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Fougere et al.

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[54] **METHOD AND APPARATUS FOR TESTING COINS EMPLOYING DIMENSIONAL CATEGORIZING MEANS**

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Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 91,871, Nov. 23, 1970, which is a continuation-in-part of Ser. No. 812,127, April 1, 1969, abandoned.

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

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

[58] **Field of Search** .... 194/99, 102, 100 R, 194/100 A

[56] **References Cited**

UNITED STATES PATENTS

3,653,481 4/1972 Boxall et al. .... 194/100 A

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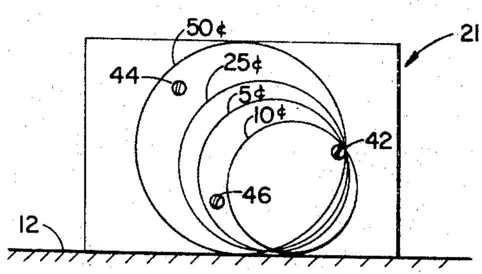
[57] **ABSTRACT**

A coin selector and a method of coin selection are disclosed which utilize a coin presence sensor array including a primary sensor and a series of secondary sensors, which together with combinatorial circuitry provide signals indicative of the size category of a coin and signals indicative of the acceptance ratio of the coin and compare the signals with predetermined values for acceptable coins.

