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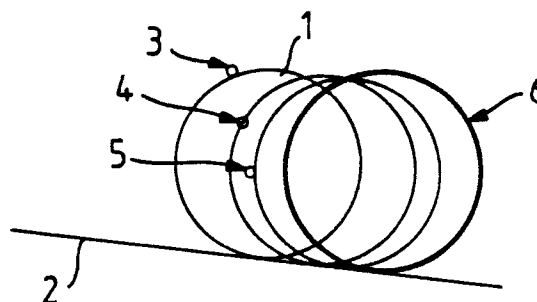
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Method and apparatus for identifying coins.

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Certain properties of a coin (1) are measured while the coin runs down a ramp (2) and passes between a pair of coils (6). Measurements in the form of attenuated signals (A1, A2, A3, Amax) are taken at several positions determined by coin edge sensing means (3, 4, 5) detecting the trailing edge of the coin.

Fig. 1.



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Method and apparatus for identifying coins

The present invention relates to a method and apparatus for identifying coins including guidance of a coin through a passage in which certain properties of the coin are measured by an electromagnetic device, and where a number of measurements are taken at different positions of the coin within the passage. Coin filters are previously known from e.g.

-UK Pat. No. 1.551.209 describes a device for checking metal pieces, particularly coins, by which electromagnetic response is measured at predetermined periods of time, related to the speed at which the coin passes the detector.

-UK Pat. Appl. No. 2.107.104 describes a coin identification apparatus having an inductive coil wound on a ferrite core having two poles adapted in size and location to the coin types to be detected. The coins's effect on the electromagnetic field is measured when the coin is between poles and when it is adjacent each pole face.

-UK Pat. Appl. No. 2.086.633 describes a coin sorting apparatus having a combination of electromagnetic and photoelectric sensors for judging between coins of different permeability.

-DE-OS No-2.716.740 describes a device including a complicated system of capacitive, inductive and photoelectric sensors for identifying coins.

These known methods are considered to give rather unreliable results and the object of the present invention is to overcome the drawbacks of the known coin filters.

The main features of the present invention are defined in the claims.

With the present invention there is obtained a coin filter which is independent of the time it takes for a coin to pass a detector. It is simple in that it uses only one set of electromagnetic coils for taking a plurality of successive electromagnetic measurements of each coin. The coin positions at which the measurements are taken are determined by the coin itself.

Above mentioned and other features and objects of the present invention will clearly appear from the following detailed description of embodiments of the invention taken in conjunction with the drawings, where

-Fig. 1 illustrates the general principles of the coin edge detecting means related to a set of coupled coils

-Figures 2 and 3 illustrate the coil input and output signals occurring in a rest mode and in an activated mode,

-Fig. 4 illustrates the effect of placing a coin edge detector close to the top of the coin,

-Fig. 5 shows a schematical block diagram of a coin identifying circuit

Fig. 6 shows voltages of significant signals occurring in the circuit of Fig. 5, and

-Fig. 7 illustrates the intermediate stored results of the coin identifier.

The general principles are illustrated in Fig. 1. All introduced coins 1 are running down a ramp 2 and all measurements are performed dynamically within a short time and using a minimum of power.

The coin interrupts a number of light channels 3, 4, 5 before passing the center of pair of coils 6.

The reduction of the coupling between coils are measured a number of times with the coin in different positions controlled by the light channels.

The principles of measurements are illustrated in Figures 2-4.

The coupling between the coils 6 will first be described. A sinusoidal signal E is emitted by one coil CE. When no coin is in between the coils (CE, CR) the signal is received un-attenuated. The amplitude of the received signal R is determined by the coupling factor of the two coils. When a coin comes in between the two coils (CE, CR). the received signal is attenuated.

The difference in amplitude (attenuation A_i) on the received signal is the results ($A_1, A_2, A_3, \dots A_n$ and A_{max}) which are measured for different positions of the coin.

The light channels 3, 4, 5 are placed in different heights over the ramp 2 and in different distance from the coil center. The light channels should be placed so that no channels simultaneously hit the trailing edge of any passing coin. For each diameter of the different coins there should be a light channel positioned close to the top of the coin, say at a position higher than 80% of the coin diameter. By making a coupling measurement just when the running coin opens for the light channel, a high diameter selectivity is obtained, because a slight difference in diameter gives a greater difference 7 in the part of the coin present between the sensitive parts 8 of the coils at that moment. This is illustrated in Fig. 4.

