

**IDENTIFICATION METHOD FOR DISCOIDAL METALLIC PIECES WITH A
CENTRAL ORIFICE.**

5 [0001] The present invention relates to an identification method for discoidal metallic pieces with a central orifice, particularly applicable to characterisation and discrimination of coins or tokens having a hole in their centre.

10 [0002] The method of the invention allows not only determining whether there is a hole or not in the centre of the coin, but also measuring the size of said hole with enough precision to be used as a basic identification parameter for the coin.

15 [0003] Obtaining dimensional characteristics of coins is a normal technique in coin characterisation or identification processes. For this selectors are used provided with means which give the information needed to know the diameter or the length of a chord of the coin.

[0004] Selectors of the type indicated are described, for example, in Spanish patents nos. 557,523 and 555,181 of these same applicants.

20 [0005] According to the first of the patents referenced, the chord of a coin is measured as it is intercepted in its path through the selector by a pair of photosensors placed level with the track of the coin. The chord intercepted by the two sensors is characteristic of the coin size and is used in the validation process for said coin.

25 [0006] Patent 555,181 combines the measuring system described above with an electromagnetic sensor which provides information on the characteristics of the alloy used for the analysed coin.

30 [0007] However, none of the coin identification systems based on the described principles can solve the specific case of analysing and discriminating coins which differ from others in having a central hole of a known size.

35 [0008] The object of the present invention is to solve the problem described by a method which allows discrimination and characterisation of coins or metal tokens characterised by having a hole in their centre.

[0009] The method of the invention can be carried out by selectors of the type described in Spanish patent no. 555,181 which provide two optical sensors and one electromagnetic sensor, in a segment of the path which the coins must travel inside the selector.

[0010] The procedure of the invention comprises, in combination, obtaining and measuring values characteristic of the signal created by the central orifice as it passes the electromagnetic sensor, and calculation of the chord length of the hole intercepted by the optical sensors.

[0011] When the coin orifice passes the electromagnetic sensor a signal is produced from which certain characteristic values are obtained, which may consist of the peak value of the central area of the signal and of the values of the far peaks in said area.

[0012] The chord length intercepted as the hole passes the optical sensors is calculated as a function of the time when the coin begins to intercept and ceases to intercept the first and second optical sensor and as a function of the times when one of the optical sensors starts to see and stops seeing the coin orifice.

[0013] All of the characteristics of the invention, as set forth in the claims, are presently described in greater detail with the aid of the attached drawings, in which an example of an embodiment is shown.

[0014] In the drawings:

[0015] Figure 1 shows a sketch of the traditional arrangement of sensors and a coin with a central orifice at the start of the track.

[0016] Figure 2 shows the typical signals given by an optical detector and an electromagnetic sensor as they are crossed by a coin without a hole.

[0017] Figure 3 shows the signals given by the same sensors when crossed by a coin with a central orifice of 3 mm diameter.

[0018] Figure 4 shows the same signals of figure 3 but given when crossed by a coin with a larger central orifice.

5 [0019] Figure 5 shows the time signals of the two optical detectors for a coin without a hole.

[0020] Figure 6 shows the time signals of the optical detectors for a coin with a small central hole.

10 [0021] Figure 7 shows the same signals of figure 6 but for a coin with a larger central orifice.

[0022] The method of the invention is aimed at the identification of metallic discoidal pieces 1 with a central orifice 2, figure 1, by a selector provided, in the segment of the path followed by the coins inside the selector, with two optical sensors 3 and 4, and an electromagnetic sensor 5, which in the example described is placed between optical sensors 3 and 4. Each type of sensor provides useful information on the characteristics of hole 2 of the coin or discoidal piece 1, the joint use of both sensors being ideal as the information given by them is complementary.

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[0023] Detectors 3 and 4 directly provide the time when the coin and the hole pass each one, and considering that the motion is uniformly accelerated, by applying a formula explained below, the chord of the hole intercepted by the optical sensors is calculated to a large degree of precision.

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[0024] Electromagnetic sensor 5 is also sensitive to the existence of a hole in the centre of the coin. Figures 2, 3 and 4 show the signal produced by the electromagnetic sensor as orifice 2 of the coin passes, where it can be seen that as hole 2 of the coin is larger there is an increase in central peak P2 given by the electromagnetic sensor's signal. This electromagnetic sensor is preferably of a small size in order to achieve greater sensitivity to small hole diameters. An ideal size for this sensor might be 9 mm.

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[0025] In order for sensor measurements to be representative of hole 2 of the coin, these sensors should be mounted in a position such that hole 2 of coin 1 intercepts electromagnetic sensor 5 and optical detectors 3 and 4. If there is a coin whose hole

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does not cross the optical sensors, whether due to the coin diameter or the size of the hole, this is not particularly problematic as there is still the electromagnetic sensor.

[0026] Figure 5 shows the signals of the two optical photosensors when crossed by a coin without a central orifice, where the top one corresponds to optical sensor 3 and the bottom one to optical sensor 4. At the time when the coin intercepts sensors 3 and 4 the corresponding signals 6 and 6', continuous, are produced, the second one being shorter since, as mentioned above, the motion of the coin is taken to be uniformly accelerated.

[0027] Figure 6 shows the same signals for a coin passing the optical sensors, but here due to a coin with a small central orifice, of for example 3 mm. In this case signals 6 and 6' produced by sensors 3 and 4 are interrupted in segments 7 and 7' which correspond to the central orifice crossing the sensors.

[0028] Lastly, figure 7 shows signals similar to figure 6, but caused by a coin with a larger central orifice, approximately 9 mm, which may match the diameter of the orifice of traditional coins.

[0029] In figure 7 the most important times in the calculations described below have been marked.

[0030] The distance between optical sensors 3 and 4 is labeled d, figure 1.

[0031] In the optical measurement a time t_J is defined which is equidistant of times t_A and t_E which correspond to the times when the coin begins to intercept optical sensor 3 and optical sensor 4 respectively.

[0032] Assuming the motion of the coin is uniformly accelerated, one can state that the instantaneous speed at time t_J is equal to the average speed between times t_A and t_E .

The distance traveled by the coin is d, and therefore:

$$V(t_J) = V_{avg}(t_A \rightarrow t_E) = d / (t_E - t_A)$$

[0033] A time t_K is defined which is equidistant of times t_D and t_H , which correspond, respectively, to the times when the coin ceases to intercept optical sensors 3 and 4.

[0034] The speed at time t_K is equal to the average speed between times t_D and t_H , and the distance traveled is also d :

$$V(t_K) = V_{avg}(t_H \rightarrow t_D) = d / (t_H - t_D)$$

- 5 [0035] The acceleration of the coin's motion is the difference between the two speeds calculated above divided by the time elapsed between t_J and t_K :

$$10 \quad a = \frac{V(t_K) - V(t_J)}{t_K - t_J} = \frac{\frac{d}{t_H - t_D} - \frac{d}{t_E - t_A}}{\frac{t_D + t_H}{2} - \frac{t_E + t_A}{2}}$$

- [0036] A time t_L is defined equidistant from times t_F and t_G , which correspond respectively to the times when the second optical sensor 4 detects the start and finish of the passing of orifice 2 of the coin. In the same manner, a time can be defined equidistant from t_B and t_C , corresponding, respectively, to the times when the first
15 optical sensor 3 detects the start and finish of orifice 2 of the coin passing.

[0037] The average speed between times t_F and t_G is equal to the instantaneous speed at t_L . This speed can be found from the speed at one point, the acceleration and the time elapsed between the two points:

$$20 \quad V_{avg}(t_F \rightarrow t_G) = V(t_L) = V(t_K) - (t_K - t_L) * a =$$

$$= V(t_K) - \left(\frac{t_H + t_D}{2} - \frac{t_F + t_G}{2} \right) * a;$$

- [0038] t_F is the time when photodiode 4 begins to see hole 2 and t_G when it ceases to
25 see it. Knowing the average speed between times t_F and t_G and the time interval $t_G - t_F$ the size of the hole of the coin is found (strictly the chord length at the height of the photodiodes).

$$\text{HOLE} = V_{avg}(t_F \rightarrow t_G) * (t_F - t_G) =$$

$$30 \quad = \left(V(t_K) - \left(\frac{t_H + t_D}{2} - \frac{t_F + t_G}{2} \right) * a \right) * (t_G - t_F) =$$

$$= \left(\frac{d}{t_H - t_D} - \left(\frac{t_H + t_D}{2} - \frac{t_F + t_G}{2} \right) * \frac{\frac{d}{t_H - t_D} - \frac{d}{t_E - t_A}}{\frac{t_H + t_D}{2} - \frac{t_E + t_A}{2}} \right) * (t_G - t_F)$$

[0039] Where "hole" stands for the chord of hole 2 of the coin intercepted by optical sensors 3 and 4, so by solving for the distance d between the photodiodes we have:

$$5 \quad \frac{HOLE}{d} = \left(\frac{1}{tH - tD} - \left(\frac{tH + tD}{2} - \frac{tF + tG}{2} \right) * \frac{\frac{1}{tH - tD} - \frac{1}{tE - tA}}{\frac{tH + tD}{2} - \frac{tE + tA}{2}} \right) * (tG - tF)$$

[0040] b) ELECTROMAGNETIC MEASUREMENT: As can be seen in figures 2, 3 and 4, the signal given by electromagnetic sensor 5 is mainly affected in its central area, with peak 2 increasing with the hole diameter. We can therefore take P2 as a parameter representative of the size of the hole. Since the value of P2 is also sensitive to other coin properties, such as the alloy or its thickness, it may be of interest to consider a relative value between the peaks, such as $P2 - P1$, $P2 - P3$ or $2 \times P2 / P1 + P3$. Any of these three values can be taken as a parameter representative of the size of the hole, being more stable than the value of peak P2.

[0041] Regarding the measurement obtained from electromagnetic sensor 5, as seen in figures 2, 3 and 4, as indicated above, signal 8 produced by electromagnetic sensor 5 is mainly affected in its central area 9, with the value of peak P2 increasing with the diameter.

[0042] We can therefore consider P2 a representative parameter of the size of the hole. Since the value of P2 is also sensitive to other coin properties, such as the alloy or its thickness, it may be of interest to consider a relative value between the peaks, such as $P2 - P1$, $P2 - P3$ or $2 \times P2 / P1 + P3$. Any of these three values can be taken as a parameter representative of the size of the hole, being more stable than the value of peak P2.



CLAIMS

[0043] 1.- Identification method for discoidal metallic pieces with a central orifice, by a selector provided, in a segment of the path traveled by the coins, with two optical
 5 sensors and an electromagnetic sensor, characterised in that it comprises, in combination, obtaining and measuring values characteristic of the signal caused by the central orifice of the coin as it passes the electromagnetic sensor, in order to obtain parameters representative of the existence and size of said hole; and the calculation of
 10 the chord length intercepted by the optical sensors, as a function of the times when the coin begins and ceases to cross the first and second optical sensor and the times in which one of the optical sensors begins and ceases to see the orifice of the coins.

[0044] 2.- Method as claimed in claim 1, characterised in that the characteristic values of the signal caused by the orifice as it passes the electromagnetic sensor consist of the
 15 value of the middle peak (P2) of the central area and the value of the far peaks (P1, P3) of said area.

[0045] 3.- Method as claimed in claim 2, characterised in that from the characteristic values obtained from the signal produced as the orifice passes the electromagnetic
 20 sensor, relative values between peaks are calculated as parameters representative of the size of the hole.

[0046] 4.- Method as claimed in claim 1, characterised in that the chord length of the coin orifice is calculated by the equation:

$$25 \quad \frac{L}{d} = \left(\frac{1}{tH - tD} - \left(\frac{tH + tD}{2} - \frac{tF + tG}{2} \right) * \frac{\frac{1}{tH - tD} - \frac{1}{tE - tA}}{\frac{tH + tD}{2} - \frac{tE + tA}{2}} \right) * (tG - tF)$$

Where L is the chord length of the orifice intercepted by the optical sensors, d, is the distance between the optical sensors, tH is the time when the coin ceases to intercept the
 30 second optical sensor, tD is the time the coin ceases to intercept the first optical sensor, tF is the time the second optical sensor begins to see the orifice, tG is the time the second optical sensor ceases to see the orifice, tE is the time the coin begins to intercept the second optical sensor and tA is the time the coin begins to intercept the first optical sensor.

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