17 Claims, 4 Drawing Figures



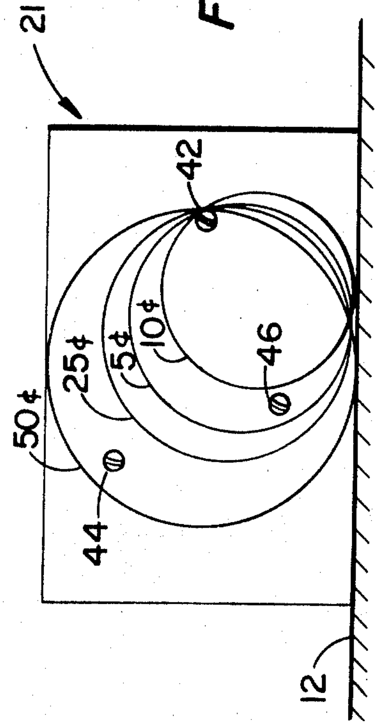


FIG. 2

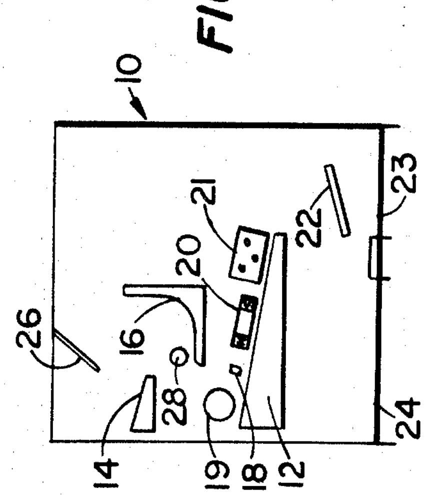


FIG. 1

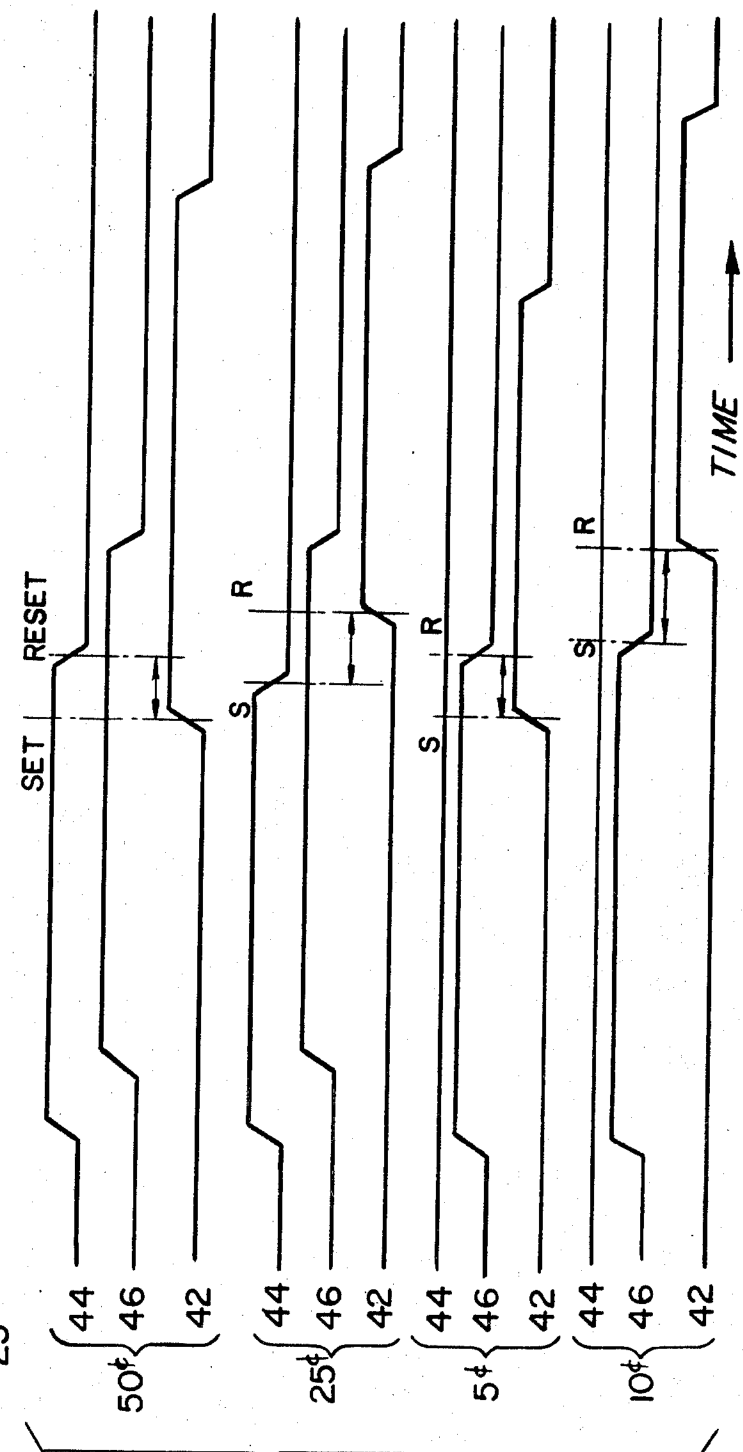


FIG. 4

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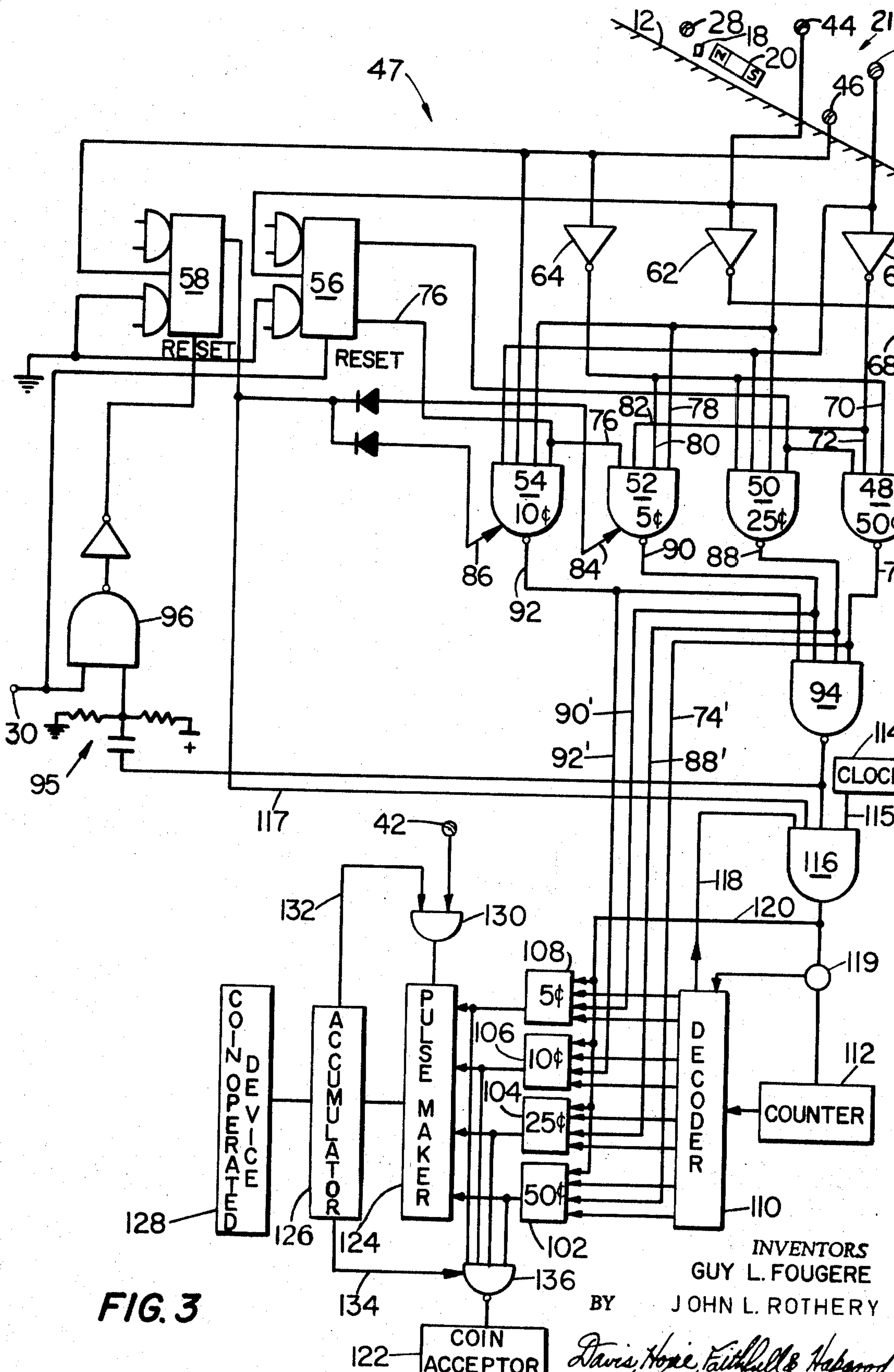

FIG. 3

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METHOD AND APPARATUS FOR TESTING COINS EMPLOYING DIMENSIONAL CATEGORIZING MEANS

This application is a continuation-in-part of our copending application Ser. No. 91,871, filed Nov. 23, 1970, which is a continuation-in-part of our application Ser. No. 812,127, filed Apr. 1, 1969, both now abandoned.

This invention relates to coin selectors and, more particularly, to a system for determining the denomination of coins and for ejecting undesired and counterfeit coins.

Throughout this specification and in the appended claims, 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.

An "acceptable" coin is an authentic coin of the monetary system in which the device is intended to operate and of a denomination which the device is intended selectively to receive for value.

