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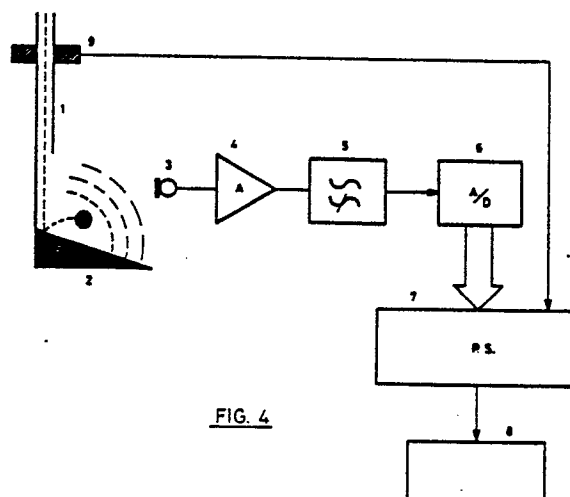
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54 **A method for the identification of coins.**

57 A method and apparatus for the identification of coins are described, in which a mechanical excitation is applied to the coin by means of an impact which produces an acoustical signal, that is collected by an electronic system transforming it into an electrical signal, that is amplified and filtered to be subsequently analysed according to the Fourier transform, for its identification and control, together with the measurement of the diameter, said coin being accepted if there is an agreement between the frequencies of the acoustical signal and the standard of frequencies corresponding to the detected diameter, and discarded in the opposite case.



"A METHOD FOR THE IDENTIFICATION OF COINS"

This invention refers to a method for the identification of coins, which is based on the analysis of the frequency spectrum of the acoustical signals produced by the vibration of the coin due to its collision with a surface. A further object of the invention is to develop an apparatus for the identification of coins, through the application of the above-mentioned method.

The method according to the invention is based on the proved fact of the existence of groups of frequencies characteristic of each one of the coins having legal tender in a country. It is statistically demonstrated the repeatability of said frequencies between coins of the same value. These groups of frequencies are clearly different between different coins, being further to note that the areas employed for the identification do not present any masking effect, considering further the existence of margins of variation.

According to the previous statements, and due to the energetic amplitude or level presented by these groups of frequencies, it is possible to easily detect them, using the same as parameters for the identification of the coins.

According to this invention, the characterization of the coin is effected considering it as a system subjected to an excitation corresponding to the delta function, considering subsequently its response, by which to said coin a mechanical excitation is applied producing a wave of acoustical pressure, characteristic of each kind of coin, and allowing to identify the kind of coin that has produced the same.

Said mechanical excitation is obtained by means of a collision having a predetermined intensity produced by the impact of the coin against a surface. For this, the coin can be allowed to freely fall upon a surface, according to a path having prefixed height and direction.

The consequent impact generates an acoustical signal, having characteristic frequencies, which is collected by an electronic system translating it in an electrical signal. Said electronic system consists of a microphone, whose output electrical signal will be amplified and filtered in order to be subsequently inspected according to the Fourier transform by means of a processor, which enables to establish directly and in a very quick way the amplitude of the frequency components of the signal, so as to be able to obtain an estimate of the frequencies forming the acoustical response of each of the coins.

The identification of the coin is obtained through the comparison with a frequency standard. Furthermore, the identification of the coin is com-

pleted with the measurement of its diameter by means, for example, of emitter and receiver diodes forming a discrete barrier of infrared light which during the lack of passage of coins activates all the receiver diodes, while during the passage of the coins intercepts the luminous flux between a fixed number of pairs of diodes, so that from the number and the position of these deactivated diodes the required diameter is obtained. It is to be understood that other measurement systems of the diameter of the coin can be used.

In the case of the coins having legal tender in Spain, for each of them a statistical analysis has been carried out, establishing a series of typical frequency groups which allow the achievement of the standards for the identification of the different coins.

The apparatus for the achievement of the method described comprises a way or circuit for the receipt of the coins, which defines a free fall path for said coin. This way or circuit attains an impact surface, against which the coin strikes, producing the corresponding sound. The receipt way or circuit for the coins is provided with a device for the measurement of the diameter of said coins. This way or circuit can be formed by a conduit having an appropriate cross-section, which drives the coin upon the impact surface.

