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(54) Coin-discriminating device.

(57) The present invention discloses a coin-discriminating device having a light-emitter (11) which is placed in a portion of a coin path (1) and which irradiates a slit-shaped beam of light onto the peripheral edge of a coin (C) moving along the coin path (1), the slit-shaped beam of light being irradiated against serrations on the peripheral edge of the coin (C); a light-receiver (12) which receives light emitted from the light-emitter (11) and reflected from the coin (C), and which converts the light into an electrical signal; and a determination section (24) which determines whether the coin (C) has serrations from a detection signal from the light-receiver (12).

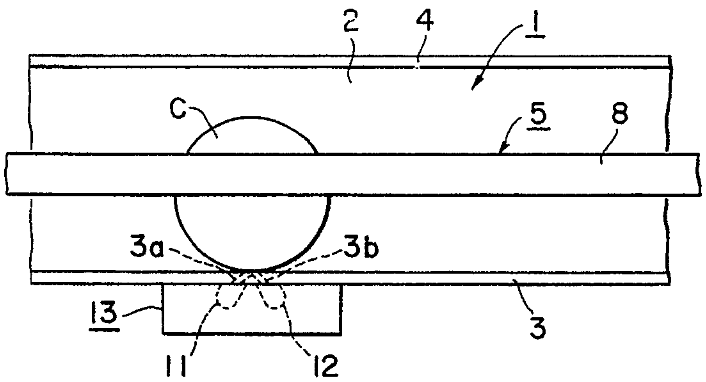

FIG. 1

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COIN-DISCRIMINATING DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a coin-discriminating device capable of detecting the presence or absence of serrations around the peripheral edge of coins and determining the value and authenticity of a coin.

In order to determine the value and authenticity of coins, detections of material, diameter, and other characteristics of the coin are generally performed. But such methods have difficulty in discriminating between coins of similar material and diameter, and often make mistakes. For example, since various coins such as the Korean 500-won coin and the Hong Kong N1-dollar coin are extremely similar in material and diameter to the Japanese 500-yen coin, it is difficult to discriminate between them.

However, these coins can be discriminated from one another by a method that detects serrations around their peripheral edges, because the Japanese 500-yen coin has no serrations around its peripheral edge whereas the Korean 500-won coin and the Hong Kong N1-dollar coin both have serrations around their peripheral edges.

A conventional method of determining whether or not there are serrations around the peripheral edge of a coin is described in, for example, Japanese Patent Laid-Open 59-17691 (1984). As shown in Fig. 10, a spot-shaped beam of light emitted from a light-emitting device a placed above a coin path is focussed onto the upper peripheral edge of a freely rotating coin in the coin path, and light reflected therefrom is received by a light-receiving device b and is converted thereby into an electric signal. The waveform of the electric signal is then shaped into a pulse signal, the pulses in the signal are counted each time a coin passes, and the coin is determined to have serrations around its peripheral edge if the number of pulses equals or exceeds a previously determined value.

However, although the Japanese 500-yen coin differs from other coins such as the Korean 500-won coin and the Hong Kong N1-dollar coin in that it does not have serrations around its peripheral edge whereas the other coins do, the Japanese 500-yen coin has "500 ◊ NIPPON" engraved around its peripheral edge. This causes a problem in that, when the spot-shaped beam of light is irradiated onto this engraved portion, a signal similar to that obtained from a serrated edge is detected, so the inscription is mistakenly determined to be serrations and the coin is incorrectly identified.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to provide a coin-discriminating device that clearly discriminates between serrations and engraving, and that can determine whether or not a coin has serrations around its peripheral edge.

The coin-discriminating device of the present invention is provided with a light-emitting means that irradiates a slit-shaped beam of light onto serrations on the peripheral edge of a coin on one side of a coin path that conveys coins, and a light-receiving means that receives light reflected from the coin. The slit-shaped beam of light is irradiated on the coin as it moves along the coin path. This slit-shaped beam of light irradiated onto the coin is reflected by the peripheral edge of the coin and is received by the light-receiving means as reflected light. A detection signal from the light-receiving means is used as the basis of a determination as to whether or not the peripheral edge of the coin has serrations.