It is known to utilize two properties of a coin to determine its denomination. The result of that determination is in many instances indicative of the coin's authenticity. Devices have been proposed in which a coin entering the device is acted upon by a magnetic field provided by a magnet mounted adjacent to a coin passageway and the coin's motion relative to the magnetic field causes eddy currents to flow within the coin. Associated with these eddy currents are magnetic fields which interact with the magnet, producing a force opposing the coin's motion through the magnetic field. The effect of an electrically conductive, non-ferromagnetic coin passing through a stationary magnetic field is the retardation of the coin in an amount directly proportional to the coin's electrical conductivity divided by its density, called the acceptance ratio. Therefore, the coin's velocity sensed downstream of the magnetic field is one examinable indicium of coin authenticity and denomination. The length of a chord of the coin is a second examinable indicium. By comparing the results of the examination of these indicia with corresponding known values for authentic coins of particular denominations desired to be accepted, determinations of acceptability are made.

It is one objective of this invention to provide a coin selector having substantially improved reliability and effectiveness in sensing the denomination of coins and which is economical to manufacture and maintain.

Another objective of this invention is to provide a coin selector having the capabilities of accepting a large number of permissible coin denominations and of being able to be modified easily on site to permit acceptance of additional or different coins.

In accordance with the present invention, the examinations are made by coin presence sensors such as photoelectric devices which transmit electrical output signals to a combinatorial circuit where the determination is made. If the coin is acceptable, a signal indicative of the denomination is transmitted to an accumulator and to the device being operated, such as a vending machine.

In a device designed to accept three or four coins, for example, three sensors can be utilized in a two-step examination process. The sensors include a primary sensor and a pair of secondary sensors spaced from the primary sensor in the direction of coin movement, the secondary sensors being spaced apart both in the direction of coin movement, and upwardly from the coin support track. In the first examination phase, the sensors, together with the combinatorial circuit, classify all coins offered as falling in one of five size categories, namely, (a) coins large enough to concurrently cover all three sensors; (b) coins only large enough to cover the third at a time when at least one of the others is uncovered; (c) coins large enough to cover concurrently the primary sensor and one of the two secondary sensors but not large enough to cover, at any time, the other secondary sensor; (d) coins not large enough to cover the higher of the secondary sensors but large enough to cover the other secondary sensor and primary sensor, successively but not concurrently, and (e) coins not large enough to cover any of the sensors.

The second phase of examination determines if a function dependent upon both the coin's velocity and chordal length is within prescribed limits. This is accomplished by causing the combinatorial circuit to measure the duration of occlusion of sensors. The circuit compares the duration of the signals with predetermined values representative of acceptable coins and, if the comparison is favorable, produces a signal indicating that the coin in the device is deemed acceptable denomination.

In the drawings:

FIG. **1** is a front elevational and schematic diagram of a coin selector device for determining the authenticity and denomination of a coin formed in accordance with this invention;

FIG. **2** is a schematic elevational diagram of a sensor array illustrating the location of the individual sensors with respect to various representative coin diameters;

FIG. **3** is a diagram of a combinatorial circuit used in conjunction with the sensor array of FIG. **2** to provide the logic determination required in the evaluation of coins; and

FIG. **4** is a sensor signal sequence table illustrating the operation of the individual sensors for four representative coins.

It should be noted that the drawings are not intended to be dimensionally proportionate or scale representations of the devices illustrated. It will be clear to those skilled in the art that, whereas the invention has been described in terms of AND and OR logic elements, alternative logical elements may be used without departing from the invention. Similarly, the word signal has been used in most cases to represent the relatively high output voltage of certain devices having two output voltages but the invention is not limited to the disclosed use of such signals.

DETAILED DESCRIPTION

Coin Selector Device

In FIG. **1**, there is illustrated a coin selector device **10** having a coin support track **12** and two inclined surfaces **14, 16**, the two inclined surfaces together making up a meander path. The device **10** also is provided with a solenoid controlled coin arrestor **18**, a magnetic coin scavenger **19**, an eddy current brake magnet **20** and an array of coin presence sensing means **21** for sensing various properties of a coin to determine the coin's acceptability. The selector device also includes a coin acceptance gate **22**, a coin acceptance passageway **23** and a coin rejection passageway **24**.

A coin is inserted into the coin selector device **10** by dropping it into a funnel shaped entrance **26** from which it drops downwardly toward the support track **12** the coin being slowed in its travel by the meander path surfaces **14, 16** and the coin is brought to rest on the support track **12** by the arrestor **18** which constitutes a mechanical stop. As the coin passes down toward the track **12,** it passes a coin arrival sensor **28** which senses the presence of a coin in the system and initiates operation of various electronic components described below.

Many sensing devices are suitable, such as mechanical or inductive switches, but a preferred sensor is a photoelectric device, for example, a photosensitive transistor operating in conjunction with a light source on opposite sides of the coin passageway with the sensor providing signals indicative of when the sensor is occluded or obscured.

While the coin is held in a stationary position on the support track **12** by the arrestor **18,** it resides adjacent to the magnetic coin scavenger **19** which may be a permanent magnet or other means known in the art for removing ferromagnetic coins or objects from the system, so they do not become trapped by its other magnets. At a predetermined period of time after the coin is sensed by the coin arrival sensor **28,** the solenoid (not shown) which controls the arrestor **18** is actuated to remove the arrestor from the path of the coin permitting the coin to pass down the track. If the coin is ferromagnetic, it will be prevented from moving down the track by the magnet **19.** Any one of several known mechanisms can be used to remove the ferromagnetic coin from the system, for example, the magnetic coin eliminator described in U.S. Pat. application Ser. No. 66,126, filed Aug. 21, 1970 as a continuation of Ser. No. 808,943, filed Mar. 20, 1969.