The apparatus further comprises a microphone to collect the sound produced by the impact of the coin against the impact surface and transform it into an electrical signal.

The apparatus is completed by an amplifier of the electrical signal, a frequency selector filter and a processor of the signals. Said filter can be a high-pass filter which eliminates the low frequencies.

In the signal processor, the electrical signal is subjected to an analysis, by means of the Fourier transform, and compared with the frequency standards of the coins having legal tender corresponding to the diameter detected in the way or circuit of receipt of the coins.

The free fall path of the coins will have a height and a direction predetermined in order to attain an impact against the impact surface having a prefixed value.

Between the above-mentioned filter and the signal processor an analog-to-digital converter can be placed, which encodes the electrical signals provided by the microphone in numerical values.

The features and advantages of this invention will be better understood by the following description, made with reference to the accompanying drawings in which in a schematic way a possible

embodiment has been illustrated, as a non limiting example.

In the drawings:

Figures 1 and 2 illustrate the frequency groups of two different coins;

figure 3 illustrates the identification areas for the two kinds of said coins, selecting as identification parameters the frequencies having the highest energetic level;

figure 4 represents a diagram of the apparatus by which the identification of the coins can be achieved.

In figure 1, with the references FA₁, FB₁ and FC₁, the selected frequency groups for a particular coin are indicated, having a sufficient energetic level to be peculiar as identification parameters. Coins different from those considered, have parameters substantially different. Thus, for other coins, as illustrated in figure 2, there is another distinctive group of frequencies FA₂, FB₂ and FC₂.

In the particular instance in which the three frequencies FA, FB and FC having the highest energetic level are employed as identification parameters, will be fixed the identification areas bearing in figure 3 the references 1, 2 and 3.

The apparatus to actuate the above-described method, as illustrated in figure 4, comprises a system for the collection of the coins 1, that can be a tube having an appropriate cross-section, which leads them on an impact surface 2, upon which they fall from prefixed height and direction. The sound produced by the impact of the coin on the impact surface 2 is collected by the microphone 3 and amplified by the amplifier 4. Subsequently the electrical signal, into which said sound has been transformed, is filtered through a highpass filter 5, that eliminates the low frequencies which could disturb the signal. Following the filter 5, the signal passes to an analog-to-digital converter 6, that encodes the signal in numerical values, arriving to a signal processor 7 which operates a Fourier analysis and compares the frequencies of the analysed signal with the standards for the identification of the coins having legal tender of the corresponding country. At the same time the diameter of the admitted coin is measured by means of an optical barrier 9, through which the result of the identification is presented in the display system 8 as discarded or accepted coin.

As can be understood, in the principle and the features of the invention as described, can be included variations of details without departing from the scope of the present invention. So, for instance, any limit of frequencies defining an area can be used. Similarly, it is possible to use an impact surface having any shape, nature and position, being possible as well to change the nature and the type of the filter, converter, processor of the

signal, measuring device of the coin diameter, kind of the frequency analysis employed, etc.

Having sufficiently described the nature of the invention, as well as the way to practice it, it is to be noted that the above-mentioned dispositions can be altered in details, provided they do not modify the basic principle.

10 Claims

1. A method and apparatus for the identification of coins, said method being characterized in that it is applied to the coin to be identified a mechanical excitation by means of an impact having a predetermined intensity, sufficient to produce an acoustical signal, which signal, having frequencies with limits exactly determined, is collected by an electronic system which transforms it into an electrical signal, that is amplified and filtered to be subsequently analysed according to the Fourier transform, for its identification and control, by means of a comparison with a standard of frequencies, together with the measurement of the diameter, said coin being accepted if there is an agreement between the frequencies of the acoustical signal and the standard of frequencies corresponding to the detected diameter, and discarded in the opposite case.

2. A method as claimed in claim 1, characterized in that the impact of the coin is obtained through the impact of said coin against a surface.