In other words, the light-emitting means irradiates a slit-shaped beam of light onto the peripheral edge of the coin. Therefore, if, for example, the peripheral edge of the coin has an engraved inscription, the inscription covers only a small portion of the entire reflective surface, so the quantity of light reflected by the inscription varies only a little, and thus the effect on the detection signal of the light-receiving means is relatively small. In contrast, if the coin has serrations around its peripheral edge, the serrations extend over the entire reflective surface, so the quantity of reflected light is greatly affected by the serrations, and so the detection signal of the light-receiving means varies largely due to the serrations. Therefore, the way in which the detection signal of the light-receiving means varies can be used to clearly determine whether or not the coin has serrations, and also to discriminate between an inscription and serrations.

Therefore, the present invention provides a coin-discriminating device that has a simple structure and that can clearly determine whether or not a coin has serrations around its peripheral edge, without incorrectly identifying an inscription as serrations.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings,

Fig. 1 is a plan view of a coin path of an embodiment of the coin-discriminating device of the present invention;

Fig. 2 is a side view thereof;

Fig. 3 is a block diagram thereof;

Fig. 4A is a perspective view of a state in which a slit-shaped beam of light irradiates onto a coin with serrations;

Fig. 4B is a perspective view of a state in which a slit-shaped beam of light irradiates onto a coin that does not have serrations but that does have an engraved inscription;

Figs. 5A, 5B, and 5C are waveform diagrams obtained in a case in which a coin has serrations;

Figs. 6A, 6B, and 6C are waveforms diagrams obtained in a case in which a coin does not have serrations;

Fig. 7 is a plan view of an entrance portion of a coin path;

Fig. 8 is a block diagram of another embodiment of the present invention;

Fig. 9 is a waveform diagram; and

Fig. 10 is a perspective view of a conventional device in a state in which a spot-shaped beam of light irradiates onto a coin that does not have serrations but that does have an engraved inscription.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In an embodiment of the coin-discriminating device of the present invention shown in Figs. 1 and 2, a path base plate 2 provided in a coin path 1 is provided on either side thereof in the widthwise direction of the path with guides 3 and 4 that are in contact with the peripheral edge of a coin C and that regulate the movement of the coin C, and a conveyor means 5 is provided above the path base plate 2. The conveyor means 5 has a conveyor belt 8 made of, for example, rubber, stretched so as to rotate about pulleys 6 and 7, the conveyor belt 8 pressing against the upper surface of the coin C entering along one of the guides 3 at an entrance portion of the coin path 1, and the pressure of the conveyor belt 8 moving the coin C along the guide 3 while ensuring that the coin C is unable to freely rotate. Note that the movement of the peripheral edge of the coin C along the guide 3 causes a certain amount of rotation of the coin, but this rotation does not enter the range of free rotation.

The outer side of the guide 3 is provided with a light-emitting and -receiving unit 13 comprising a light-emitting device 11, consisting of a light-emitting means such as a light-emitting diode that emits a slit-shaped beam of light onto the peripheral edge of the coin C, and a light-receiving device 12, consisting of a light- receiving means such as a photodiode that receives light reflected from the peripheral edge of the coin C and converts the reflected light into an electrical signal.

The light emitted from the light-emitting device 11 is passed through a slit-shaped aperture 3a in the guide 3 in such a way that a slit-shaped beam of light is constantly emitted into the coin path 1 against serrations in the peripheral surface of the coin C. As shown in Figs. 1 and 2, when the coin C moving along the guide 3 passes the side part of the light-emitting and -receiving unit 13, the slit-shaped beam of light shines onto the peripheral edge of the coin C, light reflected from the peripheral edge of the coin C passes through another aperture 3b in the guide 3 to irradiate onto the light-receiving device 12, and the light-receiving device 12 converts the light into an electrical signal equivalent to the quantity of light received thereon. Note that the irradiation of the slit-shaped beam of light onto the peripheral edge of the coin C could either be over the entire width of the coin's edge, or over only a portion thereof.

A detector that is not shown in the figures is provided to detect the fact that the coin C moving along the coin path 1 has passed the side portion of the light-emitting and -receiving unit 13, and an output from this detector forms a reset signal SR that will be described later.