A coin released by arrestor **18** is accelerated and decelerated in a manner which is dependent upon the coin's physical properties. In this embodiment when a coin is released it proceeds to roll down the support track **12** and passes through a magnetic field produced by the magnet **20.** The magnet **20,** a permanent magnet or an electromagnet is located on one side of the support track **12.** The magnetic field circuit is completed by a second magnet or a plate (not shown) of ferromagnetic material such as mild steel which may be located directly opposite the magnet **20** in order to provide a field across the passageway through which the coin passes. The eddy currents induced in the coin as the coin moves through the magnetic field magnetically interact with the magnet **20,** producing a retarding force on the coin. The magnitude of the retarding force exerted on the coin is directly proportional to the velocity of entry of the coin into the magnetic field and the coin's conductivity. The preferred strength of the magnetic field is such as to reduce the velocity of the coins intended to pass through the system by between 10 and 50 per cent. The change in coin velocity as it passes through the magnetic field is an indicia of the coin's acceptability.

After the coin passes by magnet **20,** it passes between a light source (not shown) on one side of the track **12** and a sensor array **21** on the other. Here a determination the coin's acceptability and denomination is made. This sensor array is described in greater detail below. After the coin passes the sensor array **21,** it rolls off the track **12** and drops downwardly toward a coin acceptance gate **22.** The gate is solenoid actuated and extends into the coin passageway. If the coin sensor array together with logic circuitry discussed hereafter determines that the coin passing through the system is not acceptable, the gate is not removed from the passageway and the coin bounces from the gate **22** into the rejection passageway **24.** If the sensors and logic system determines that an acceptable coin has passed through the system, a signal is transmitted to the gate solenoid which retracts the gate **22** from the coin passageway and the coin drops into the acceptance passageway **23.**

Coin Sensor Array

Turning now to FIG. **2,** the coin sensor array **21** is schematically illustrated so that the principle of its operation may be described. In the following description, coin movement in FIG. **2** will be assumed to be from the viewer's left to right.

The sensor array **21** is primarily designed for the recognition of at least four different denomination coins which, for simplicity of discussion, shall be considered to be the 5, 10, 25 and 50 cent pieces of U.S. coinage. The coin sensor array **21** comprises a primary sensor **42** and a series of secondary sensors **44** and **46** spaced from the primary sensor **42,** with the entire array **21** mounted in a fixed relationship to the coin support track **12** which supports the edge of the coins being examined. Secondary sensor **46** is spaced from the primary sensor **42** by a distance which is (1) greater than the chord length along the line between sensors **42** and **46** of the largest coins of the acceptable denomination of smallest diameter, namely a 10 cent piece, when that coin is resting in the track between the sensors with one edge just barely obscuring sensor **42;** and the largest coins of the acceptable denomination of smallest diameter (2) less than the chord length along that line of the smallest coins of the acceptable denomination of the second smallest diameter, namely a 5 cent piece, when that coin is resting on the track between the sensors with one edge just barely obscuring sensor **42.** The location of sensors **42** and **46** above the coin support track **12** is less than the diameter of the smallest acceptable coin of all, namely the smallest acceptable 10 cent piece.

The second secondary sensor **44** is spaced from the primary sensor **42** by a distance which is (1) greated than the chord length along the line between sensors **42** and **44** of the largest coins of the acceptable denomination of second largest diameter, namely the 25 cent piece, when that coin is resting on the track between the sensors with one edge just barely obscuring sensor **42;** and (2) less than the chord length along that line of the smallest coins of the acceptable denomination of largest diameter, namely the 50 cent piece, when that coin is resting on the track between the sensors with one edge just barely obscuring sensor **42.** The location of sensor **44** above the coin support is greater than the diameter of the largest coins of the acceptable denomination of second smallest diameter, the 5 cent piece, and less than the diameter of the smallest coins of the acceptable denomination of second largest diameter, the 25 cent piece.

It can be seen that the three sensors **42, 44** and **46** are arrayed so that sensor **44** is never obscured by either 10 or 5 cent pieces but is obscured by both 25 and 50 cent pieces and, that sensors **42** and **44** can be concurrently obscured (i.e.: sensor **42** will be obscured during part of the period when sensor **44** is obscured by the 50 cent piece but not by the 25 cent piece. Likewise, sensor **46** is obscured by all acceptable coins and the sensors **46** and **42** are concurrectly obscured by the three larger coins, the 5, 25 and 50 cent pieces, but are not concurrently obscured by the smallest acceptable coin, the 10 cent piece. By the use of a relatively simple logic system described below, the information provided by these three sensors can be used to classify all coins into five categories as follows: (a) coins large enough to concurrently cover all three sensors; (b) coins only large enough to cover a selected to of the three sensors concurrently but large enough to cover the third at a time when at least one of the others is uncovered; (c) coins large enough to cover concurrently the primary sensor and one of the two secondary sensors but not large enough to cover, at any time, the other secondary sensor; (d) coins not large enough to cover the higher of the secondary sensors but large enough to cover the other secondary sensor and primary sensor, successively but not concurrently and (e) coins not large enough to cover any of the sensors.

COMBINATORIAL CIRCUIT

Coin Size Categorization Circuit

While many different combinatorial circuits or logic systems can be used to provide the desired results a specific circuit or logic system **47** is illustrated in FIG. **3** which should be read in combination with the sensor signal sequence table shown in FIG. **4.** The logic system utilizes four coincidence gates **48, 50, 52, 54** and two bi-stable multivibrators or flip-flops **56, 58.** Each gate represents one acceptable coin and is set to produce an output signal when all of its input signals are in the high state. Each gate is responsive to signals from the three coin property sensing array sensor **42, 44, 46,** as well as signals from the flip-flop **56.** For illustrative purposes, the signals from the sensors are considered to be "high" when the sensors are lighted and not obscured, and "low" when they are obscured by a coin.