By making more measurements in sequence with the same pair of coils, the "rate" of attenuation change will be measured in addition to the maximum attenuation. This gives an indication of the stamp of the coin. The largest and normally most valuable coins will break most of the light channels and thereby give relevant measurements. The first measurement should preferably show the smallest

attenuation. The light channels should be arranged so that at least 1% (preferably between 1 -20%) of the coin area is within the sensitive part of the coil when the first measurement is taken.

The block diagram of a coin identifier circuit is given in fig. 5 (In the following description the number of light channels is set to three). The coin identifier includes a micro computer 10 having the following control lines:

LC1, LC2 and LC3: Light channel selection

RESET: Reset line for resetting an 8 bit counter 11 after completion of measurements.

Information is given to micro-computer 10 via the following output lines:

DATA BUS (DB): All measured results (A1, A2, ...) are transmitted to the micro computer 10 via 8 output lines from an 8 bit port 12.

INTERRUPT (INT): This line signals (INT) to the micro-computer 10 that a result is present at the port 12.

The counter 11 counts the number of pulses seen on a line CP2 from a clock pulse generator 13. This is a direct binary measure of attenuation Ai.

Selection of light channels ELC1-3, RLC1-3 is made in a selector/decoder 14 by the micro computer 10 via the control lines LC1, LC2 and LC3, which are enabled when the counter 11 goes from its reset rest position.

The receiver part of the selector/decoder 14 sends the signal INT to the micro computer 10 for each position of the coin where the results are to be read from the port 12. When the signal INT is present the contents of the port 12 is latched.

The clock pulse generator 13 supplies the transmitting or emitting coil CE with an alternating voltage CP1 which is made sinusoidal by an RC-network RCE.

The generator also loads the counter 11 with clock pulses CP2 when not inhibited by a comparator 15. The generator 13 is provided with a pulse stretching arrangement for the inhibiting signal INH from the comparator 15.

The contents of the counter 11 is transmitted to the micro-computer 10 via the port 12. When the signal INT goes "low", the contents are latched. With a "high" on the INT line the counter contents is transmitted directly to the data bus DB.

A digital/analog converter (D/A) 16 translates the binary contents of the counter 11 into an analog signal which is fed to the comparator 15.

On the inputs of the comparator 15, the level of the received signals OUT-COIL from the received coil CR is compared with the output OUT-DA from the D/A converter 16, confer Fig. 6.

When the OUT-COIL signal becomes lower than the OUT-DA signal, the comparator output INH becomes low. In rest position this will happen for every negative half wave of the OUT-COIL signal. The pulse stretcher in the clock pulse generator 13 covers the period between half waves, and as long pulses arrive with short intervals (see Figure 6), the clock pulse CP2 to the counter 11 is inhibited.

Execution of measurements will now be described with reference to Figures 5 and 6. In the rest mode RM the level of the OUT-DA signal is preset, so that when the counter contents is zero, the negative half wave of the received signal OUT-COIL always goes below the signal OUT-DA. Each time OUT-COIL comes below OUT-DA, the output of the comparator 15 goes low, and the clock pulse CP2 for the counter 11 is inhibited. The pulse stretcher in the clock pulse generator 13 covers the period between negative half waves. The counter 11 remains at zero and the OUT-DA signal remains stable.

The voltages on the following outputs are - schematically illustrated: OUT-COIL, OUT-DA, INH and CP2. Frequencies are not correct in relation to the time for the passage of the coin.

The passage of a coin between coils is the activated mode AM which will now be described. The effect of a coin in between the emitter coil CE and the receiver CR is that the amplitude of the received signal OUT-COIL is attenuated. This means that the negative half wave of the received signal will no longer go below OUT-DA. Consequently no more pulses will be detected in the INH signal at the output of the comparator 15.

With the INH signal being stable at its high level, the clock pulse signal CP2 is no longer inhibited and the counter 11 starts counting. The contents of this counter is now converted into an analog signal via the D/A converter 16. Since the binary input of the D/A converter 16 increases, its output signal OUT-DA will increase too.

As can be seen on Fig. 6 the signal OUT-DA will follow the attenuated amplitude of the received signal until the maximum attenuation is reached. Once this level has been reached by OUT-DA, the amplitude of the signal OUT-COIL starts increasing and the negative half wave of the signal will go below OUT-DA again. As a consequence the INH-line will start pulsing again, CP2 is inhibited and the counter stops in the position it reached and remains stable. The contents of the counter is a number indicating the maximum attenuation for the coin and OUT-DA remains stable at the maximum attenuation level. Also the information from the port 12 to the DB line remains stable at its highest value for the particular coin.