In Figure 3, an integrating circuit 21 removes a noise component from a detection signal input from the light-receiving device 12. Since this integrating circuit 21 removes noise component using smoothing function thereof, a smoothing circuit may be used in place of the integrating circuit. A waveform shaping circuit 22 is constructed from elements such as a comparator or a Schmitt trigger circuit, and converts an output signal input from the integrating circuit 21 into a pulse signal. A counter 23 that is one example of a determination means 24 counts the total number of pulses in the pulse signal that is input from the waveform shaping circuit 22 to a clock input terminal CK. If this total number equals or exceeds a fixed value, a determination signal s is output from a carry output terminal CA, and the total number is reset to zero by the reset signal SR input to a reset input terminal R.

The operation of the above embodiment of the present invention will now be described.

As the conveyor belt 8 of the conveyor means 5 rotates, the coin to be identified is transferred along the coin path 1. The conveyor belt 8 presses against the upper surface of the coin C that enters the entrance portion of the coin path 1 and moves along one of the guides 3, and the coin C moves along in contact with the guide 3 while being restrained against free rotation by the pressure of the conveyor belt 8.

The slit-shaped beam of light that is constantly irradiated from the light-emitting device 11 passes through the slit-shaped aperture 3a into the coin path 1, and, when the coin C is moved by the conveyor belt 8 to the side of the light-emitting and -receiving unit 13 along the guide 3, the slit-shaped beam of light irradiates onto the peripheral edge of the coin C, the light reflected from the coin C passes through the aperture 3b in the guide 3 and enters the light-receiving device 12, and the light that enters the light-receiving device 12 is converted into a signal corresponding to the quantity of light.

If, as shown in Fig. 4A, the coin is one that has serrations around its peripheral edge, such as a Korean 500-won coin, the quantity of light reflected by the serrations varies widely. Therefore, a number of peak waveforms are generated in accordance with the crests and troughs of the serrations in the detection signal output by the light-receiving device 12 that receives the slit-shaped beam of reflected light, and the result is a regular waveform with a large amplitude, as shown in Fig. 5A.

If, as shown in Fig. 4B, the coin is a Japanese 500-yen coin with no serrations around its peripheral edge, the detection signal output by the light-receiving device 12 that has received the slit-shaped beam of reflected light should have just one normal peak, as shown in Fig. 6A.

However, as previously mentioned, the Japanese 500-yen coin has the inscription: "500 ◊ NIPPON" engraved around its peripheral edge, and this inscription can easily affect the detection signal. In such a case, if the spot-shaped beam of light of the conventional device is irradiated onto the edge of the coin to obtain a detection signal, the quantity of light reflected by the inscription will vary widely in the same way as when there are serrations around the edge (as shown in Fig. 5A). Therefore, a detection signal of a waveform similar to that obtained from a coin with serrations is generated, so the detection signal is greatly affected by the inscription. In contrast, if a slit-shaped beam of light is irradiated onto the edge of the coin to obtain a detection signal, however, the quantity of reflected light will vary slightly and part of the peak waveform will change, but this peak waveform will be irregular and of a small amplitude, as shown for example in Fig. 6A, so the detection signal will be virtually unaffected thereby.

The integrating circuit 21 that inputs the detection signal from the light-receiving device 12 removes noise from the waveform of the detection signal, as shown in Fig. 5B or Fig. 6B, then outputs it.

The waveform shaping circuit 22 inputs the signal output by the integrating circuit 21, converts this output signal into a pulse signal, as shown in Fig. 5C or Fig. 6C, then outputs it. In general, if the coin has serrations, a pulse signal of at least five pulses is obtained, as shown in Fig. 5C; on the other hand, if the coin does not have serrations, a pulse signal of about one or two pulses is obtained, as shown in Fig. 6C.

