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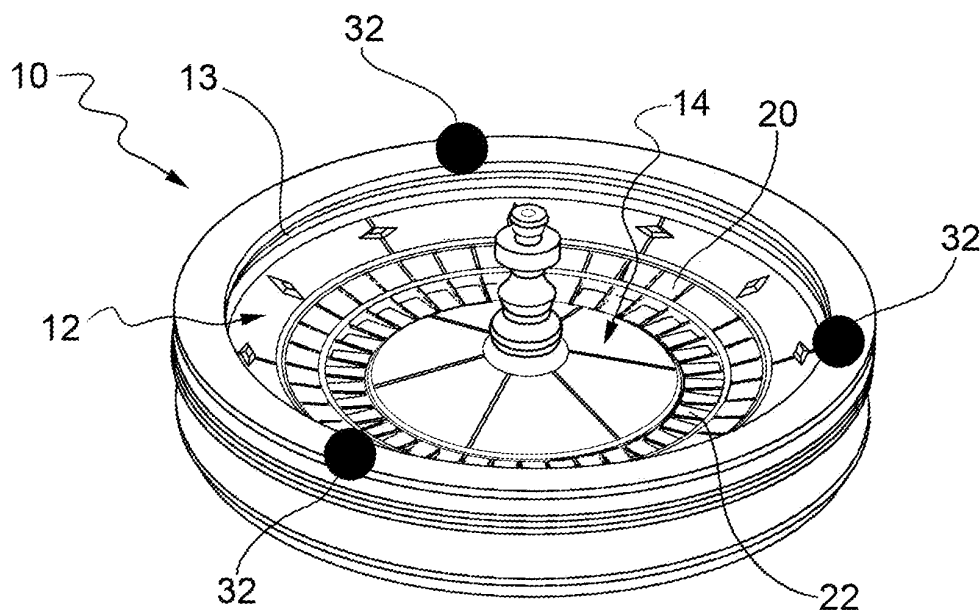
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(54) **Roulette wheel equipped with an electronic control system**

(57) A roulette wheel is described, of the type comprising a wheel (14) which includes a first ring (20) on which numbered compartments are shown and a second ring (22) provided with pockets corresponding to the numbered compartments of the first ring (20) and adapted to receive and retain a ball during the course of the game. An associated control system comprises:  
- first optical sensors (24), adapted to detect the angular position of rotation of the wheel (14) by means of the

detection of markings (26,30) associated therewith;  
- second optical sensors (32) arranged in association with said second ring (22) and adapted to detect the angular position of revolution of the ball along the circumference of said ring (22); and  
- a data collection and processing unit (40) connected to said first and second sensors (24,32) and arranged for the synchronous acquisition and analysis of the position signals of the wheel (14) and the ball, respectively, during the various stages of the game.



**FIG.1a**

## Description

**[0001]** The present invention relates to improvements in the structure of roulette wheels and more specifically to a roulette wheel equipped with an electronic control system.

**[0002]** Roulette is a game which is very common all over the world. In order to monitor the progress of the game and ensure the correctness thereof, electronic control systems have been developed over time, these being intended to detect automatically the position of the ball on the moving roulette wheel.

**[0003]** These systems are based on detector devices adapted to receive the reflections of a controlled light beam which are produced by the outer numbered ring and the inner ring provided with pockets able to receive the ball, forming part of the roulette wheel, and by the ball itself.

**[0004]** The reflections are analysed in order to determine the instantaneous angular position of the wheel and the position of the ball with respect thereto.

**[0005]** EP 0 757 582 describes a method and a system for detecting the position of the ball on a roulette wheel based on the use of LED light sources adapted to emit non-coherent light in the visible range at one or more specific wavelengths which are predetermined depending on the relative chrominance parameter for the ball and the rotating wheel, with a view to maximizing the colour contrast between the ball and background.

**[0006]** In the case of traditional roulette wheels which use a white ball which may be positioned in a red or green compartment, the maximum contrast can be obtained with blue or yellow illuminating light, while detection of the angular position of the wheel can be obtained by illuminating the numbered ring (with red, black and green compartments) using red-light emitting sources.

**[0007]** All the light emitters and detectors are incorporated in a single device adapted to be installed on the edge of the roulette rim and having three light sources, two of which are directed towards spaced positions on the numbered ring and the remaining one of which is directed towards the ring provided with pockets for receiving the ball.

**[0008]** The object of the present invention is to provide a roulette wheel equipped with an improved electronic system adapted to analyse the progress of the game in a rapid and efficient manner also in the case of non-traditional roulette wheels, and ensure the correctness of the game.

**[0009]** According to the present invention, this object is achieved by means of a roulette wheel having the characteristic features described in Claim 1.