Examining first the 50 cent piece coincidence gate **48,** it can be seen that gate **48** will produce a low signal only when a coin large enough to obscure all three sensors **42, 44, 46** passes through the system. The output from each sensor **42, 44, 46** is directed through an inverter **60, 62, 64,** respectively, which then leads to the inputs of the gate **48.** The fourth input to the gate **48** comes from the flip-flop **56** which is set by a signal from the sensor **44.** Before a coin obscures the sensors, the sensors produce a high signal which results in the impressing of a low signal, because of the inverters **60, 62, 64,** on the input of the gate **48.** Furthermore, the flip-flop **56,** which is reset by the entry of a coin into the system such as by a signal from the coin arrival sensor **28,** will not provide a proper signal on the input to the gate until the sensor **44** is covered setting the flip-flop **56.** As a large coin passes down the support track **12** after passing the eddy current magnet, it first covers sensor **44** which sets the flip-flop **56** to provide the desired high signal on the input lead **66** of the gate **48** as well as producing the enabling high signal, because of the inverter **62,** on the input lead **68.** The coin then obscures sensor **46** producing a high signal, because of the inverter **64,** on the lead **70** and then obscures sensor **42** producing a high signal on the lead **72** because of inverter **60.** The condition of four simultaneous high signals on the inputs to the gate **48** occurs only when all three sensors are simultaneously obscured (see FIG. 4) resulting in the generation of a low signal on the output lead **74** of the gate **48** until the trailing edge of the coin passes the first sensor **44.** Therefore, a low signal on the output lead **74** indicates that a coin large enough to cover all three sensors simultaneously has passed the sensor array **21.** This coin size category includes 50 cent pieces.

Similarly, it can be seen that the only time all four input leads of coincidence gate **50** are high is when the coin is large enough to cover sensor **44,** thus triggering the flip-flop **56,** and large enough to cover the sensors **42** and **46** concurrently but not large enough to cover the sensor **44** during the time that sensors **42** and **46** are covered. This is because the output from sensor **44** is fed directly to the gate **50** rather than through the inverter **62** whereas the output from the sensors **46** and **42** are fed to inverters **64** and **60** respectively before going to the gate **50.**

Looking now at the coincidence gate **52,** representing a coin size category which includes the 5 cent piece, a high signal will be produced on input lead **76** coming from the flip-flop **56** only when the flip-flop **56** had not been set by a coin obscuring the sensor **44** since the output from the flip-flop **56** to the gate **52** is opposite to the one that is fed to the coincidence gates **48** and **50.** Furthermore, it can be seen that the output signal from the sensor **44** goes directly to the input lead **78** rather than through the inverter **62** so that a high signal exists on lead **78** only when sensor **44** is not obscured. Input leads **80** and **82** representing sensors **46** and **42** respectively lead to those sensors through inverters **64** and **60** respectively thus experiencing simultaneous high signals only when those sensors are obscured concurrently.

A similar analysis of coincidence gate **54** shows that it will receive four high input signals only when sensor **44** has not been obscured at all and sensors **42** and **46** are not concurrently obscured. Coincidence gates **52** and **54** have a fifth input, namely, inputs **84, 86** derived from flip-flop **58.** The purpose of this input is to indicate that a coin has passed through the system which has a diameter at least equal to the height of the sensor **46** above the track. Since gate **54** is enabled when none of the three sensors **42, 44, 46** are covered, it is appreciated that that condition also exists when no coin passes through the system. To avoid this ambiguity, the flip-flop **58** is reset by a coin entering the system by means of the arrival sensor **30** to produce a low signal on the inputs **84, 86** and, when sensor **46** becomes obscured by a coin, the flip-flop **58** is set and produces a high signal on the inputs **84, 86** thus enabling the gates **52, 54** if the other conditions are met. Therefore, a low signal on the output lead **92** of gate **54** indicates that a coin large enough to obscure sensor **46** but not sensor **44** and not large enough to obscure sensors **46** and **42** concurrently has passed the sensor array **21.** This coin size category includes the 10 cent piece.

The output leads **74, 88, 90** and **92** from the gates **48, 50, 52, 54** respectively lead to a gate **94** which produces a high output signal when the signal on any one of its inputs, leads **74, 88, 90** or **92** is low. The output signal from the gate **94** is directed through a differentiator **95** and an OR gate **96** to the flip-flop **58.** The flip-flop **58** is reset as soon as a high output signal from gate **94** indicates it has become disabled by the completion of a coin size categorization signal. As was mentioned above the flip-flop **58** is also reset by a signal from the coin arrival sensor **30** indicating that a coin has entered the device.

The output signal from the gate **94** is also directed to the coin acceptance ratio examination phase of the combinatorial circuit **47** as described below. In addition to the leads **74, 88, 90** and **92** leading to the gate **94** corresponding individual leads **74', 88', 90'** and **92'** are also provided to make available individual signals indicating the size category of the coin passing through the coin selector device. When a coin does not obscure sensor **46,** either because it is too small or it does not reach the sensor **46,** no signal occurs on any of the leads **74', 88', 90'** and **92'.** This completes the discussion of size category determination.