The counter 23 inputs the pulse signal from the waveform shaping circuit 22 through the clock input terminal CK, counts the pulses in the pulse signal, and, if the number of pulses equals or exceeds a fixed value (for example, 5 pulses), it outputs the determination signal S from the carry output terminal CA. In other words, if the coin has serrations, the number of pulses in the pulse signal exceeds the fixed value, so the determination signal S is output from the carry output terminal CA. Conversely, if the coin does not have serrations, the number of pulses in the pulse signal does not exceed the fixed value, and, at the point at which the coin moving along the coin path 1 passed over the side of the light-emitting and -receiving unit 13, the number of pulses is reset to 0 by the input of the reset signal SR to the reset input terminal R.

If the determination signal S is output from the counter 23, the coin is determined to have serrations. On the other hand, if the determination signal S is not output from the counter 23, the coin is determined to have no serrations.

Note that, since the presence or absence of serrations is determined as the coin C being conveyed along the coin path 1 moves along the guide 3, and the slit-shaped beam of light is emitted from and received by the guide 3 side of the coin path 1, there is no particular need to adjust the mechanism in accordance with the diameter of the coin, so the coin-discriminating device of the present invention can be used for discriminating between metal coins of different diameters.

Since the coin C cannot rotate freely as it is being conveyed, the output signal of the light-receiving device 12 is obtained in proportion to the speed of movement alone of the coin and also to the distance between serrations around its peripheral edge. In other words, it is not affected by rotation of the coin. Therefore, it is easy for the device to discriminate between a component of the output signal due to the presence of serrations and a noise component, regardless of how fast the coin is moving, and the device can clearly determine whether or not the coin has serrations.

Note that one method of conveying a coin C along the coin path 1 while preventing it from rotating freely could be a conveyor method in which the coin path 1 is placed on a slant with the guide 3 side downward, with the conveyor belt 8 being employed to convey the coin C while controlling it to prevent it from rotating.

A method of moving the coin C along the guide 3 of the coin path 1 may be as shown in Fig. 7 in which, at a point at which each coin C is sent into the coin path 1 by centrifugal force imparted by a circular rotating plate 31, it is controlled by the conveyor belt 8 in such a manner that it does not freely rotate as it is impelled to move along the guide 3 by the centrifugal force. In another method, rotating rollers may be positioned at an angle inclined toward the guide 3 placed on the upper side of the coin path 1, and the coin C is continuously pushed thereby toward the guide 3 as it is conveyed thereby toward the end of the coin path 1.

In the above embodiment, a slit-shaped beam of light is irradiated onto the peripheral edge of a coin from a slit formed in the guide 3 that is a side surface of the coin path 1, but the construction could be such that, instead of a slit being formed in the guide 3, a specially prepared slit could be placed between the light-emitting device 11 and the coin. In addition, the construction of the above embodiment in which a slit placed between the light-emitting device 11 and the coin faces the serrations could be replaced by a construction in which the slit is made larger and the light is focussed through a lens, or any construction such that ultimately the light irradiated onto the peripheral edge of the coin is aimed so as to strike the serrations.

In the above embodiment, the presence or absence of serrations is determined by whether the determination signal S is output from the carry output terminal CA when the count of the counter 23 acting as the determination means 24 has reached a fixed value, but a comparator may be used as the determination means 24 and the presence or absence of serrations could be determined by whether the count matches a set value.

For example, as shown in Fig. 8, the determination means 24 could be constructed of a CPU 41, a ROM 42, and a RAM 43. In this case, the detection signal from the light-receiving device 12 is sampled by a sample-and-hold circuit 44, the resultant sample data is stored in the RAM 43, and the determination is based on the contents of the RAM 43. More specifically, an amplitude detection means 41a of the CPU 41 could function in such a way as to take the amplitude voltage (V_1, V_2, V_3, ..., V_n in Fig. 9) of each peak in the amplitude of the waveform from the light-receiving device 12 that exceeds a specific voltage (for example, 1 V), summing these voltages

$$\left(G_1 = \sum_{i-1}^{n} V_i\right),$$

and determining whether or not the value obtained in this way is a specific value. Another method could be a voltage difference calculus method that takes differences between waveform peaks, calculates the degree to which the amplitude voltage of the signal waveform varies, using the equation

$$\left(V_s = \frac{}{n-1} \sum_{i-1}^{n-1} |V_{i+1} - V_i|\right),$$

and bases the determination on a comparison of this value with a predetermined value. A repetition period detection means 41b of the CPU 41 may function in such a way as to base the determination on an investigation of whether or not repetition periods of each peak in the waveform (T_1, T_2, T_3, ..., T_n in Fig. 9) exceed a fixed value, or on a time difference calculus method that calculates the degree of randomness in periods by determining whether or not a value obtained from the equation

$$\left(T_s = \frac{1}{n-1} \sum^{n-2} |T_{i+1} - T_i|\right)$$

exceeds a specific value.

The determination may also be based on a combination of the determination method of the above embodiment and any of the voltage summation method, voltage difference calculus method, and time difference calculus method.

Claims

1. A coin-discriminating device characterized by comprising:

light-emitting means (11, 3a, 3b) provided in a portion of a coin path for irradiating a slit-shaped beam of light onto the peripheral edge of a coin moving along said coin path, said slit-shaped beam of light being irradiated against serrations on said peripheral edge of said coin;

light-receiving means (12) for receiving light emitted from said light-emitting means and reflected from said coin, and converting said light into an electrical signal; and

determination means (21, 22, 23) for determining whether said coin has serrations from a detection signal from said light-receiving means.

2. A coin-discriminating device according to claim

1, further comprising coin movement means for moving said coin along said coin path, while preventing said coin from rotating.

3. A coin-discriminating device according to claim 2, wherein said coin movement means is a belt drive means (5) which causes said coin to move in contact with a surface of said coin.

4. A coin-discriminating device according to claim 1, wherein said determination means is counting means (23) for counting a signal obtained by said light-receiving means, totalling said electrical signals outputted by said light receiving means and outputting a determination signal when count values reach or exceed a predetermined value.

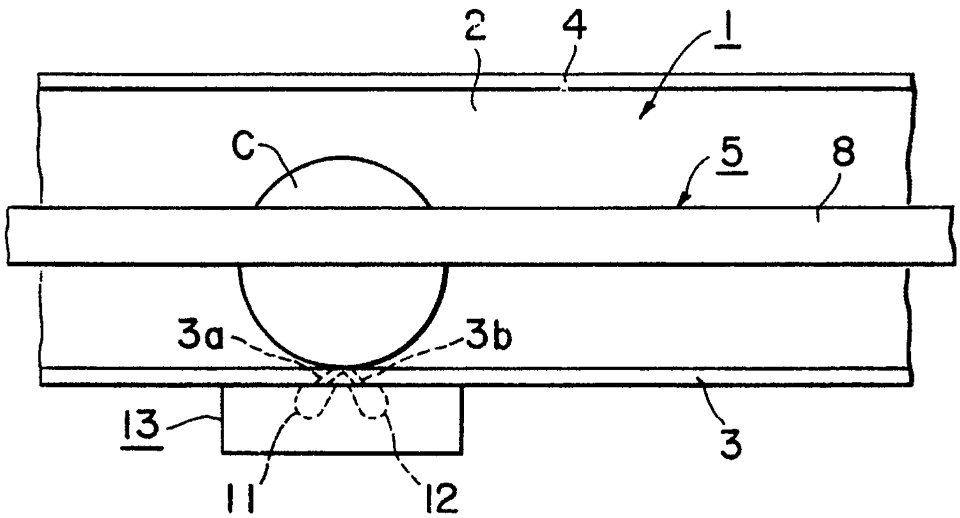


FIG. 1

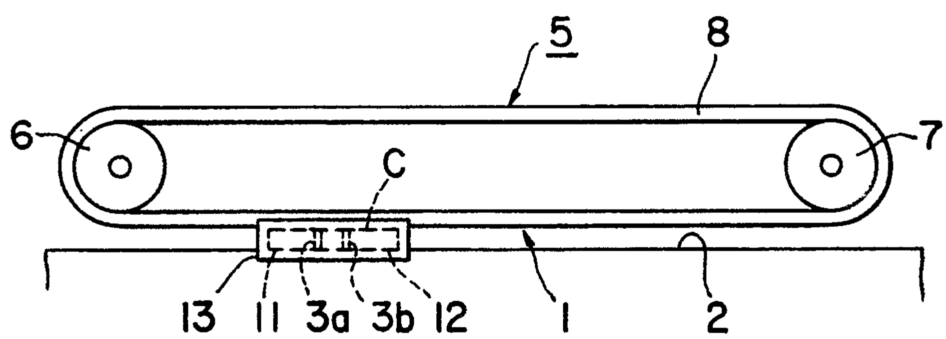


FIG. 2

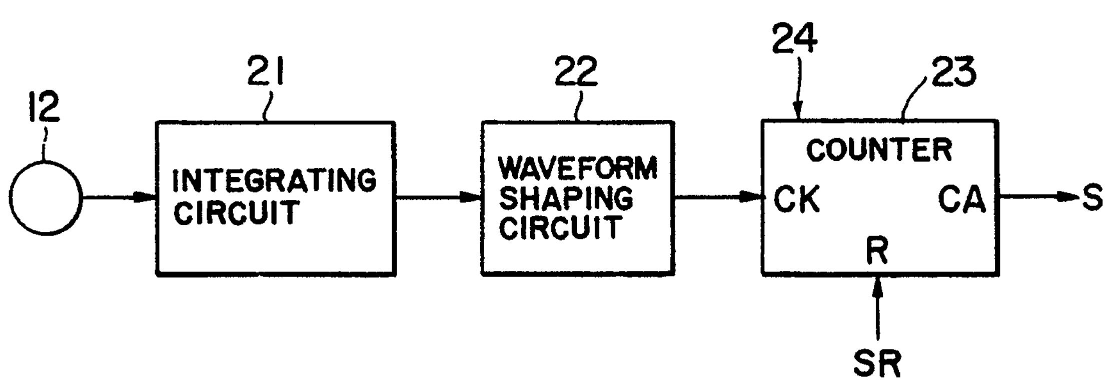


FIG. 3

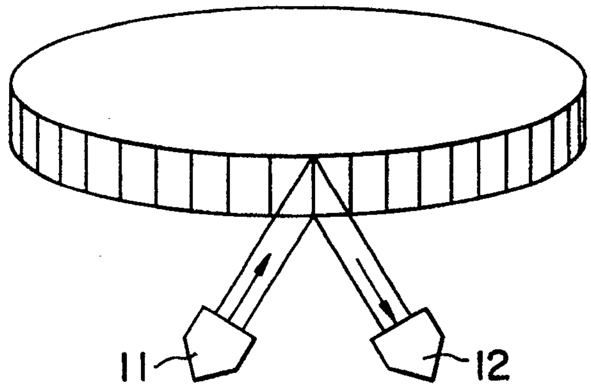


FIG. 4A

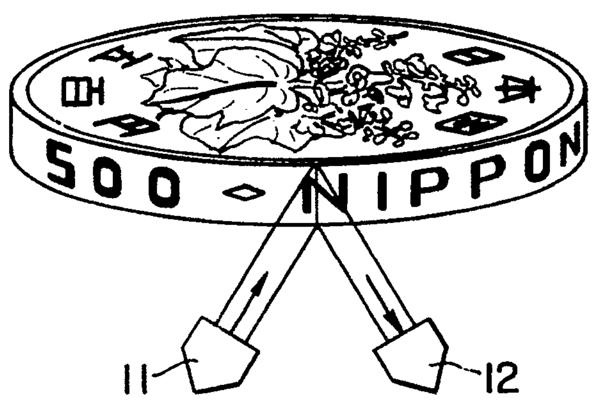


FIG. 4B

FIG. 5A

FIG. 5B

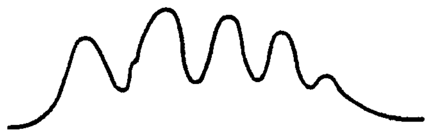
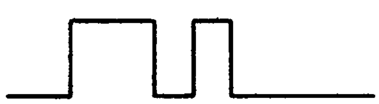