**[0010]** Particular embodiments form the subject of the dependent claims.

**[0011]** Further advantages and characteristic features of the present invention will become clear from the detailed description which follows, with reference to the accompanying drawings, provided purely by way of a non-

limiting example, in which:

Figures 1a and 1b are schematic illustrations of a roulette wheel equipped with an electronic control system according to the invention;

Figures 2a and 2b are, respectively, a top plan view of the roulette wheel structure according to Figure 1a, without the wheel, and a plan view of a marker disc fixed to the wheel; and

Figures 3a and 3b are schematic illustrations of a further portion of the electronic control system of a roulette wheel according to the invention.

**[0012]** Reference numeral 10 denotes generally a roulette wheel structure comprising a fixed rim 12 which is bounded by an upper ring 13 and with, arranged inside it, a wheel 14 having a first outer ring 20 on which numbered compartments are shown and a second, concentric, inner ring 22 with pockets corresponding to the numbered compartments of the first ring and adapted to receive and retain a ball during the course of the game.

**[0013]** Conventionally, the numbered compartments have a background which is alternately coloured red and black, except for the compartment representing the number "0" which has a green coloured background.

**[0014]** Recently there has been trend towards using a greater variety of colours for the wheel, and thus the numbered compartments may also have a bronze or silver coloured background.

**[0015]** Optical sensor devices 24 forming part of a first group, visible in Figure 2a, are arranged in the roulette wheel structure underneath the wheel and include LED transmitters and corresponding receivers which are adapted to detect the position of the roulette wheel by means of the detection of printed notches on a marker disc 25 fixed thereto (shown in Figure 2b).

**[0016]** More particularly, they consist of two sensors 24a, 24b which are arranged radially aligned, the outer sensor 24a being designed to detect a plurality of black notches 26 alternating with a corresponding plurality of white spaces 28 on the disc mounted underneath the wheel, and the inner sensor 24b being designed to detect a single additional marker notch 30 situated opposite the "0" compartment of the wheel.

**[0017]** The outer sensor 24a allows to detect the position of the wheel as fractions of a revolution corresponding to the subdivision of the numbers, while the inner sensor 24b, owing to the single notch 30 positioned at the "0", allows to detect the absolute position of the wheel 14.

**[0018]** The sensors are of the digital optical type, based on an LED transmitter and a corresponding receiver.

**[0019]** Reference numeral 32 denotes optical sensor devices forming part of a second group, arranged along the upper ring 13 which acts as a rolling track for the ball, and including laser transmitters and associated receivers which are oriented towards the circumference of rotation

of the ball at rest 22 and adapted to detect the ball during play.

**[0020]** The optical sensors 32 are two or more in number, preferably three in number, and are arranged at angular intervals which are typically, but not necessarily equivalent to 12/37ths, 12/37ths and 13/37ths of a revolution in single "0" roulette wheels and 13/38ths, 12/38ths and 13/38ths of a revolution in double "0" roulette wheels.

**[0021]** The sensors 32 are coherent-light digital optical sensors based on a pulsed semiconductor laser transmitter.

**[0022]** Both sensors 24, 32 operate by means of detection of a variation in luminance in the direction of observation, due to the alternating succession of black notches 26 and white spaces 28, or the succession of the reflecting surface of the ball receiving pockets (regarded as a background irrespective of their colour) and the reflecting surface of the ball itself. They have a high degree of precision, of the order of 1 mm at a distance of 300 mm, also in the case where the ball is distant from the light beam source.

**[0023]** The first and second sensors 24, 30 are linked to respective control panels 35, 36 which are connected to a data collection and processing unit 40 designed for the synchronous acquisition and analysis of the position signals, of the wheel and ball respectively, during the various stages of evolution of the game.

**[0024]** The beams of light reflected by the objects to be detected (ball or compartment) are received by the sensors via a semi-reflective mirror arranged inside the sensor and are amplified and analysed by the unit 40.

**[0025]** Reference numeral 50 denotes generally a levelling system adapted to control and adjust the parallelism in relation to the equipotential surface of the gravitational field of the roulette wheel structure, which is situated underneath it and comprises a base 52 for supporting the roulette wheel, connected to a plurality of legs 54 for resting on the ground, which can be adjusted heightwise by means of screw/screw nut assemblies controlled micrometrically by means of a lever mechanism of the axial/radial transfer type and position sensors 56 visible in Figure 2b. This system allows the roulette structure to be isolated from external stresses, at the same time ensuring that the predetermined position is maintained by means of a prior calibration operation.

**[0026]** The levelling system 50 is connected to the data collection and processing unit 40 so as to signal in real time any anomaly detected, anomaly being understood as meaning the deviation from the predetermined position.

**[0027]** An internal accelerometer is also connected to the unit 40 and is adapted to detect accelerations of the roulette wheel structure in the two or three spatial directions with respect to the original rest condition, for example owing to sudden impacts. Preferably the measuring precision is about 1mg over a maximum scale of 2g, corresponding to  $\pm 1.5$  mm/m of inclination with respect to

the equipotential surface of the gravitational field for a dual-axis (planar) sensor and about 2mg over a maximum scale of 3g per axis, corresponding to  $\pm 2.0$  mm/m of inclination for a three-axis sensor.

**[0028]** A dual-axis accelerometer is adapted to detect raising of the roulette wheel structure on one side (and consequent loss of the original position) or a lateral impact. A three-axis accelerometer allows to determine also the acceleration or displacement along the vertical axis. It should be noted that in most cases a dual-axis accelerometer may be sufficient since it is very difficult to manage to raise a roulette wheel structure without inclining it in a manner detectable by the instrument owing to its sensitive nature.

**[0029]** The unit 40 is designed to store the instant in time when an anomaly occurs, whether it be detected by the levelling system or the accelerometer, its magnitude and duration.

**[0030]** Advantageously, it is also arranged a temperature sensor (not shown) associated with the roulette wheel structure and connected to the unit 40, for detecting the temperature of the roulette wheel in order to monitor possible thermal deformations.

**[0031]** Also possible is a magnetic field sensor, such as a compass, also connected to the unit 40 and adapted to determine the orientation of the roulette wheel structure with respect to the earth's magnetic field and detect any variation in the magnetic field close thereto.

**[0032]** The data collection and processing unit 40 is able to communicate, in a network having similar units associated with other roulette wheel structures of different tables, with a central processing system 70 adapted to execute a computer program or set of computer programs designed to supply the collected data to the surveillance personnel, for example by means of a simple and immediate graphics interface, and store the progress of the game conditions and any alarm situations requiring intervention of the personnel.

**[0033]** With this data relating to the position of the roulette wheel and the location of the ball it is possible to detect, during the course of the game (throwing of the ball, placing of the bets, completion of the bets, dropping of the ball into a pocket corresponding to a numbered compartment and identification of the winning number), valid game conditions (the winning number may be automatically detected as well as, in real time, the instantaneous speed of the wheel and its direction of rotation (clockwise, anti-clockwise), the speed of the ball and its direction of rotation). With this recorded data it is possible to assess the validity of the throw in accordance with the existing regulations and analyse whether the directions and speed of the wheel and ball are compliant.

**[0034]** In a further improved embodiment, a geographical positioning system, similar to a GPS satellite positioning system, is incorporated in the roulette wheel structure, in order to monitor any displacement of the structure, for example transportation of the structure from a warehouse to a games room, or transfer between different

rooms. The positioning system is adapted to be connected to the data collection and processing unit 40 so as to signal in real time any displacement and store the temporal data relating to the displacements which occur over time.

**[0035]** The operating principle of the control system is described below.

**[0036]** In the rest condition the system waits for the ball to be thrown.

**[0037]** According to the traditional game rules, at the start of the game, the roulette wheel is rotated in the desired direction and then the ball is thrown in the direction opposite to that of rotation of the wheel. In order for the game to be valid, the wheel must rotate at a speed greater than a predetermined threshold speed which can be personalized and, similarly, the ball must be thrown so as to initiate its own rotation within the wheel at a speed which is greater than a predetermined threshold speed which can also be personalized on the basis of the regulations existing at the place of installation.

**[0038]** The control system, depending on the data supplied by the sensors for detecting the kinematic data of the wheel and the ball, identifies the following stages in the game essentially as follows:

- placing of the bets: stage of the game where the direction of rotation of the ball is opposite to that of the wheel, and wheel and ball rotate at greater speeds than the respective threshold speeds;
- completion of bets: the speed of rotation of the ball falls below the threshold speed;
- detection of the winning number: the ball falls into the wheel and therefore the wheel and the ball have the same speed and direction of rotation; the relative position of the ball with respect to the wheel is detected and the data of the winning number is acquired after the reading of all the sensors has been verified.

**[0039]** The direction of rotation of the wheel is detected by the sensors 24 of the first group and acquired once only with each rotation of the wheel and it is therefore necessary to wait at the most for one complete rotation in order to define the direction of rotation of the wheel.

**[0040]** The direction of rotation of the ball is instead detected by means of the sensors 32 of the second group and determined after the passing movement of the ball has been detected by at least two sensors and, therefore, in the example of embodiment described, after about 2/3rds of a revolution, namely about 240 degrees.

**[0041]** In detail, the signal of the outer sensor 24a of the first group is sent to a digital counter of the control unit 40 which is able to increment stored data, indicating the physical position of the wheel, every two notches (internally the number of pulses is divided by 2). This signal is also used, by means of a dedicated input of the unit, to calculate the speed of rotation of the wheel, measuring the time which lapses between the passing movement of two notches in front of the sensor. The signal of the

inner sensor 24b of the first group is used to synchronize the counter of the unit 40 with the "0" compartment of the wheel.

**[0042]** The signals of the sensors of the second group 32 are sent to three separate inputs of the unit 40.

**[0043]** At the instant when the ball intercepts the light beam of a sensor, the angular position of the wheel is stored and this is converted into the number of the compartment of the wheel in which the ball is situated, on the basis of the predefined succession of the numbers on the ring.

**[0044]** By means of the interception sequence of these sensors it is also possible to determine the direction of rotation of the ball.

**[0045]** The three signals are sent to an adder circuit, the output of which is used to calculate the speed of rotation of the ball, calculating the time which has lapsed when passing from one sensor to the adjacent sensor.

**[0046]** The data processed by the unit 40 is supplied via a serial output to an external processor for display and statistical processing.

**[0047]** A computer program or set of computer programs adapted to be executed by the central processing system manages the data processed by each control unit 40 of a roulette table, analysing the progress of the game and signalling to the competent personnel any anomalies which may adversely affect the correctness thereof.

**[0048]** Obviously, without modifying the principle of the invention, the embodiments and constructional details may be greatly varied with respect to that which has been described and illustrated purely by way of a non-limiting example, without thereby departing from the scope of protection of the present invention defined by the accompanying claims.

## Claims

1. Roulette wheel, comprising a wheel (14) which includes a first ring (20) on which numbered compartments are shown and a second ring (22) provided with pockets corresponding to the numbered compartments of the first ring (20) and adapted to receive and retain a ball during the course of the game, as well as an associated control system comprising detector devices adapted to determine game conditions depending on the detection of reflections of a controlled beam of light, produced by at least one of said rings and by the ball,

**characterized in that** said control system includes:

- first optical sensor means (24), adapted to detect the angular position of rotation of the wheel (14) by means of the detection of markings (26, 30) associated with said wheel;
- second optical sensor means (32) arranged in association with said second ring (22) and adapted to detect the angular position of revo-

lution of the ball along the circumference of said ring (22); and

- a data collection and processing unit (40) connected to said first and second sensor means (24, 32) and designed for the synchronous acquisition and analysis of the position signals of the wheel (14) and the ball, respectively, during the various stages of the game;

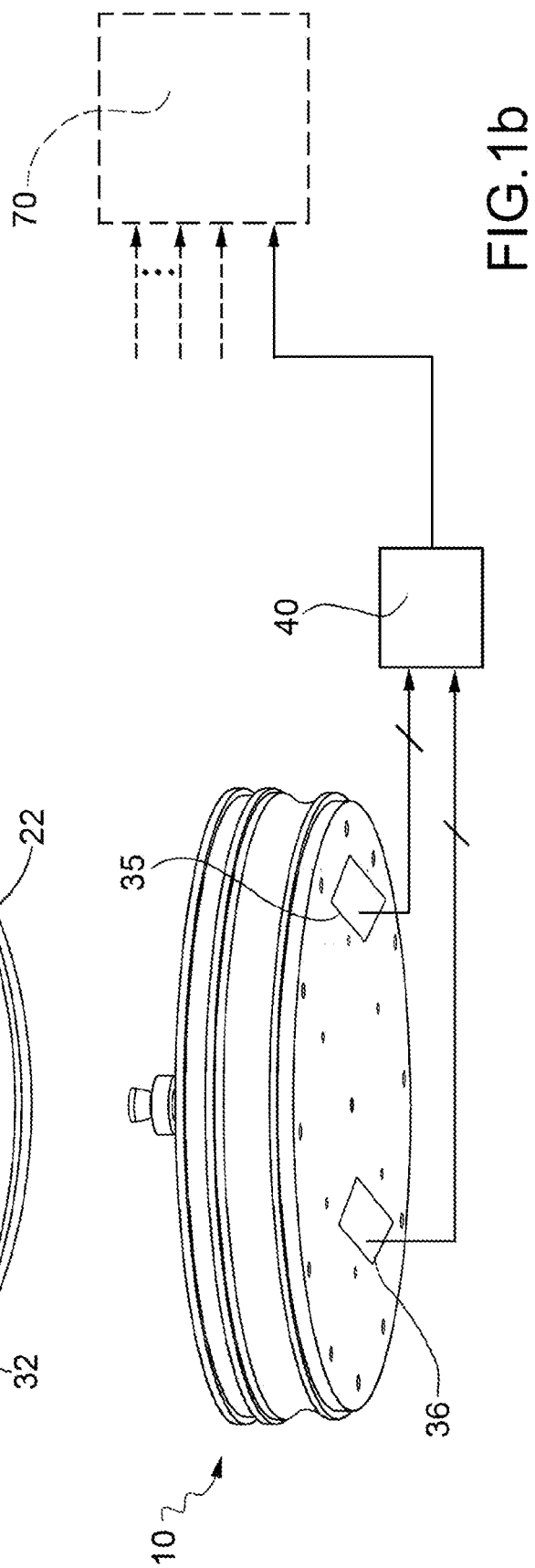
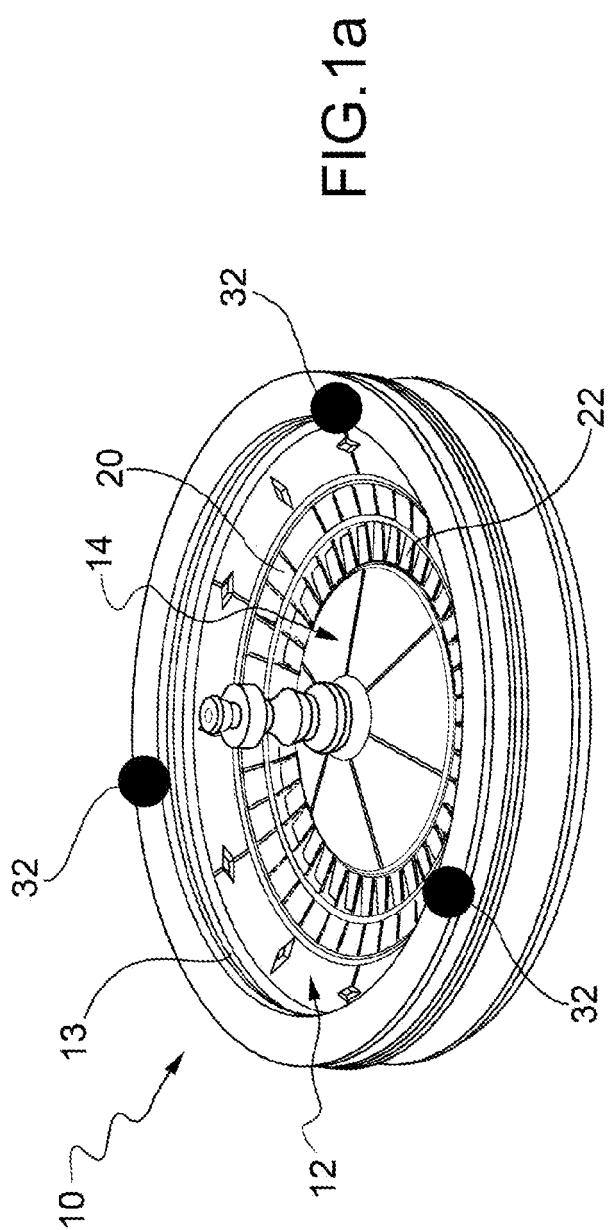
in which said first sensor means (24) include a pair of sensor devices arranged radially aligned with respect to the roulette wheel (14), i.e. an outer sensor device (24a) arranged to detect a plurality of markings (26) having a first colour, alternating with a corresponding plurality of spaces (28) having a second colour, present on a support disc (25) fixed underneath the wheel, and an inner sensor device (24b) arranged to detect a predetermined marking (30) arranged in correspondence to a predetermined numbered compartment of the wheel (14); and in which said second sensor means (32) include a plurality of sensor devices which are arranged circumferentially with respect to the roulette wheel (14) and oriented towards an associated observation point of the circumference of revolution of the ball on the second ring (22).

2. Roulette wheel according to Claim 1, in which each sensor device (24a, 24b) of said first sensor means (24) includes LED transmitter means and corresponding photodetector means for an optical signal reflected by said markings.
3. Roulette wheel according to Claim 1 or 2, in which each sensor device of said second sensor means (32) includes coherent-light transmitter means and corresponding photodetector means for an optical signal reflected by the observation point of said second ring.
4. Roulette wheel according to Claim 3, in which said coherent-light transmitter means include pulsed semiconductor laser generator means.
5. Roulette wheel according to any one of the preceding claims, in which said second sensor means (32) comprise three sensor devices arranged at angular intervals equivalent to 12/37ths or 13/37ths of a revolution in single "0" roulette wheels and 12/38ths or 13/38ths of a revolution in double "0" roulette wheels.
6. Roulette wheel according to any one of the preceding claims, comprising a levelling system (50) adapted to control and adjust the parallelism in relation to the equipotential surface of the gravitational field of the roulette wheel structure.
7. Roulette wheel according to Claim 6, in which said

levelling system (50) comprises a base (52) for supporting the roulette wheel structure, connected to a plurality of legs (54) for resting the roulette wheel structure on the ground, which can be adjusted heightwise, and position sensors (56).

8. Roulette wheel according to Claim 7, in which said support legs (54) include screw /screw nut assemblies controlled micrometrically by means of a lever mechanism of the axial/radial transfer type, for adjusting said legs (52) heightwise.
9. Roulette wheel according to Claim 7, in which said position sensors of the levelling system are adapted to transmit associated signals indicating the inclination of the roulette wheel structure to said data collection and processing unit (40).
10. Roulette wheel according to any one of the preceding claims, comprising accelerometer means adapted to detect accelerations of the structure of the roulette wheel with respect to an original rest condition and transmit associated signals indicating accelerations affecting said structure to the data collection and processing unit (40).
11. Roulette wheel according to Claim 10, in which said accelerometer means comprise a dual-axis accelerometer adapted to detect raising of the roulette wheel structure on one side or a lateral impact against said structure, or a three-axis accelerometer, adapted to determine acceleration or displacement of the roulette wheel structure along the vertical axis.
12. Roulette wheel according to any one of the preceding claims, comprising temperature sensor means associated with the roulette wheel structure and arranged to supply associated signals indicating the temperature of said structure to the data collection and processing unit (40).
13. Roulette wheel according to any one of the preceding claims, comprising magnetic field sensor means connected to the unit (40), adapted to determine the orientation of the roulette wheel structure with respect to the earth's magnetic field and arranged to supply associated signals indicating a variation in the magnetic field in the vicinity of said structure to the data collection and processing unit (40).
14. Roulette wheel according to any one of the preceding claims, comprising a geographical positioning system adapted to detect and store a displacement of the roulette wheel structure with respect to a predetermined siting position and arranged to supply associated signals indicating displacements which occur over time to the data collection and processing unit (40).

15. Roulette wheel according to any one of the preceding claims, in which the data collection and processing unit (40) is arranged to store the instant in time when an anomaly occurs, its magnitude and its duration.
16. Roulette wheel according to any one of the preceding claims, in which said data collection and processing unit (40) is adapted to communicate in a network with similar units associated with other roulette wheel structures and with a central processing unit (70) adapted to execute a program or a set of programs designed to supply the data collected to surveillance personnel and/or store the progress of the game conditions and/or for the displaying and statistical processing of the data relating to game conditions.
17. Roulette wheel according to any one of the preceding claims, in which said data collection and receiving unit (40) is arranged to identify the stages of the game based on the data supplied by the first and second sensor means, as:
- a first stage involving placing of the bets, when the direction of rolling of the ball determined is opposite to the direction of rotation of the wheel (14), the wheel and ball rotating at speeds greater than respective predetermined threshold speeds;
  - a second stage involving completion of the bets, when the rolling speed of the ball falls below said threshold speed; and
  - a third stage involving detection of the winning number, when the wheel and the ball have the same rotational/rolling speed and same direction of rotation.
18. Roulette wheel according to Claim 17, in which said unit (40) is adapted to detect the direction of rotation of the wheel by means of said first sensor means (24) once only with each rotation of the wheel (14).
19. Roulette wheel according to Claim 17, in which said unit (40) is adapted to detect the direction of rotation of the ball by means of said second sensor means (32) after the passing movement of the ball has been detected by at least two sensor devices.
20. Roulette wheel according to any one of the preceding claims, in which said unit (40) is adapted to increment counting data indicating the physical position of the wheel upon detection of two successive markings (26) of the disc (25) by said first sensor means (24) and is adapted to calculate the speed of rotation of the wheel (14) depending on the time which has lapsed between detection of said two markings (26), the counting data being synchronized depending on the detected passing movement of the marking (30) arranged in correspondence of a predetermined numbered compartment of the wheel (14).
21. Roulette wheel according to any one of the preceding claims, in which said unit (40) is adapted to store the angular position of the wheel (14) when a sensor device of said second sensor means (32) intercepts the ball and to convert said angular position into a compartment number of the wheel (14) indicating the compartment in correspondence of which the ball is situated, on the basis of a predefined succession of the numbers on the ring (20).
22. Roulette wheel according to any one of the preceding claims, in which said unit (40) is arranged to determine the direction of rolling of the ball depending on the sequence in which the ball is intercepted by the plurality of sensor devices of said second sensor means (32).
23. Roulette wheel according to any one of the preceding claims, in which said unit (40) includes an adder circuit adapted to receive the signals supplied by the plurality of sensors of said second sensor means (32) and is arranged to calculate the speed of rotation of the ball depending on the time which has elapsed during detection thereof by two adjacent sensor devices in succession.



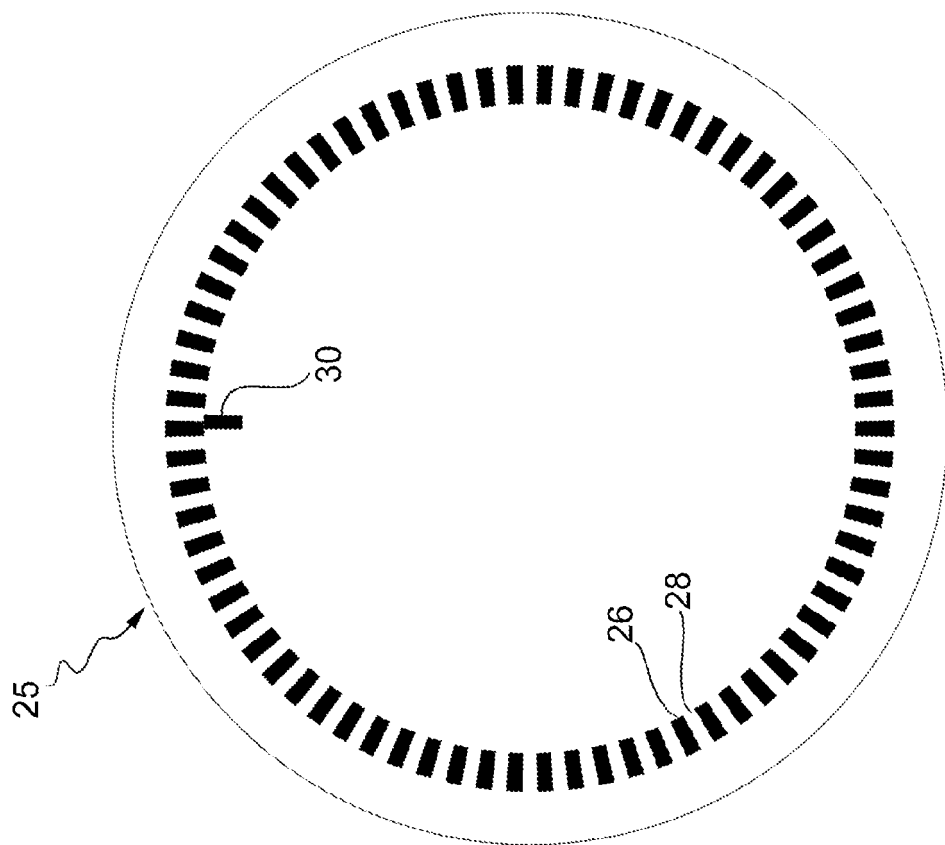


FIG. 2b

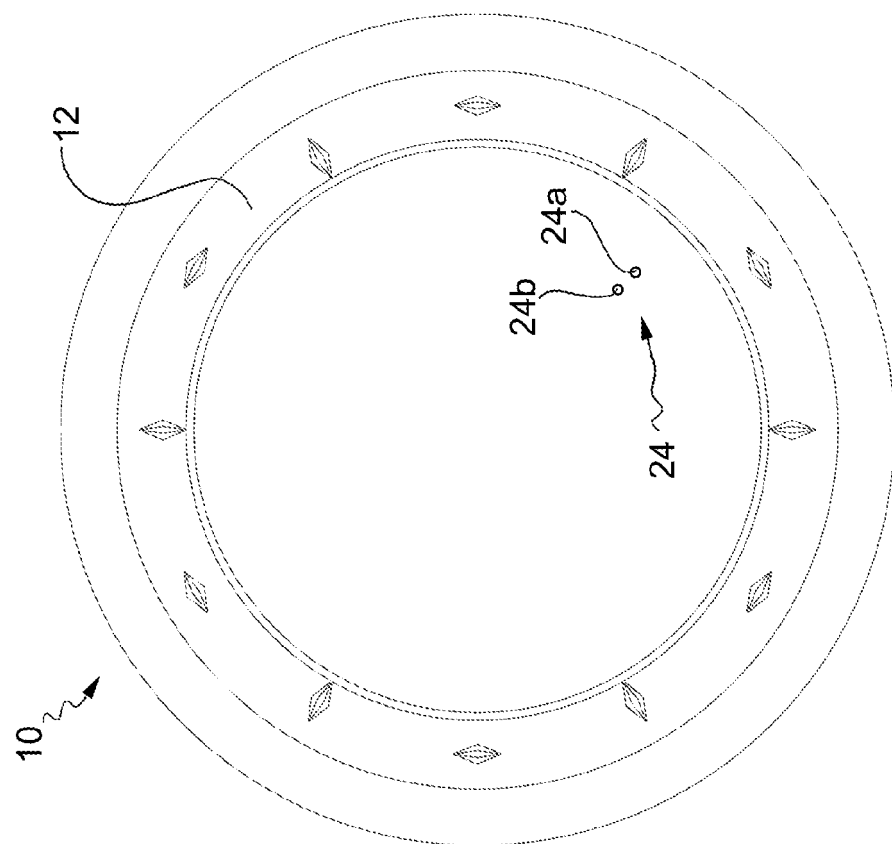


FIG. 2a

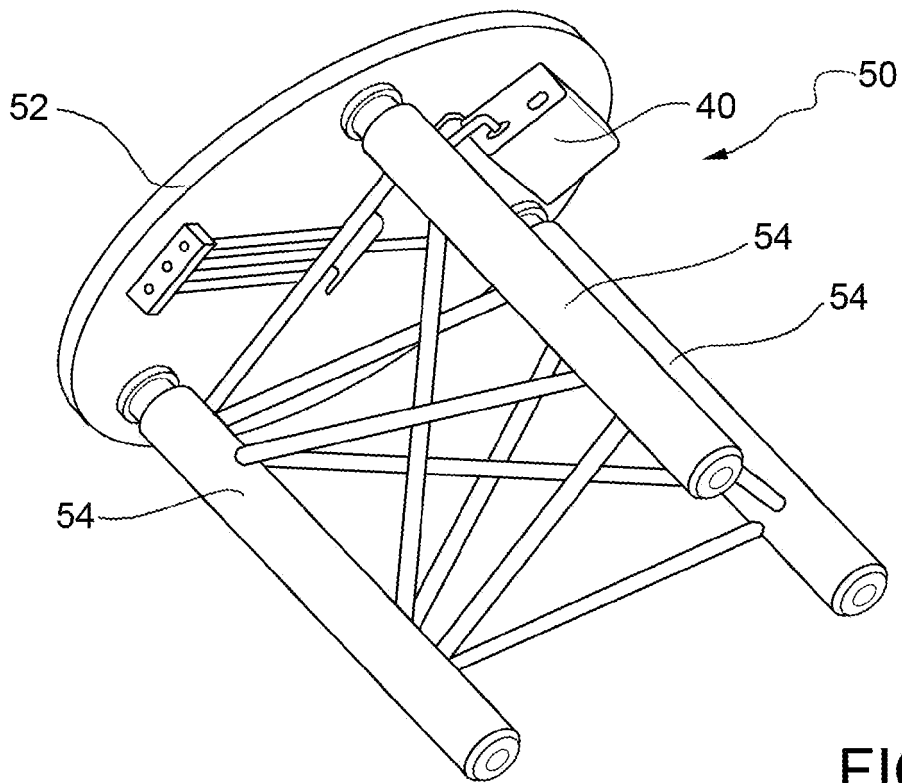


FIG. 3a

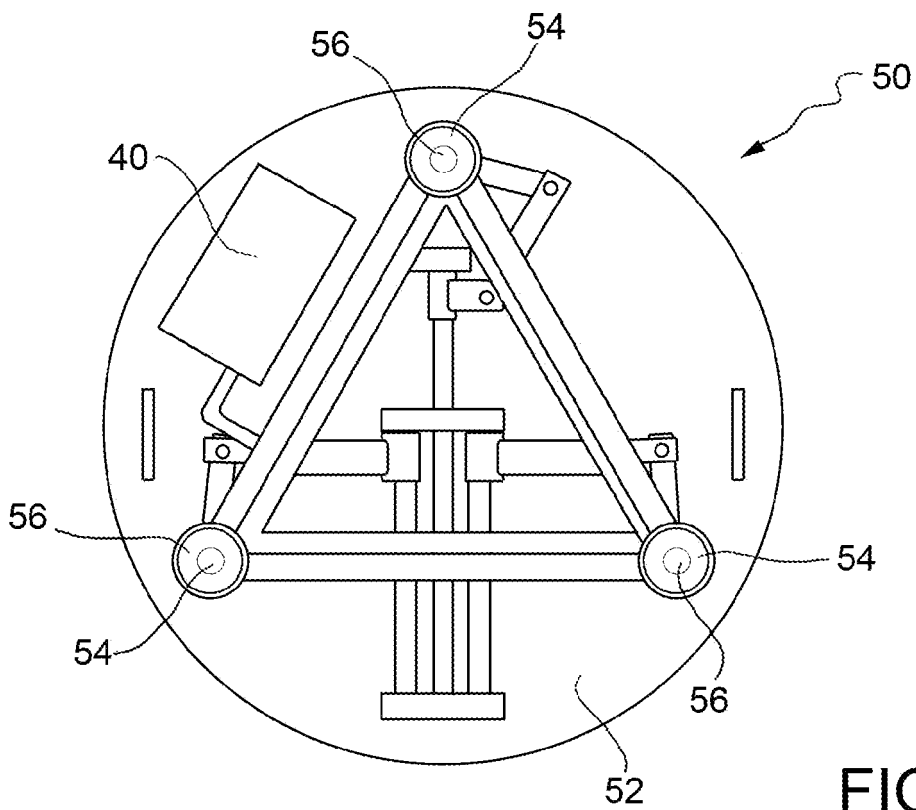


FIG. 3b



European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 07 42 5704

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                              |                                                   |                                         |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                              |                                                   |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                              | Date of completion of the search<br>25 March 2008 | Examiner<br>Shmonin, Vladimir           |
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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 42 5704

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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