Measurements of the "rate" of attenuation change will now be described. With the identifier in its rest position, the counter 11 is reset to zero and a high level signal is put on the light selector line LC1. When now a coin enters between the coils and starts attenuation of the OUT-COIL signal, the selector/decoder 14 will put a signal on to the emitter of the first light channel ELC1. When the coin opens for the light to the first light receiver RLC1, the selector/decoder 14 will latch the contents of the port 12 and give an INT signal to the micro-computer 10. The micro-computer will read the port 12, store this result as "RESULT FIRST ATTENUATION" A1 and change the high level signal from LC1 to LC2.

The INT signal disappears so that the port 12 is opened for new data and ELC2 is on. The counter will continue to run as the coin passes the coil on its way to the maximum attenuation position. When RLC2 receives light, the contents of the port 12, which reads the accumulated number in the counter 11, will again be latched, a new INT signal causes the micro computer 10 to read the port 12, store the result as "RESULT SECOND ATTENUATION" A2 and change the high level signal from LC2 to LC3. After storing the "RESULT THIRD ATTENUATION" A3, the high level signal on LC3 is removed, and the INT signal disappears so that the port 12 is again opened for new data.

Thereafter the micro computer 10 waits for the maximum attenuation level for the particular coin by checking the contents of the counter 11 via the port 12 every 8 msec. When two successive measurements show that the counter contents remain unchanged (different from zero), the port contents is stored as "RESULT MAX. ATTENUATION" - (Amax). After that the counter 11 is reset and a high level signal is put onto LC1, waiting for the next coin. The emitter ELC1 is, however, not lit before a new coin starts attenuating the coil signals.

For an identifier with three light channels there will be four intermediate stored results, A1, A2, A3 and Amax, as indicated in Fig. 7.

Fig. 7 shows the attenuation as represented by the OUT-COIL signal occurring during the passage AM of the coin. The clock pulses CP2 to the counter 11 are also indicated as well as the positions on the OUT-COIL envelope curve where the attenuation measurements A1, A2, A3 and Amax are taken. The OUT-DA signal will go low as soon as the counter 11 is reset.

Since for one specific coin the maximum attenuation (Result Amax) has a correlation to the other measured attenuations, (Result A1, A2 and A3) determined by the geometry and stamp of the coin, the difference between the adjoining results will be represented by a much narrower Gauss

distribution curve for a random sample, than the maximum result Amax would give alone. The measured values may be combined in many ways. A high selectivity may be obtained by using two calculated values Amax-A3 and A3-A2 in addition to three of the initial measured results (A1, A2, and Amax).

For a coin identifier with three light channels the following results will thus have to be within pre-programmed acceptance limits:

Result max. attenuation Amax
Result first attenuation A1
Result second attenuation A2
Result correlation C1 Amax -A3
Result correlation C2 A3 -A2

Setting of the limits can be done by inserting a random sample of a coin type in the coin identifier. The result of the different measurements for this sample can then be represented by Gauss distributions characterised by mean value (μ) and standard deviation (d).

The limits for the five results are then calculated (e.g. $\mu \pm 2d$) and stored in an EPROM.

By selection of the coins to be sampled the number of coins in each sample for setting limits can be small.

A "flow chart" of the present invention can be listed as follows:

- Counter is reset, -lights are off
- Un-attenuated signal is received by receiver coil
- Coin enters between coils
- The signal starts getting attenuated
- The counter starts counting, not time, but stepwise (incrementals) increases in attenuation
- Light channel 1 is turned on
- Coin blocks light
- Coin opens for light
- Counter status is registered (A1)
- Light channel 1 is turned off
- Light channel 2 is turned on
- Coin opens for light
- Counter status is registered (A2)
- Light channel 2 is turned off
- Counter contents are continuously checked to find maximum attenuation
- Max attenuation is found
- Counter status is registered (Amax)
- Counter is reset
- Registered numbers (A1, A2 Amax) are evaluated individually and/or in combination.
- Coin is accepted or rejected.
- Ready for new coin

Smaller coins do not block for light channel 1 (and 2). The results A1 (and A2) are registered immediately in the counter.