FIG. 5C

FIG. 6A

FIG. 6B

FIG. 6C



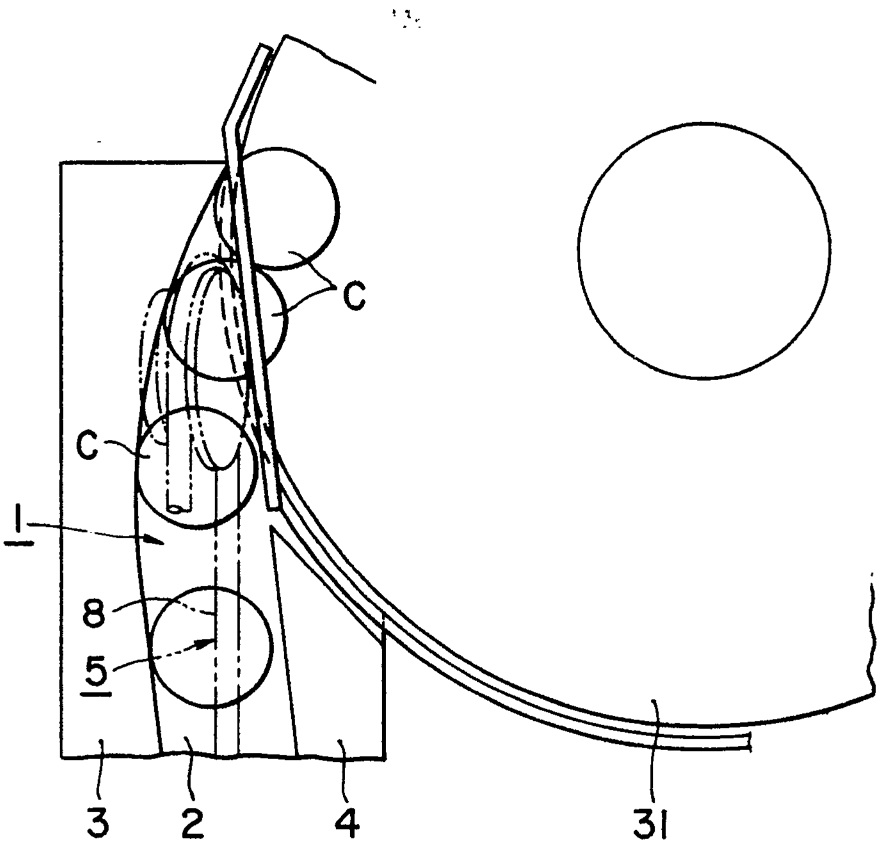

C
C
1
8
5
3
2
4
31

FIG. 7

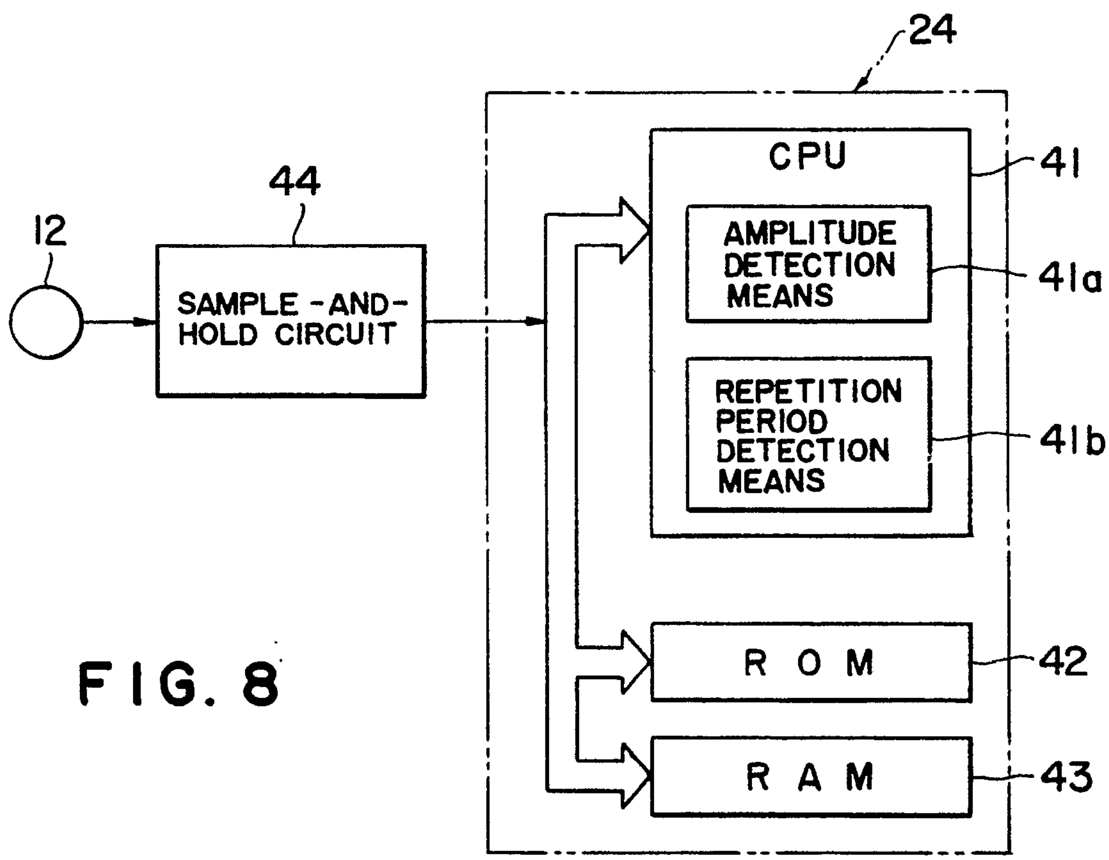

24
CPU
41
AMPLITUDE DETECTION MEANS
41a
44
12
SAMPLE -AND-HOLD CIRCUIT
REPETITION PERIOD DETECTION MEANS
41b
ROM
42
RAM
43

FIG. 8

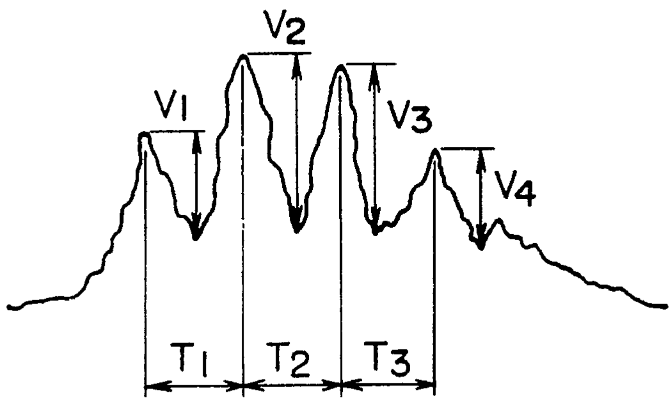


FIG. 9

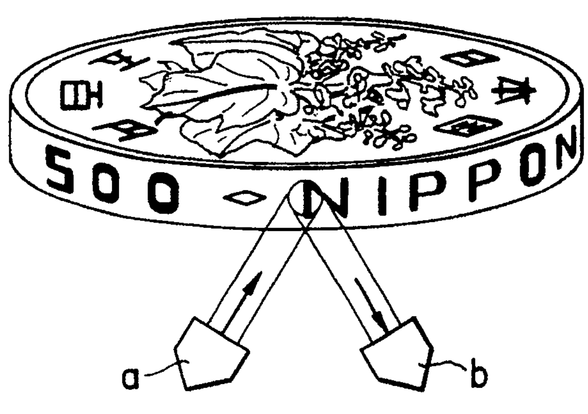


FIG. 10 PRIOR ART

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90309798.8

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	EP - A2 - 0 311 554 (WH MÜNZPRÜFER DIETMAR TRENNER GMBH) * Totality * --	1,4	G 07 D 5/10
X	DE - A1 - 3 711 941 (STANDARD ELEKTRIK LORENZ AG) * Totality * --	1,4	
X	DE - A1 - 3 335 347 (SIEMENS AG) * Totality * --	1,4	
A	DE - A1 - 3 108 150 (MARS INC.) * Totality * --	1,4	
D,A	JP - A - 59- 17 691 * Totality * ----	1,4	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 07 D 5/00
G 07 F 3/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	11-12-1990	BEHMER

CATEGORY OF CITED DOCUMENTS

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