Coin Velocity and Chordal Length Examination Circuit

FIG. **3** also illustrates the remainder of the logic system which completes the combinatorial circuit **47** allowing comparison of the signals generated by the various sensors which form the coin property sensing array **21** with predetermined signals to determine whether or not an acceptable coin has passed through the system. Four flip-flops **102, 104, 106** and **108** are provided representing the acceptable coins, in this case a 50, 25, 5 and 10 cent piece, respectively. An enabling lead from the corresponding coincidence gates **48, 50, 54, 52** is fed into each of the flip-flops **102, 104, 106** and **108,** so that a low signal on any one of the gate output leads **74', 88', 90'** and **92'** partially enables one of the flip-flops **102, 104, 106** and **108.** Since only one of these output leads can have a low signal at any one time, the remaining three flip-flops are disabled.

Each of the flip-flops, **102, 104, 106** and **108** are connected to a decoder **110** which is fed by a counter **112.** A timing oscillator or clock **114** is gated to the counter **112** along lead **115** by a coincidence gate **116** which directs a desired signal to the counter **112** only when all of its inputs are high. The other inputs to the gate **116** are the output lead from the gate **94**, a lead **117** from the "set" output of the flip-flop **58** indicating that a proper size coin is in front of the coin sensor array **21,** and a lead **118** from the decoder **110.** The decoder lead **118** represents a high count stop so that once the counter gets beyond the highest count that an acceptable coin will have, the signal on lead **118** automatically disables gate **116** to prevent recycling of the counter.

The timing oscillator signal is converted by a circuit **119** into positive pulses referred to as A-clock pulses and negative pulses referred to as B-clock pulses, the pulses being out of phase with one another. The positive pulses are fed to the counter **112** and the negative pulses are directed to the decoder **110** in order to trigger the decoder to read the counter **112** intermediate the transitions between high and low state of the positive pulses.

For a four coin set as described in this embodiment, the decoder provides a series of four sets of output signals, each set consisting of a low and high count for each particular coin. Each of these sets of decoder output signals are directed to the corresponding one of the flip-flops **102, 104, 106** and **108,** the low count signal being an enabling signal and the high count signal being a disabling signal. The fourth enabling signal to each flip-flop is a signal on the common lead **120** from the output of the coincidence gate **116** so that the flip-flop cannot be enabled unless the gate **116** has all four inputs as desired, in this case high. This prevents setting of these flip-flops if the counter or decoder is erroneously triggered by stray signals.

When a coin which fits within a size category corresponding to either 10, 5, 25 or 50 cent pieces, passes through the coin selector **10** the gate **116** is enabled and the positive pulses are fed to the counter **112.** The number of pulses fed to the counter **112,** and hence to the decoder **110,** are related to the size of the coin and are inversely proportional to the velocity of the coin that is passing through the system. As soon as the gate **48, 50, 52** or **54** which enabled the gate **94** becomes disabled, the gate **116** becomes disabled and the counter stops receiving pulses.

Looking at the sensor signal sequence table in FIG. **4**, there is illustrated the time during which the flip-flops **102, 104, 106** and **108** are enabled for acceptable coins. If the counts received by the decoder during the interval represented by the set and reset dotted lines in the sequence table is equal to the prescribed acceptable number for an acceptable coin represented by the flip-flop enabled by the coin size determination, that flip-flop remains set. The set flip-flop provides a signal indicating that a coin of acceptable chordal dimension and velocity has passed through the system and indicates the denomination of that coin. Since the counts are representative of the size and velocity of the coin and, for the reasons described above, since the velocity of an electrically conductive, non-ferromagnetic coin after it is exposed to the magnet **18** is related to the coin's acceptance ratio, this examination of coin size and coin velocity provides an accurate means for determining the authenticity and denomination of a moving coin.

Because only one of the flip-flops **102, 104, 106, 108** can be set at any one time, there is no ambiguity.

A signal from the enabled flip-flop is then fed to a coin acceptance means **122** which energized the coin acceptance solenoid (not shown) to remove the coin acceptance gate **22** from the path of the coin and allow the coin to drop into the coin acceptance passageway **23.** If none of the flip flops **102, 104, 106, 108** are enabled by the time the coin reaches the coin acceptance gate **22,** the coin will hit the gate and be directed into the coin rejection passageway **24.**

In addition to the enabled flip-flop transmitting a signal to the coin acceptor **122**, a signal also is transmitted to a conventional pulse maker **124** which in turn sends a weighted signal to a conventional binary accumulator **126.** The weighted signal is representative of the particular flip-flop that is enabled. For example, the pulsemaker **124** will transmit a single pulse is the 5 cent flip-flop **108** is enabled, a double pulse if the 10 cent flip-flop **106** is enabled, five pulses if the 25 cent flip-flop **104** is enabled and ten pulses if the 50 cent flip-flop **102** is enabled. Alternatively, for a 50 cent whose weighted value is ten times that of the 5 cent the pulsemaker could gate five pulses into the second stage of the binary accumulator **126.** The accumulator is conventionally gated to the coin operated device **128** so that the device may vend at certain predetermined accumulated values.

A pulsemaker disabling coincidence gate **130** is provided having a pair of inputs, one input coming from the accumulator and representing a high price disable and the second input coming from the last of the sensors **42** in the array **21.** A high price disabler lead **132** disables the pulsemaker **124** when the accumulator has registered a predetermined maximum value, such as the price of the highest priced item in the coin operated device. A similar high price disabler lead **134** is directed to a coincidence gate **136** to prevent acceptance of any coins after the accumulator has registered the predetermined maximum value. If any additional coins are inserted into the coin sensing device after the accumulator has reached its maximum value, the coins will be rejected and returned to the depositor.

The signal from the sensor **42** is provided to the pulsemaker **124** in order to disable the pulsemaker until the coin has cleared the sensor **42** so that it is certain that the counter has completed registration of an appropriate count for the coin before the pulsemaker examines each of the flip-flops **102, 104, 106, 108.** This will preclude the pulsemaker from recognizing a signal from one of the flip-flops during an interim period while the counter is still recording coin velocity.

