chosen such that the signal obtained by adding the signal from the pick-up device and the coil around the coin would be substantially the same if the coin is made from a non-magnetic material or a magnetic material.

In drawings which illustrate an embodiment of the invention,

FIGURE 1 is a schematic view of a coin selector mechanism according to the invention,

FIGURE 2 is a cross-section of a portion of the device of FIGURE 1,

FIGURE 3 is a plan view in cross-section of the coin sensing device,

FIGURE 4 is similar to FIGURE 2 but shows an additional winding that encircles the coin as it passes through the sensing station,

FIGURE 5 is a plan view in cross-section of the coin sensing device showing the additional winding,

FIGURE 6 is a block diagram of the electronic circuitry of the device,

FIGURE 7 is a schematic view of the magnetic field producing and detecting circuitry, and

FIGURE 8 is a graph of experimental results showing the relationship of frequency to response of some typical coin materials.

Referring to FIGURE 1 a coin selector mechanism is shown in somewhat schematic form. A plate structure **10** carries an input chute **11** which leads to a coin sizing and weighing mechanism **12**. This type of device is well known and in use at present and therefore forms no direct part of the present invention. After the coin is accepted by device **12** is would pass or roll down an inclined chute **13** past a coin sensing station **14** which will be described in more detail below. The coin then passes a selector gate **15** hinged at **16**. Gate **15** is operated by a solenoid or relay (not shown) which in turn is connected to the operating circuitry. If the coin is to be accepted gate **15** pivots to allow the coin to pass straight down chute **17**. If to be rejected, the gate pivots to allow the coin to go down chute **18**.

FIGURE 2 shows a coin **19** passing down inclined chute **20** past a sensing station made up of a magnetic core **21** energized by means of a winding **22** connected to an oscillator **23**. FIGURE 3 shows the sensing station in more detail. The coin **19** (seen here from the top) passes between the pole faces of a magnetic field producing core **21**. The frequency of oscillator **23** is pre-determined and pre-set such that an alternating magnetic field of known frequency is set up. An alternating voltage is induced in detection winding **25** on magnetic core **24** and is applied to the selection circuits **26**. The amplitude of the voltage produced is dependent on the attenuation in the magnetic field between the pole faces of cores **21** and **24**. If a coin is positioned between these pole faces the attenuation varies with the size, shape, and electrical properties of the coin.

FIGURE 4 and FIGURE 5 are similar to FIGURES 2 and 3 but show an additional winding **27** which is positioned to encircle the coin as it passes through the sensing station. This winding is connected in series with detection winding **25** and therefore adds a voltage related to the magnetic flux passing through the coin and not reaching core **24**. This winding is not necessary in all cases but adds flexibility to the invention in that the device may be designed to accept certain types of coins that it might otherwise be difficult to accommodate due to their electrical and magnetic characteristics.

FIGURE 6 shows the selection circuitry in block form. The coin **19** is positioned between energizing circuitry **22** and detection winding **25**. By-pass winding **27** may be connected in at points X and Y if desired. The alternating voltage induced in detection winding **25** is rectified in rectifier **28** and the D.C. voltage obtained is applied to a peak detector (A) **30** which gives an output signal if the voltage exceeds a predetermined and pre-set level and also to a peak detector (B) **31** which gives an output signal if the voltage exceeds another pre-determined and pre-set level. The output signals from the detectors **30** and **31** are applied to a logic gate **32** which gives an output only if there is a signal from detector **31** and not from detector **30**. It will be realized that an output is obtained only if the voltage level induced in detection winding lies between the two pre-set levels and therefore a pass band of pre-determined size can be established in the system. The output from logic gate **32** is applied to a relay driver **33** which operates a relay **34** when energized. The relay is connected to operate selection gate **15** (see FIGURE 1) in such a way as to send a coin down chute **17** if and only if the correct operating signal is obtained.