It should be obvious that the above detailed specification is to be considered as an example only of one way of realizing the principles of the present invention.

Drawing designations

1 coin
 2 ramp, passage
 3, 4, 5 light channels
 6 coils
 7 difference
 8 sensitive part
 10 micro-computer
 11 counter
 12 8-bit counter
 13 clock pulse generator
 14 selector/decoder
 15 comparator
 16 digital/analog converter (D/A)
 E; R sinusoidal emitted signal; received signal
 CE; CR emitter coil; receiver coil
 RCE, RCR RC networks
 LC1-LC3 light channel selection
 ELC1-3 light channels
 RLC1-3 light channels
 CP1; CP2 alternating voltage; clock pulses
 OUT-COIL signal
 OUT-DA signal
 INH inhibiting signal
 INT interrupt line, signal
 DB data bus
 RESET reset line, signal
 RM rest mode
 AM activated mode (passage of coin)
 Ai attenuation
 A1, A2, A3, Amax results

Claims

1. Method for identifying coins including guidance of a coin (1) through a passage (2) in which certain properties of the coin are measured by an electromagnetic device (6), and where a number of measurements are taken at different positions of the coin within the passage, **characterized in this that** at least two electromagnetic measurements are taken at positions determined by coin edge sensing means (3, 4, 5).

2. Method according to claim 1, **characterized in this that** each of said measurements include registration of a signal (A1, A2, A3, Amax) representing a certain attenuation of a rest mode signal delivered from the electromagnetic device.

3. Method according to claim 2, **characterized in this that** measurements are taken by reading a counter (11) which is stepped by incremental increases in the attenuation.

4. Method according to claim 2, **characterized in this that** the attenuation is measured at at least one position in addition to a maximum attenuation measurement position.

5. Method according to claim 3, **characterized in this that** the counter (11) is started by entrance of the coin (1) into the electromagnetic field of the electromagnetic device (CE/CR).

6. Method according to claim 3, **characterized in this that** at least one reading of the counter is taken in a coin position where one of the coin edge sensing devices (3, Fig. 1) is close to the top edge of the coin (1).

7. Method according to claim 1, **characterized in this that** measurements are taken at positions - (3, 4, 5) where the 'trailing edge' of a passing coin is sensed.

8. Apparatus for performing the method according to claim 1, **characterized in this that** it includes at least one coin edge sensing device placed near the top edge (higher than 80% of the coin diameter) of at least one of the coins to be measured.

9. Apparatus according to claim 8, **characterized in this that** the coin edge sensing means (3, 4, 5) are arranged such that at least 1% (preferably 1 -20%) of the coin area is within the electromagnetic field of the electromagnetic device when the first of said means senses said coin.

10. Apparatus for performing the method of claim 1, **characterized in this that** the coin edge sensing means (3, 4, 5) are optical sensors.

Fig.1.

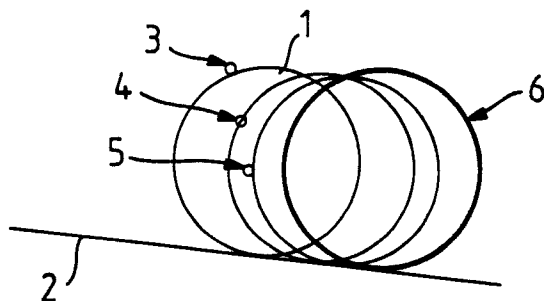


Fig.2.

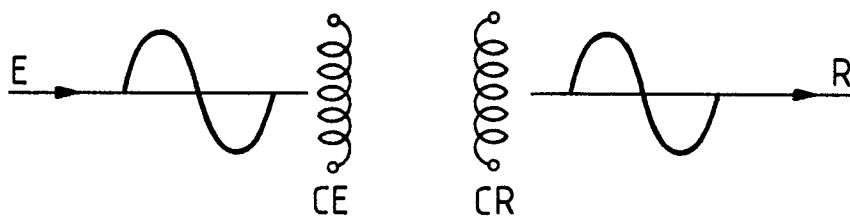


Fig.3.

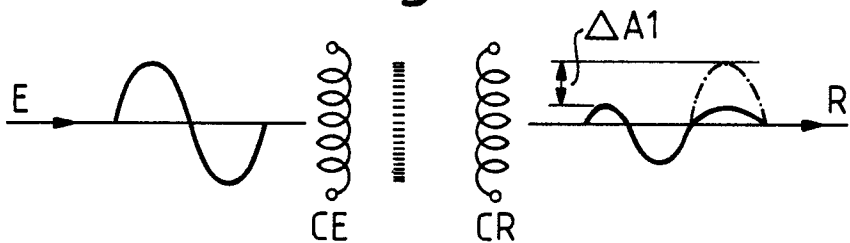


Fig.4.

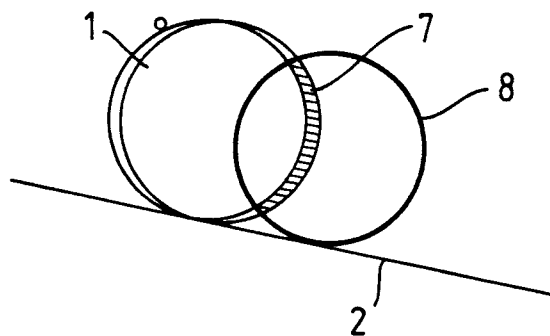


Fig. 5.

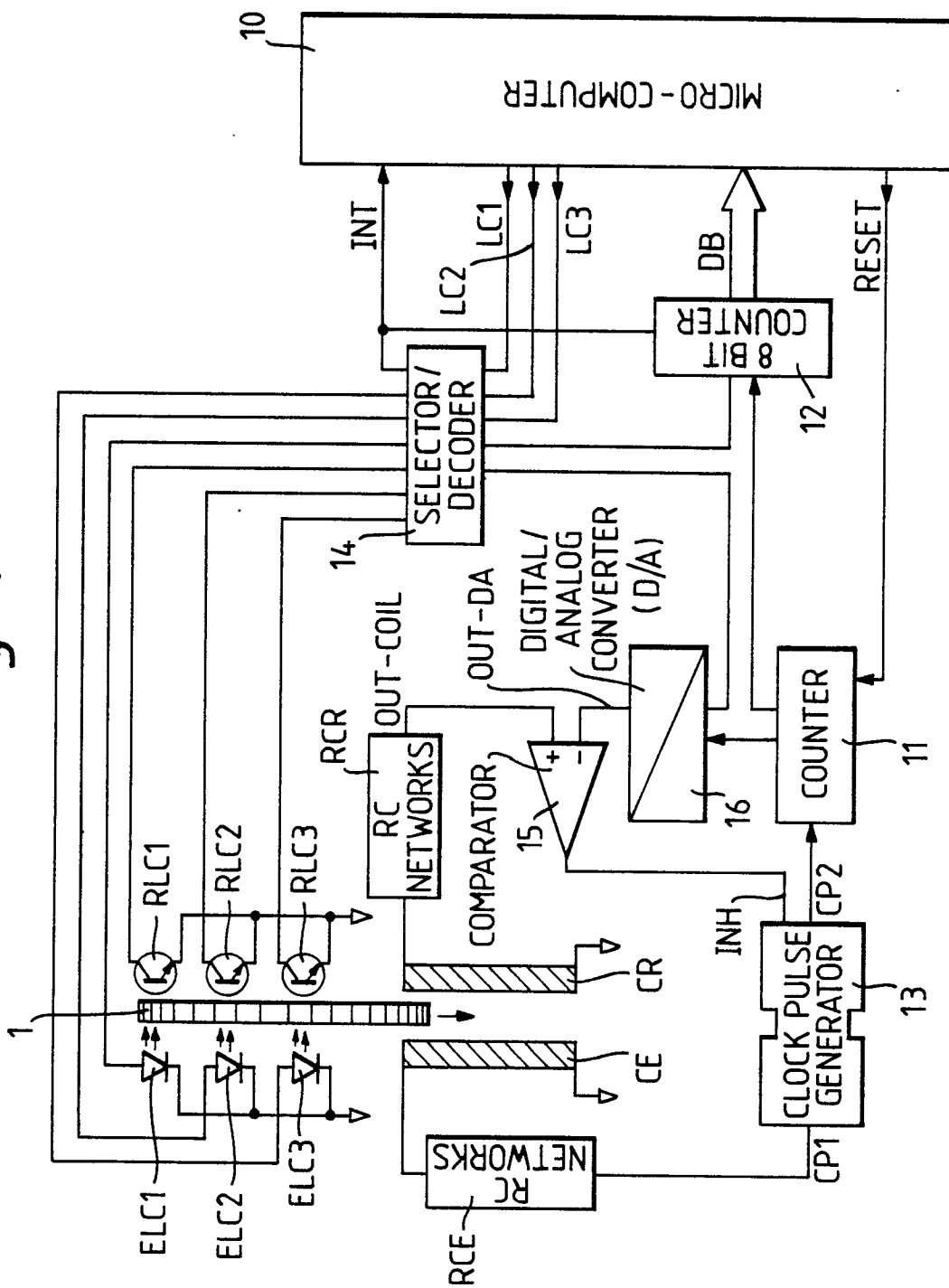


Fig.6.