While the above discussion pertains to a coin sensing array **21** having a single primary sensor **42** and a series of two secondary sensors **44, 46** it is clear that the disclosed embodiment can be modified to use a single secondary sensor or a number greater than two can be used. Each secondary sensor provides the capability of accurately evaluating at least two different but similar size coins. While each secondary sensor together with the primary sensor **42** is capable of examining more than a pair of coins, for maximum accuracy it is preferred that the secondary sensor be located with respect to the primary sensor such that the time duration during which the velocity check of the coin is being made is minimal. For example, turning to FIG. **2,** secondary sensor **24** together with primary sensor **42** could be used to examine the velocity properties of all coins larger than the spacing between these two sensors, namely the 5, 25 and 50 cent pieces. However, the time duration of a velocity check for the 25 and 50 cent pieces would be undesirably large and render the coin sensing system less acurate. The acuracy of the system is increased greatly by the addition of one more sensor **44** which provides the ability to more closely examine the coin acceptance ratio of the two larger coins and also the chordal dimension of the two larger coins. It should also be noted that while the description above and the accompanying drawings assume location of the series of secondary sensors ahead, with respect to coin travel, of the primary sensor **42,** the orientation of these sensors could be reversed with an accompanying modification of the logic circuitry. Finally, it should be noted that the coin sensing array described herein is useful not only in the disclosed embodiment for conductive, non-ferromagnetic coins, but also in any other coin or token discriminator in which the velocity of a moving coin or token is dependent in some way upon factors associated with the denomination and authenticity of the coin.

I claim:

1. A device for determining the authenticity and denomination of coins of a plurality of acceptable denominations comprising,

a passageway along which coins may travel,

means for causing a magnetic field to move relative to a coin in the passageway,

at least two coin presence sensors spaced apart in the direction of coin travel, the distance between the sensors being such that when the edge of a coin of the largest acceptable diameter of one acceptable denomination is at a first sensor the chord of that coin along the line between the sensors is shorter than the spacing of the sensors and when the edge of a coin of the smallest acceptable diameter of another acceptable denomination is at the first sensor the chord of that coin along the line between sensors is longer than the spacing of the sensors,

means to establish the coin path in the region of the sensors,

means to measure the duration of concurrent presence of a coin at at least two of the sensors,

means to measure the interval subsequent to the presence of a coin at the first sensor and prior to the arrival of the coin at a second sensor,

means to compare each of the measurements with standards for acceptable coins, and

means to produce an output signal if a measurement is within a predetermined tolerance of a standard.

2. A device for determining the authenticity and denomination of coins of a plurality of acceptable denominations comprising,

a coin passageway,

means for causing a magnetic field to move relative to a coin in the passageway,

an array of coin presence sensors down the passageway from at least a portion of the magnetic field,

the array including a primary sensor and secondary sensors each spaced from the primary sensor and secondary sensors each spaced from the primary sensor distances less than a given chordal dimension of an acceptable denomination coin and greater than the chordal dimension of the next smaller acceptable denomination diameter coin,

means to determine the coin path in the region of the array,

means to generate a signal denoting the occlusion of each sensor,

a logic circuit using the signals to determine whether a coin is large enough to be particular acceptable denomination and small enough not to be the next larger acceptable denomination, the logic circuit having an output representative of the denomination determined,

means to measure the duration of concurrent signals,

means to measure the interval between the end of a signal and the beginning of another signal,

means to compare each of the measurements with standards for acceptable coins, and

means to produce an output signal if a measurement is within a predetermined tolerance of a standard.

3. A device for determining the authenticity and denomination of coins of a plurality of permissible denominations comprising,

a coin track,

first means for comparing a value related to a chordal dimension of the coin with predetermined values, and

second means for comparing a value related to the coin velocity and chordal dimension with predetermined values,

wherein the first means includes a primary sensor and two or more secondary sensors, each secondary sensor being spaced by a different distance than the other secondary sensors (a) from the primary sensor in the direction of coin travel and (b) normal to the crack transversely of the direction of coin travel, at least one of the sensors being spaced from the track in a direction normal to the track a distance less than the diameter of the smallest permissible coin,

a first circuit to determine if said chordal dimension is at least equal to the distance between the primary sensor and one of the secondary sensors, and

wherein the second means includes means for producing a magnetic field in a zone through which the coin passes before the coin reaches at least one of said sensors, and

a second circuit for examining the time that a coin, whose said chordal dimension is at least equal to the distance between the primary and one of the secondary sensors, is sensed concurrently by those sensors, and a coin, whose said chordal dimension is less than the distance between the primary sensor and one of the secondary sensors, takes to travel between those sensors.

4. A device as defined in claim **3** wherein the distance between at least one secondary sensor and the primary sensor is greater than the maximum acceptable predetermined dimension of a permissible coin.

5. A device as defined in claim **3** wherein the distance between at least one secondary sensor and the primary sensor is less than the maximum acceptable predetermined dimension of a permissible coin.

6. A device as defined in claim **3** wherein the distance between each secondary sensor and the primary sensor is greater than the maximum acceptable predetermined dimension of one permissible coin and less than the minimum acceptable predetermined dimension of another permissible coin.

7. A device as defined in claim **3** wherein, for a coin whose said chordal dimension is less than the distance between the primary and any of the secondary sensors, the second circuit means examines the time interval between the instant the coin ceases being sensed by one of said primary and secondary sensors until it is sensed by the other of said primary and secondary sensors.