3. A method as claimed in claims 1 and 2, characterized in that the impact of the coin is obtained by means of the free fall of said coin upon said surface, following a path having predetermined height and direction.

4. An apparatus for the identification of coins, characterized in that it is carried out a method as claimed in anyone of the claims 1 to 3.

5. An apparatus as claimed in claim 4, characterized in that it comprises a way or circuit for the collection of coins, which defines a path of free fall for said coin and is provided with a device for the measurement of the diameter; and impact surface for the coin, onto which arrives the said way or circuit; a microphone for the collection of the sound produced by the impact of the coin against the impact surface and transform it in an electrical signal; an amplifier of the electrical signal; a filter for the selection of the frequencies; and a processor of the signal, into which the electrical signal is subjected to an analysis, by means of the Fourier transform, and compared with the frequency standards of the coins having legal tender corresponding to the diameter detected in the way or circuit

for the receipt of the coins; the free fall path of the coin, till the impact surface, having a predetermined height and direction.

6. An apparatus as claimed in claim 5, characterized in that said filter is a high-pass filter, which eliminates the low frequencies.

7. An apparatus as claimed in claim 5, characterized in that between said filter and the signal processor, an analog-to-digital converter is placed, which encodes the electrical signal in numerical values.

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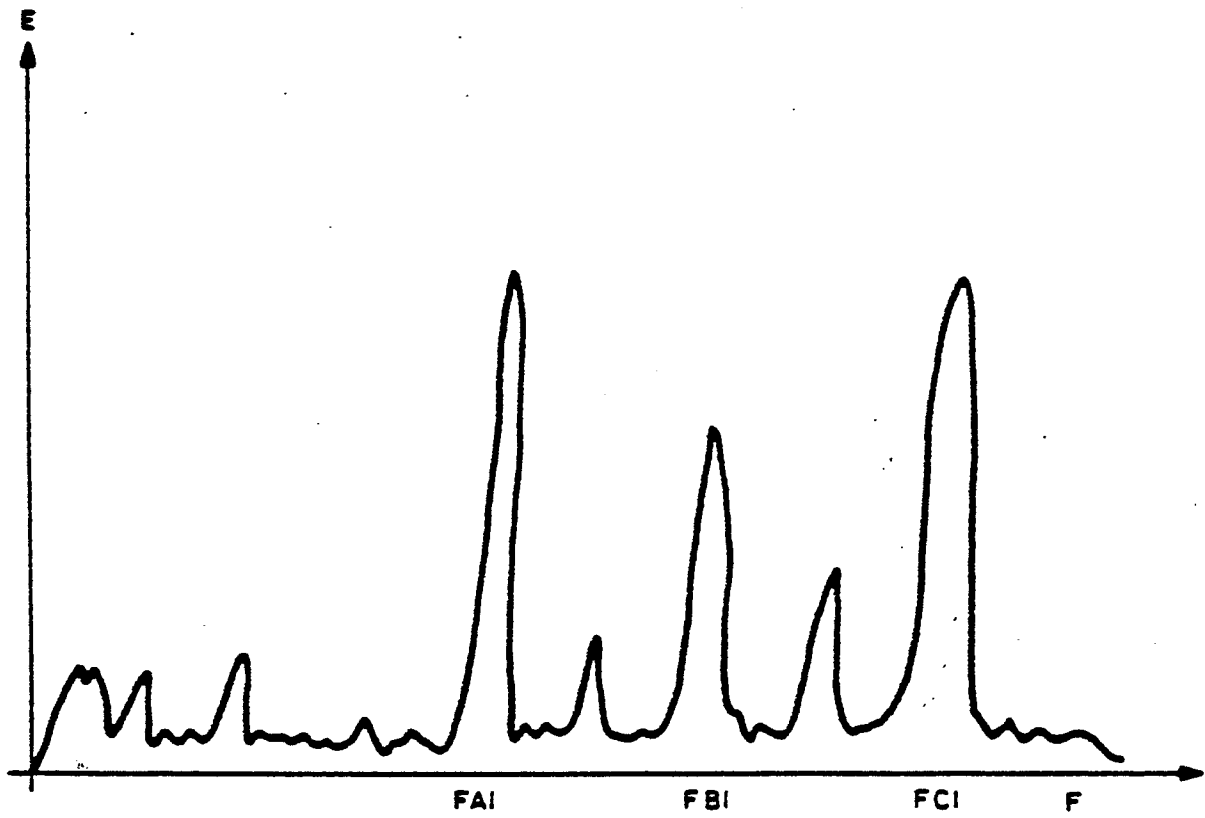
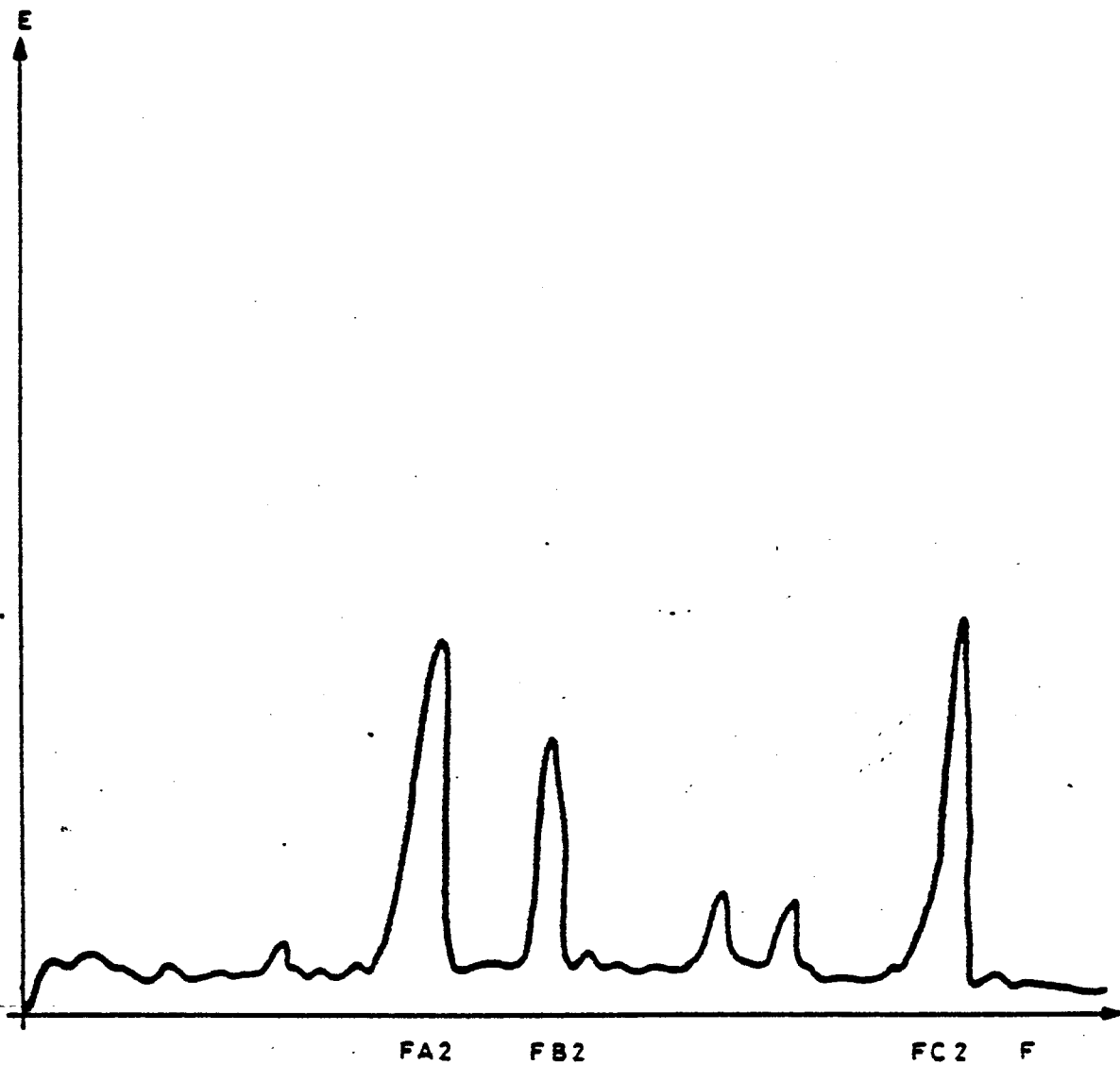
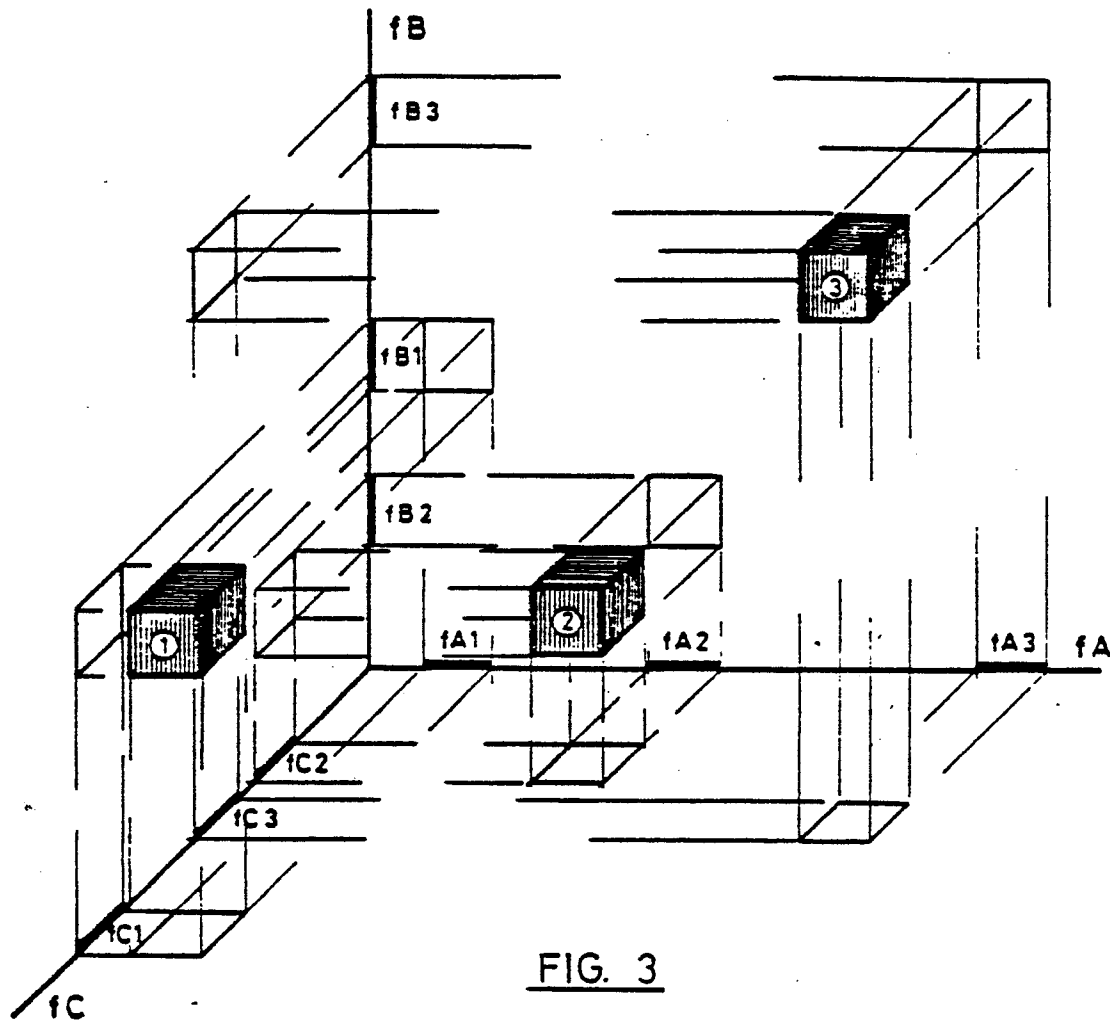


FIG. 1

FIG. 2

FIG. 3