FIGURE 7 shows the magnetic circuitry and some of the parameters that might be considered in the design of the device or that could be arranged to be varied as required. A coin **19** of diameter C is between the pole faces of magnetic cores **38** and **39** of pole spacing S and in which the gap spacing is G. In a working device this gap spacing could be made adjustable to meet varying conditions by means of a suitable screw adjustment.

FIGURE 8 is a graph of results obtained from an experimental set-up wherein different types and sizes of coins were tested. Voltage response (actually attenuation caused by the coins) is plotted against frequency. It will be seen that in coins that are made of non-magnetic material (copper, silver, aluminum, brass) the response is frequency dependent. For magnetic materials (steel) the response is generally independent of frequency. Nickel would be similar to steel but the Canadian 5-cent piece tested is made of nickel that has conductive and magnetic properties and therefore has a curve that lies between the curves for the other materials. The important point to be gained from this graph is that for any two types of coin materials there is a frequency at which the curves cross or in other words at which the signal response is the same. From this it follows that for a coin made of magnetic material and another coin made of a non-magnetic material, a frequency can be determined that will give the same voltage response and a selecting device can be designed and built according to the invention that will find both types of coins "acceptable."

In addition to the operating frequency the relative response between magnetic and non-magnetic materials is affected by the geometry of the magnetic devices, e.g. pole spacing and air gap. A third method of varying the response for magnetic coin materials is to place a coil around the coin when it is in the detecting position. This coil would measure the by-pass flux, that is, the flux that passes down the coin and does not reach the core on the opposite side of the coin (see coil **36** of FIGURE 7). The voltage induced in this coil may be added to the voltage obtained from the detection winding. In this way the response curve of a coin of a magnetic material may be altered and in some cases this may be necessary or desirable. A magnetic shunt **40** (FIGURE 7) may be used if necessary to by-pass a portion of the flux through by-pass coil **36**. This may be desirable when operating with certain coins. It will be realized that there are various parameters that can be designed into the apparatus or adjusted after the apparatus is built which give flexibility and wide capability to a selector mechanism built according to this invention.

In the above description and in the claims that follow the method and apparatus has been described in terms of a "coin" selector mechanism. It should be pointed out that applicants consider the word "coin" in this context applies not only to the official coinage of a country or state but also to tokens, slugs, and other objects of this nature and also to key-like devices that might be used in automated merchandise processing systems.

What is claimed is:

1. A method of testing coins comprising passing an alternating magnetic field through the coin to be tested, measuring the variation in the field strength due to the coin, and applying the measurement so obtained to discrimination means such that coins causing a variation in field strength that lie within a pre-determined range are found to be acceptable and all others rejected.

2. A method of testing coins comprising passing an alternating magnetic field through the coin to be tested and measuring the variation in the field strength due to the coin, the frequency of the alternating magnetic field being chosen such that the said variation in field strength will be substantially the same for a coin made of a magnetic material having predetermined characteristics and a coin made of non-magnetic material having pre-determined characteristics.

3. A method of testing coins comprising generating an alternating magnetic field on one side of the coin to be tested, obtaining an electrical signal related to the field strength at a position on the opposite side of the coin, and applying the signal to a gating device adapted to operate to send the coin to an "accept" location when the signal lies within a pre-determined range.

4. A method of testing coins comprising generating

an alternating magnetic field on one side of the coin to be tested, obtaining an electrical signal related to the field strength at a position on the opposite side of the coin, and applying the signal to a gating device adapted to operate to send the coin to an "accept" location when the signal lies within a pre-determined range, the frequency of the alternating magnetic field being chosen such that the signal obtained will be substantially the same for a coin made of a magnetic material having pre-determined characteristics and a coin made of non-magnetic material having pre-determined characteristics.

5. A coin selector mechanism comprising:

(a) means for producing an alternating magnetic field positioned on one side of the coin to be tested,

(b) magnetic pick-up means positioned on the opposite side of the said coin to obtain an output signal, the amplitude of which is related to the attenuation caused by the coin to the magnetic field as it passes from the means for producing an alternating magnetic field to the pick-up means,

(c) discriminator means connected to said pick-up means adapted to discriminate between a relatively narrow pre-determined signal band and all other signal levels, and

(d) a coin selector actuating mechanism operatively connected to said discriminator means adapted to direct the test coin to an "accept" location when the signal level received in the discriminator lies within the pre-set band and to a "reject" location when the signal level lies outside the pre-set band.

6. A coin selector mechanism comprising:

(a) means for producing an alternating magnetic field positioned on one side of the coin to be tested,

(b) magnetic pick-up means positioned on the opposite side of the said coin to obtain an output signal, the amplitude of which is related to the attenuation caused by the coin to the magnetic field as it passes from the means for producing an alternating magnetic field to the pick-up means,

(c) discriminator means connected to said pick-up means adapted to discriminate between a relatively narrow pre-determined signal band and all other signal levels, and

(d) a coin selector actuating mechanism operatively connected to said discriminator means adapted to direct the test coin to an "accept" location when the signal level received in the discriminator lies within the pre-set band and to a "reject" location when the signal level lies outside the pre-set band,

(e) the frequency of operation of the said means for producing an alternating magnetic field being chosen such that the attenuation of the electrical signal between the said means for producing the alternating magnetic field and the said magnetic pick-up means is substantially the same for a coin made of non-magnetic material and a coin made of a metal or alloy having at least some ferromagnetic properties.

7. A coin selector mechanism as in claim **5** wherein the said means for producing an alternating magnetic field is a coil wound on a core and positioned on one side of the coin to be tested, the windings of said coil being connected to an oscillator.

8. A coin selector mechanism as in claim **5** wherein the said magnetic pick-up means is a coil wound on a core positioned adjacent the opposite side of the coin from that of the means for producing an alternating magnetic field.

9. A coin selector mechanism as in claim **5** wherein coil means surrounds the coin to be tested and is adapted to produce a signal related to the magnetic flux passing through the coin and not reaching said magnetic pick-up means, said signal being added to the signal obtained by the said magnetic pick-up means.

10. A coin selector mechanism as in claim **5** wherein the said means for producing an alternating magnetic field is a coil wound on a U-shaped core positioned on one side, of the coin to be tested, said core having a magnetic shunt positioned in relation to it such that a portion of the flux passing through the said core is by-passed and does not pass through the said coin.

11. A coin selector mechanism comprising:

(a) an oscillator,

(b) coil means for producing an alternating magnetic field connected to said oscillator and positioned adjacent one face of the coin to be tested,

(c) magnetic coil pick-up means positioned adjacent the opposite face of the coin to be tested and adapted to provide an output voltage signal, the amplitude of which is related to the attenuation caused by the coin to the magnetic field strength between said coil means and said magnetic pick-up means,

(d) rectifier means connected to said pick-up means to change said output voltage to a D.C. voltage level,

(e) a first detector connected to the output of said rectifier and adapted to give an output signal when the said D.C. voltage level exceeds a first pre-set voltage level,

(f) a second detector connected to the output of said rectifier and adapted to give an output signal when the said D.C. voltage level exceeds a second pre-set voltage level, said first and second pre-set voltage levels defining a voltage level band,

(g) a logic gate connected to the outputs of said first and second detectors, said gate giving an output signal when the said D.C. level falls within the said voltage level band,

(h) a relay driver circuit connected to the output of said logic gate and adapted to operate a relay, and

(i) mechanical gating means connected to said relay and adapted to direct the coin after test either to an "accept" location or a "reject" location depending on whether the said output D.C. voltage level lies within or without the defined voltage level band.

12. A coin selector mechanism as in claim **11** wherein the frequency of operation of the said oscillator is chosen such that the attenuation to the magnetic field strength will be substantially the same for a coin made of non-magnetic material and a coin made of a metal or alloy having magnetic properties.

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SAMUEL F. COLEMAN, *Primary Examiner.*