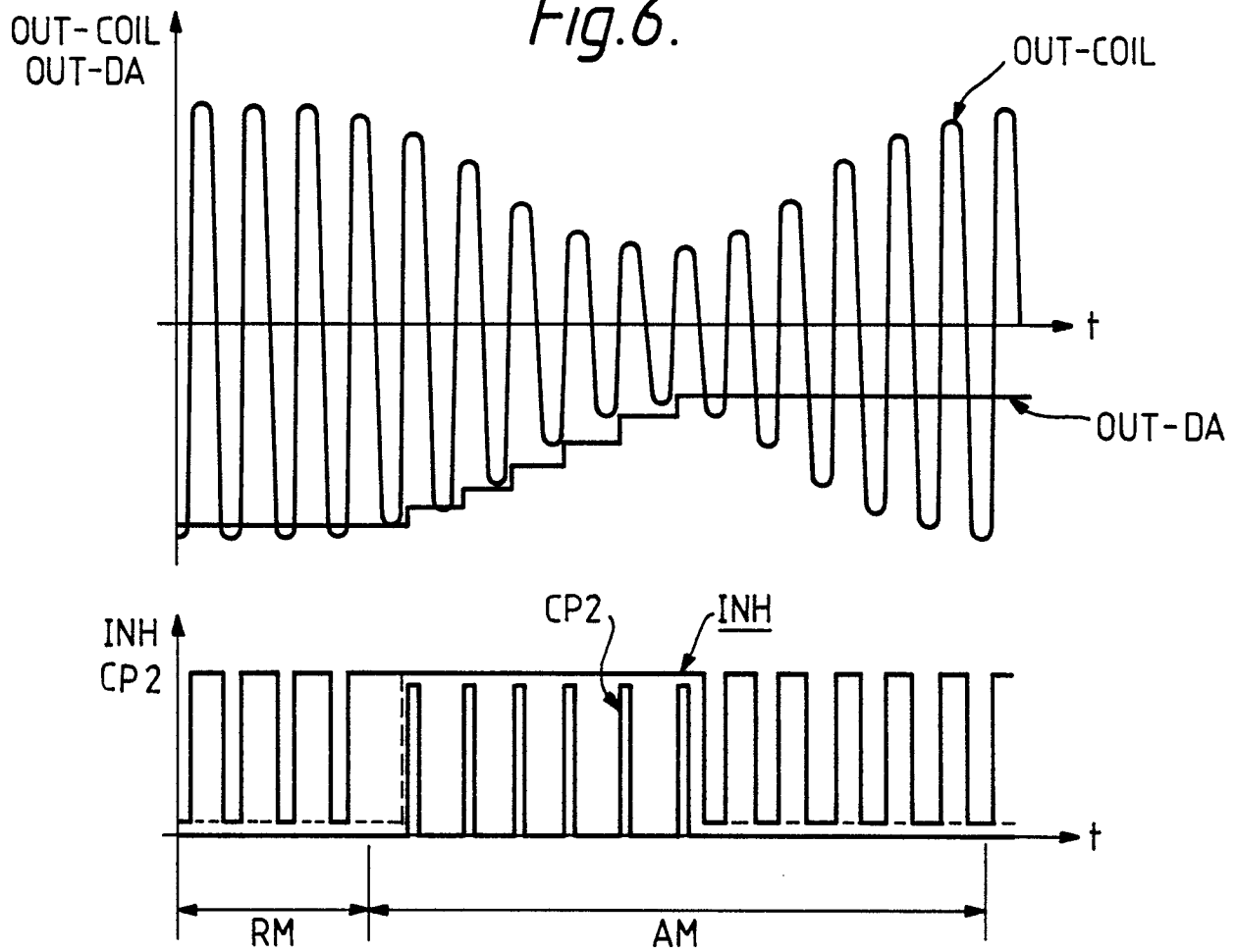


Fig.7.