8. A device as defined in claim **3** including a third circuit for comparing the time with predetermined values representative of acceptable coins, the third circuit means providing a signal indicative of the denomination of acceptable coins.

9. A device as defined in claim **3** including means for sensing the arrival of a coin at a point prior to said first means and said second means and including means for enabling the first and second circuits to perform their intended functions, the enabling means being actuated by the arrival sensing means.

10. A device as defined in claim **3** wherein the second circuit includes a signal gate responsive to the primary sensor and the secondary sensors, a signal source and a counter, the signal from the signal source being directed to the counter through the signal gate, the signal received by the counter being representative of the combined property of the coin as it travels between the sensors.

11. A device as defined in claim **3** wherein the first circuit includes at least a first and a second coincidence gate, the first coincidence gate being responsive to signals indicating concurrent coin presence at the primary sensor and a secondary sensor, and the second coincidence gate being responsive to signals indicating initial coin presence at one of the sensors and the concurrent absence of a coin at the primary sensor and a secondary sensor, the first gate when enabled indicating the existence of a coin in the device within the group of coins whose said chordal dimensions is at least equal to the distance between the primary and secondary sensors and the second gate when enabled indicating the existence of a coin in the device within the group of coins whose said chordal dimension is less than the distance between the primary and secondary sensors.

12. A device as defined in claim **3** wherein the second circuit includes a signal gate responsive to each of the coincidence gates, a pulse source and a counter, the signal from the pulse source being directed to the counter through the signal gate, the signal received by the counter being representative of the duration of presence signals, the device including means for receiving information from the counter and from the coincidence gates and for comparing such information with predetermined values characteristic of acceptable coins, and means for providing a signal representative of the denomination of the coin if said values are equal to the predetermined values.

13. A device as defined in claim **3** including at least a first and second secondary sensor and where the first circuit comprises first, second, third and fourth coincidence gates;

the first coincidence gate being responsive to signals indicating concurrent coin presence sensing by the first secondary sensor and the primary sensor;

the second coincidence gate being responsive to signals concurrently indicating a concurrent coin presence sensing by the second secondary sensor and the primary sensor, and the absence of concurrent coin presence sensing by the first secondary sensor and the primary sensor;

the third coincidence gate being responsive to signals indicating absence of coin presence sensing by the first secondary sensor and concurrent coin presence sensing by the second secondary sensor and primary sensor;

and the fourth coincidence gate being responsive to signals indicating absence of coin presence sensing by the first secondary sensor, absence of concurrent coin presence sensing by the second secondary sensor and primary sensor and previous coin presence sensing by the second secondary sensor, each of the coincidence gates providing a signal when it is enabled.

14. A device as defined in claim **13** wherein the second circuit includes a signal gate responsive to each of the coincidence gates, a pulse source and a counter, the signal from the pulse source being directed to the counter through the signal gate, and including means for receiving output information from the counter and from the coincidence gates, means for comparing such information with predetermined values characteristic of acceptable coins, and means for providing a signal representative of the denomination of the coin if said values are within a predetermined tolerance of predetermined values.

15. A method for determining the authenticity and denomination of coins of a plurality of permissible denominations comprising,

propelling a coin at a velocity influenced by the motion relative thereto of a magnetic field,

subsequent to affecting the velocity of the coin, passing the coin by at least two coin presence sensors spaced apart in the direction of coin travel, the distance between the sensors being such that when the edge of a coin of the largest acceptable diameter of one acceptable denomination is at a first sensor the chord of that coin along the line between the sensors is shorter than the spacing of the sensors and when the edge of a coin of the smallest acceptable diameter of another acceptable denomination is at the first sensor the chord of that coin along the line between sensors is longer than the spacing of the sensors,

measuring the duration of concurrent presence of a coin at least two of the presence sensors,

measuring the interval subsequent to the presence of a coin at a first sensor and prior to the presence of the coin at a second sensor,

comparing each of the measurements with standards for acceptable coins, and

producing an output signal if a measurement is within a predetermined tolerance of a standard.

16. A method for determining the authenticity and denomination of coins of a plurality of permissible denominations comprising,

affecting the velocity of a coin by causing the coin to move with respect to a magnetic field,

subsequent to affecting the velocity of the coin, passing the coin by an array of sensors at least two of the sensors of the array being spaced apart in the direction of coin travel, the distance between the sensors being such that when the edge of a coin of the largest acceptable diameter of one acceptable denomination is at a first sensor the chord of that coin along the line between the sensors is shorter than the spacing of the sensors and when the edge of a coin of the smallest acceptable diameter of another acceptable denomination is at the first sensor the chord of that coin along the line between sensors is longer than the spacing of the sensors,

generating a signal denoting the occlusion of each sensor of the array,

measuring the duration of concurrent signals,

measuring the interval between the end of a signal and the beginning of another signal,

comparing each of the measurements with values representative of acceptable coins, and

producing an output signal if a measurement is within a predetermined tolerance of a value.

17. The method of claim **16** wherein signals are also introduced to a logic circuit which operates on the signals to produce an output signal representative of the denomination of the coin.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,739,895 Dated June 19, 1973

Inventor(s) GUY L. FOUGERE and JOHN L. ROTHERY

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

Column 3, line 63, after "tion" insert --of--.

Column 4, line 44, "greated" should read --greater--.

Column 5, line 10, after "selected", "to" should read --two--.

Column 8, line 52, after "pulse", "is" should read --if--.

Column 9, line 40, correct the spelling of "acurate" and "acuracy" to --accurate-- and --accuracy--.

Column 10, (Claim 3) line 67, "crack" should read --track--.

Signed and sealed this 23rd day of April 1974.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents