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(54) **WEAPON AND EQUIPMENT FOR A FENCING DISCIPLINE HAVING ADVANCED HIT
DETECTION FUNCTIONALITIES**

(57) A weapon for a fencing discipline 1 is described, which is usable for sports or games, and which is suitable to be connected to a detection apparatus 2 provided with at least a first 21 and a second apparatus terminal 22.

The fencing weapon 1 comprises a percussion element 11, having a percussion portion 12 suitable to deliver a hit on a target X, and an electrical device 10, incorporated in the weapon 1.

The aforesaid electrical device 10 comprises a reference terminal Tr, adapted to be connected to the first apparatus terminal 21 to receive a reference electrical potential Vr, and a measuring terminal Tm, adapted to be connected to the second apparatus terminal 22 to supply an electrical measuring potential Vm. The electrical device 10 further comprises a first contact terminal Tc1 and a second contact terminal Tc2, arranged so as to come simultaneously into contact with the target X when the aforesaid percussion portion 12 delivers a hit on the target X.

The electrical device 10 is configured to take a signalling condition when it is connected to the detection apparatus 2 and at a hit has been delivered on the target X by the percussion portion 12, wherein the reference terminal Tr is kept at the electrical reference potential Vr and is further electrically connected to the first contact terminal Tc1; the first and the second contact terminals (Tc1, Tc2) are adapted to be electrically connected by means of a target portion X comprised there between so as to apply a detection voltage ΔV , depending on the electrical reference potential Vr, to such a target portion; and furthermore either the first or the second electrical contact (Tc1, Tc2) is electrically connected to the measuring terminal Tm, so that the electrical measuring potential Vm takes a signalling value S, depending on the electrical reference potential Vr and the detection voltage ΔV .

A fencing equipment and a hit detection method using the aforesaid weapon are also described.

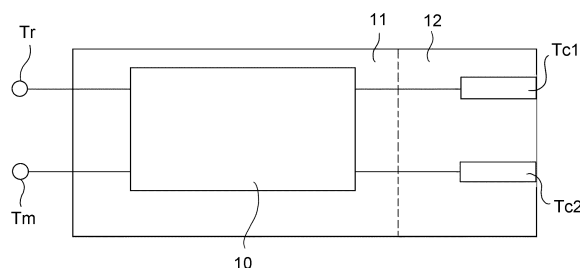


FIG. 1

Description

TECHNOLOGICAL BACKGROUND OF THE INVENTION

Application field

[0001] The present description relates to the technical field of the electronic functionalities of a fencing equipment, aimed at automatically detecting hits, in particular thrusts and cuts.

[0002] In particular, the present description relates to fencing weapons, equipment, uniforms, kits and systems provided with electronic hit/touch detection functions and respective methods in which they are used for sport- or even game-type applications.

Description of the prior art

[0003] Fencing weapons and hit detection systems provided with electronic functions for detecting hits and determining scores in fencing competitions are well known. The fencing weapon to which reference is made is, for example, foil, épée and sabre, corresponding to the most widespread fencing disciplines. It is well known that each discipline has its own rules with regards to valid hits or touches (thrusts and cuts) and to the zone of the opponent's body valid for the hit and to the strength with which the hit must be landed. The known systems, dedicated to the various disciplines mentioned above, by means of electrical/electronic functions, can detect the hits, discriminate whether they are valid or not and, when hits from both contenders are detected, establish a "priority", i.e., the order in time at which they occurred.

[0004] The aspect of determining priority is apparently essential to allow a correct determination of the score of a fencing competition and is an indispensable requirement for the electrical/electronic detection system to be used and possibly approved by international fencing sport authorities.

[0005] In order to ensure the time accuracy features needed for a correct priority evaluation, in the currently known and widespread systems the fencing weapon and the respective equipment are connected by means of wires to a detection station capable of providing a common ground to the weapons/equipment of the two fencers.

[0006] In particular, the operation of such known systems, although with some differences from discipline to discipline, is based on the common principle according to which a circuit which crosses the weapons/equipment of both contenders is closed when a target is touched. The fact that the two possible different circuits (which are formed as a result of the hits of one or the other of the two fencers, respectively) have a common ground and are closed through the detection station allows the detection station to establish not only the type of hit (valid/invalid) but also the time of the hits, and thus their

priority.

[0007] For the sake of use convenience, simplicity and freedom of action of the fencers (or of game users), the need to use fencing equipment and systems which operate in wireless manner, i.e., without the need to connect the equipment of each fencer to the detection station, is more and more felt. Wireless-type test systems have been developed, in which the electrical signal related to the hit/touch is detected (and sometimes partially processed) by the fencer's equipment and then sent to the detection station in wireless manner. In such systems, the communication of signals between fencer's equipment and detection station via wire is replaced by a wireless communication, which may be obtained rather easily by means of known wireless transmission techniques. However, such systems require anyway a wired connection between fencer's equipment and detection system in order to guarantee the further aforesaid requirement of the presence of a common ground. Thus, such test systems are not completely wireless and do not fully satisfy the mentioned need.

[0008] On the other hand, further test systems - entirely wireless - have been tested, but have been found to be not sufficiently accurate in defining the hit/touch priority, to the extent of leading to errors in determining the score and with an error probability which could be not acceptable or appropriate for use in official competitions.

[0009] Thus, actually, the need of having electrical/electronic hit/touch detection equipment and systems in fencing disciplines such to be completely wireless and such to guarantee sufficient performance for practical use is not satisfied today, to the Applicants' knowledge.

[0010] In light of the above, it is the object of the present disclosure to devise and provide a fencing weapon (i.e., gear), respective equipment and a fencing uniform usable in conjunction with the weapon/equipment (each expressed in different embodiments adapted to the various fencing disciplines), which are improved so as to satisfy the needs mentioned above and able to at least partially avoid the drawbacks described above with reference to the prior art.

[0011] It is another object of the present invention to provide systems and methods for detecting hits/touches and determining scores of fencing disciplines, which use the aforesaid fencing weapons, equipment and uniforms.

SUMMARY OF THE INVENTION

[0012] Such an object is achieved by means of a fencing weapon according to claim 1.

[0013] Further embodiments of such fencing weapon are defined in dependent claims from 2 to 10.

[0014] A fencing equipment using the aforesaid fencing weapon is defined in claim 11.

[0015] Further embodiments of such fencing equipment are defined in claims 12-14.

[0016] A method for detecting hits in fencing disciplines, carried out by means of the weapon and equip-

ment of the invention, is defined in claim 15.

BRIEF DESCRIPTION OF THE DRAWINGS.

[0017] Further features and advantages of fencing weapon and respective fencing equipment, according to the present description, and of systems using the aforesaid fencing weapon and equipment, will be apparent in the following description which illustrates preferred embodiments, given by way of indicative, non-limiting examples, with reference to the accompanying figures, in which:

- figure 1 shows a functional diagram of a fencing weapon according to the present invention;
- figures 2A and 2B illustrate the structure and two possible operating conditions of an item of fencing equipment according to the invention, comprising the fencing weapon of figure 1;
- figure 3 shows a functional diagram of an embodiment of the fencing equipment, usable in the foil discipline;
- figure 4 shows a structural diagram of an embodiment of the fencing weapon, usable in the foil discipline;
- figure 5 shows a functional diagram of an embodiment of the fencing equipment, usable in the épée discipline;
- figure 6 shows a structural diagram of an embodiment of the fencing weapon, usable in the épée discipline;
- figure 7 shows a functional diagram of an embodiment of the fencing equipment, usable in the sabre discipline;
- figure 8 shows a structural diagram of an embodiment of the fencing weapon, usable in the sabre discipline;
- figure 9 shows a functional diagram of a system for hit detection and score determination comprised in the invention and using the aforesaid fencing equipment.

DETAILED DESCRIPTION

[0018] With reference to figures 1-8, a weapon for a fencing discipline 1, usable for sports or games, is described, the weapon being suitable to be connected to a detection apparatus 2 provided with at least a first apparatus terminal 21 and a second apparatus terminal 22.

[0019] The fencing weapon 1 comprises a percussion element 11, having a percussion portion 12 suitable to deliver a hit on a target X, and an electrical device 10, incorporated in the weapon 1.

[0020] The aforesaid electrical device 10 comprises a reference terminal Tr, adapted to be connected to the first apparatus terminal 21 to receive a reference electrical potential Vr, and a measuring terminal Tm, adapted to be connected to the second apparatus terminal 22 to

supply an electrical measuring potential Vm. The electrical device 10 further comprises a first contact terminal Tc1 and a second contact terminal Tc2, arranged so as to come simultaneously into contact with the target X when the aforesaid percussion portion 12 hits the target X.

[0021] The electrical device 10 is configured to take a signalling condition, when it is connected to the detection apparatus 2 and upon a hit of the percussion portion 12 on the target X; in the signalling condition, the reference terminal Tr is kept at the electrical reference potential Vr and is further electrically connected to the first contact terminal Tc1; the first and the second contact terminals (Tc1, Tc2) are adapted to be electrically connected by means of a target portion X comprised there between so as to apply to such a target portion a detection voltage ΔV depending on the electrical reference potential Vr; and furthermore either the first or the second electrical contact (Tc1, Tc2) is electrically connected to the measuring terminal Tm so that the electrical measuring potential Vm takes a signalling value S, depending on the electrical reference potential Vr and the detection voltage ΔV .

[0022] According to an implementation option, the fencing weapon 1 is further configured to take a resting position, when it is connected to the detection apparatus 2 and when it is not in the signalling condition; in the resting position, the first and the second contact terminals (Tc1, Tc2) are not electrically connected to each other through the target X and the electrical measuring potential Vm takes a resting value N distinguishable from the signalling value S.

[0023] In accordance with an example of implementation, the resting value N of the electrical measuring potential Vm is representative of the resting condition of the electrical device 10 and the signalling value S of the electrical measuring potential Vm is representative of the signalling condition and is further indicative of at least one electrical property of the target X.

[0024] The fencing weapon 1 according to the present description may be any one piece of fencing gear/weapon used in the known fencing disciplines, in particular a foil or an épée or a sabre or a kendo "shinai".

[0025] The embodiments comprised in the present invention corresponding to the various mentioned items of fencing gear/weapon will be illustrated in detail below. The differences in the implementation details depend on the well-known different rules of the various fencing disciplines and on the opportunity of keeping compatibility with traditional fencing weapons, where possible.

[0026] According to an embodiment, illustrated in figures 3 and 4, the fencing weapon is a foil 1.

[0027] In such a case, the percussion element 11 is a foil blade 11 and the percussion portion 12 is the blade tip 12, adapted to deliver a thrust as a hit (i.e., to touch with a thrust, according to the terminology used with reference to foil). According to the rules of foil, the signalling condition corresponds to a situation in which the percussion portion 12 hits a target X and exerts against it a force

higher than a predetermined threshold.

[0028] In this embodiment, the electrical device further comprises a first conductive element 13, configured to electrically connect the reference terminal Tr to the first contact terminal Tc1 in permanent manner; a second conductive element 14, configured to electrically connect the measuring terminal Vm to the second contact terminal Tc2 in permanent manner; a switch element 15, configured to connect the first 13 and the second conductive element 14, when the device 1 is in resting condition, and to disconnect the first 13 and the second conductive element 14, when the device 1 is in signalling condition.

[0029] In a particular example of implementation, the first conductive element 13 comprises a wire 13 arranged within the blade of the foil and the second conductive element 14 comprises the blade 11 of the foil 1.

[0030] According to an implementation option, the foil 1 further comprises a thrust detection element 16, in which the first and the second contact terminals (Tc1, Tc2) are arranged; the thrust detection element 16 is arranged at the tip 12 of the blade of the foil.

[0031] Such a detection element 16 is slidingly connected to the percussion element 11 of the foil 1 so as to take either a resting position or a signalling position relative to the electrical device 10. In the resting position, corresponding to the resting condition of the electrical device 10, the detection element 16 keeps the switch element 15 closed to connect the first 13 and the second conductive element 14. In the signalling position, corresponding to the signalling condition of the electrical device 10, the detection element 16 keeps the switch element 15 open, to disconnect the first 13 and the second conductive element 14.

[0032] In accordance with another embodiment, illustrated in figures 5 and 6, the fencing weapon is an épée 1.

[0033] In such a case, the percussion element 11 is a blade 11 of the épée 1 and the percussion portion 12 is the tip of the blade, adapted to deliver a thrust as a hit (i.e., to touch with a thrust, according to the terminology used with reference to épée). According to the rules of épée, the signalling condition corresponds to a situation in which the percussion portion 12 hits a target X and exerts against it a force higher than a predetermined threshold.

[0034] In this embodiment, the electrical device 10 further comprises: a switch element 17, connected to the reference terminal Tr by means of a conductive element 13, and configured to connect the reference terminal Tr to the first contact terminal Tc1, when the electrical device 10 takes the signalling condition, and to disconnect the reference terminal Tr from the first contact terminal Tc1, when the electrical device 10 takes the resting condition; and finally a ground terminal Tg, suitable to be connected to a third apparatus terminal 23 connected to ground.

[0035] The electrical device 10 is configured so that the first contact terminal Tc1 is electrically connected in permanent manner to the measuring terminal Tm, by means of a second conductive element 14, and the sec-

ond contact terminal Tc2 is electrically connected in permanent manner to the ground terminal Tg, by means of a third conductive element 18.

[0036] In an example of implementation, the first conductive element 13 comprises a first wire 13 arranged within the blade, the second conductive element 14 comprises a second wire arranged within the blade and the third conductive element 18 comprises the blade of the épée 11.

[0037] According to an implementation option, the épée 1 further comprises a thrust detection element 16, in which the first and the second contact terminals (Tc1, Tc2) are arranged; the thrust detection element 16 is arranged at the tip of the blade of the épée. The detection element 16 is slidingly connected to the percussion element 11 of the épée, so as to take either a resting position or a signalling position relative to the electrical device. In the resting position, corresponding to the resting position of the electrical device, the detection element 16 keeps the switch element 17 open to disconnect the reference terminal Tr and the first contact terminal Tc1 from each other. In the signalling position, corresponding to the signalling condition of the electrical device 10, the detection element 16 keeps the switch element 17 closed to connect the reference terminal Tr and the first contact terminal Tc1 to each other.

[0038] Both in the case of foil and of épée, the thrust detection element 16 may comprise a button, arranged at the tip of the blade, and substantially shaped as a cylinder or truncated cone; such a button is adapted to hit the target by means of a substantially planar contact surface thereof corresponding to a base of said cylinder and/or truncated cone. In such a case, the first and the second contact terminals (Tc1, Tc2) comprise respective portions of the button, mutually insulated and facing the contact surface, so that both contact terminals touch the target simultaneously when the contact surface hits the target.

[0039] According to an implementation option, the foil or the épée further comprises a spring-piston element 19, mechanically connected to the detection element 16. The spring-piston element 19 is configured to keep the detection element 16 in the resting position, with respect to the percussion element 11, while the detection element 16 is not in contact with the target X or is in contact with the target X but is subjected to a force lower than the predetermined threshold, and to allow instead a movement of the detection element 16, with respect to the percussion element 11, up to the signalling position, when the detection element 16 is in contact with the target X and is subjected, because of the contact, to a force higher than the predetermined threshold.

[0040] In accordance with another embodiment, illustrated in figures 7 and 8, the fencing weapon 1 is a sabre 1.

[0041] In such a case, the percussion element 11 is a blade 11 of the sabre and the percussion portion 12 is the blade itself adapted to deliver a cut as a hit (i.e., to

touch with a cut, according to the terminology used with reference to sabre).

[0042] According to the rules of sabre, the signalling condition corresponds to a situation in which the percussion portion 12 touches a target, regardless of the force exerted against it.

[0043] In this embodiment, the first contact terminal Tc1 comprises a threadlike conductive element Tc1, electrically insulated with respect to the blade 11 of the sabre 1, and arranged on the blade 11 in a substantially coiled (i.e., spiral-like) configuration. The second contact terminal Tc2 comprises the blade of the sabre; the first contact terminal Tc1 is electrically connected in permanent manner to the reference terminal Tr, by means of a further conductive element, and the second contact terminal Tc2 is electrically connected in permanent manner to the measuring terminal Tm.

[0044] According to an implementation example, the aforesaid further conductive element comprises a further wire arranged within the blade of the sabre.

[0045] In the previously described embodiments, the percussion element is metallic because it consists of the blade of the foil, or of the épée, or of the sabre.

[0046] In accordance with another embodiment, the fencing weapon is a kendo "shinai".

[0047] In such a case, the percussion element 11 is a stick (e.g., made of wood) comprised in the "shinai" and the percussion portion 12 is the stick itself, adapted to deliver a cut as a hit.

[0048] According to the rules of kendo, the detection element 16 comprises a portion of the surface of the stick. The signalling condition corresponds to a situation in which the percussion portion 12 touches a target X, regardless of the force exerted against it.

[0049] In this embodiment, the first contact terminal Tc1 comprises a first threadlike conductive element, arranged on the stick in substantially coiled configuration; the second contact terminal Tc2 comprises a second threadlike conductive element, arranged on the stick so as to be electrically insulated, in resting condition, relative to the first contact terminal Tc1. Furthermore, the first contact terminal Tc1 is electrically connected in permanent manner to the reference terminal Tr and the second contact terminal Tc2 is electrically connected in permanent manner to the measuring terminal Tm.

[0050] It can be easily understood that the embodiment may be adapted also to applications other than those of sports and competitions, such as for example games, on the basis of the same previously illustrated inventive concept.

[0051] In particular, according to a yet further embodiment, the weapon is a gear for games or toys. In such a case, the percussion element 11 is a percussion element made of plastic or wood or other synthetic material.

[0052] The signalling condition corresponds to a situation in which the percussion portion 12 touches a target X.

[0053] According to an implementation example, the

first contact terminal Tc1 comprises a first conductive element arranged on the percussion element 11; the second contact terminal Tc2 comprises a second conductive element arranged on the percussion element 11 so as to be electrically insulated, in resting condition, with respect to the first contact terminal Tc1.

[0054] Furthermore, the first contact terminal Tc1 is electrically connected in permanent manner to the reference terminal Tr and the second contact terminal Tc2 is electrically connected in permanent manner to the measuring terminal Tm.

[0055] An item of fencing equipment 100 for a fencer will be now described with particular reference to figures 2A and 2B.

[0056] Such fencing equipment 100 comprises a weapon for a fencing discipline 1, adapted to deliver a hit on a target X, and a detection apparatus 2, electrically connected to each other.

[0057] The weapon 1 and the detection apparatus 2 comprise components and electrical connections configured to form, in the fencing equipment 100, an autonomous electric detection circuit having an autonomous ground.

[0058] Such an electrical detection circuit is configured to take a resting condition, or, when the fencing weapon 1 delivers a hit on the target X, a signalling condition. The aforesaid electric detection circuit is further configured to generate an electric signal Vm, which is representative of the resting or signalling condition and, in the signalling condition, is indicative of at least one electric property of the target X.

[0059] According to different particular embodiments, the fencing equipment 100 comprises a fencing weapon 1, according to any one of the forms and embodiments described above. It is worth noting that, according to other embodiments comprised in the invention, the electrical detection circuit of the fencing equipment may be made by electrical connections which may be different from those of the fencing weapon 1, provided they can define a configurable circuit with autonomous ground, as illustrated above.

[0060] In accordance with an embodiment of the fencing equipment 100, the electrical detection apparatus 2 comprises at least a first (21) and a second apparatus terminal (22), connectable to a reference terminal Tr and to a measuring terminal Tm of the fencing weapon 1, respectively, and further comprises power supply means 25, control means 26 and transmission means 27.

[0061] The power supplying means 25 are operatively connected to the fencing weapon 1 to supply power by means of the first apparatus terminal 21.

[0062] The control means 26 are operatively connected to the fencing weapon 1 to receive, through the second apparatus terminal 22, an electrical signal Vm according to the electrical measuring potential present at the measuring terminal Tm of the fencing weapon 1. The control means 26 are configured to process such an electrical signal Vm to recognize whether a hit was delivered (i.e.,

landed) and in the affirmative case to discriminate whether the hit was delivered on a target X of insulating material or of resistive material or of conductive material. The control means 2 are further configured to associate a time information T to each recognized hit and to generate, based on the processing of the electrical signal processing Vm, an information message M representative of the type C of the hit being recognized and of the time information T associated thereto.

[0063] The transmission means 27 are operatively connected to the control means 26 and are configured to transmit the aforesaid information message M.

[0064] According to an implementation option, the electric signal Vm coincides with the measuring potential present at the measuring terminal Tm. According to another implementation option, the electric signal Vm depends on such an electrical measuring potential, but does not coincide therewith (e.g., it may also take into account the reference potential at the reference terminal Tr).

[0065] According to an embodiment of the equipment 100, corresponding to the embodiment of the fencing weapon in which such weapon is a foil, the first apparatus terminal 21 is connected to a power supply voltage Vcc through a first resistor R1 having a zero or positive resistance R1 and the second apparatus terminal 22 is connected to ground through a second resistor R2 having a positive resistance R2, so as to determine the operation described hereto.

[0066] While the electrical device 10 takes the resting condition, the measuring potential Vm takes a resting value N equal to a maximum value, depending on the ratio between the second resistance R2 and the sum of the first R1 and the second resistance R2, according to a voltage splitter configuration with resistors in series.

[0067] When the electrical device 10 takes the signaling condition, and the contact terminals (Tc1, Tc2) are in contact with a target X of conductive material having substantially zero resistance, the measuring potential Vm takes a value substantially coinciding with the aforesaid resting value N.

[0068] When the electrical device 10 takes the signaling condition, and the contact terminals (Tc1, Tc2) are in contact with a target X of insulating material having substantially infinite resistance, the measuring potential Vm takes a minimum value, which is substantially zero.

[0069] When the electrical device 10 takes the signaling condition, and the contact terminals (Tc1, Tc2) are in contact with a target portion X of resistive material having a finite positive target resistance Rb, the measuring potential Vm takes an intermediate value between aforesaid maximum and minimum values, depending on the ratio between the second resistance R2 and the sum of the first resistance R1, second resistance R2 and target resistance Rb, according to a voltage splitter configuration with resistors in series.

[0070] According to another embodiment of the equipment 100, corresponding to the embodiment of the fencing weapon in which such weapon is an épée, the fencing

equipment 100 further comprises a third apparatus terminal 23. In such a case, the first apparatus terminal 21 is connected to a power supply voltage Vcc through a first resistor R1 having a zero or positive resistance R1, and the second apparatus terminal 22 is connected to ground through a second resistor R2 having a positive resistance R2, so as to determine the operation described below.

[0071] While the electrical device 10 takes a resting condition, the measuring potential Vm takes a resting value N equal to a substantially zero minimum value.

[0072] When the electrical device 10 takes the signaling condition and the contact terminals (Tc1, Tc2) are in contact with a target X of conductive material having substantially zero resistance, the measuring potential Vm takes a value equal to said substantially zero, minimum value.

[0073] When the electrical device 10 takes the signaling condition and the contact terminals (Tc1, Tc2) are in contact with a target X of insulating material having substantially infinite resistance, the measuring potential Vm takes a maximum value, depending on the ratio between the second resistance R2 and the sum of the first R1 and the second resistance R2, according to a voltage splitter configuration with resistors in series.

[0074] When the electrical device 10 takes the signaling condition and the contact terminals (Tc1, Tc2) are in contact with a target portion X of resistive material, having a positive finite target resistance Rb, the measuring potential Vm takes an intermediate value between aforesaid maximum and minimum values, i.e., a value equal to the detection voltage ΔV , which depends on the ratio between the parallel of the target resistance Rb and of the second resistance R2 and the sum of the parallel and of the first resistance R1.

[0075] According to another embodiment of the equipment 100, corresponding to the embodiment of the fencing weapon in which such weapon is a sabre or a shinai, the first apparatus terminal 21 is directly connected to a power supply voltage Vcc, and the second apparatus terminal is connected to ground through a second resistor R2 having a positive resistance R2, so as to determine the operation described below.

[0076] While the electrical device 10 takes a resting condition, the measuring potential Vm takes a resting value N equal to a substantially zero minimum value.

[0077] When the electrical device 10 takes the signaling condition and the contact terminals (Tc1, Tc2) are in contact with a target X of conductive material having substantially zero resistance, the measuring potential Vm takes a maximum value substantially equal to said power supply value Vcc.

[0078] When the electrical device 10 takes the signaling condition and the contact terminals (Tc1, Tc2) are in contact with a target X of insulating material having substantially infinite resistance, the measuring potential Vm takes a value equal to said substantially zero minimum value.

[0079] When the electrical device 10 takes the signaling condition and the contact terminals and the contact terminals (Tc1, Tc2) are in contact with a target portion X of resistive material, having an finite target resistance Rb, the measuring potential Vm takes an intermediate value between aforesaid maximum and minimum values, depending on the ratio between the second resistance R2 and the sum of the second resistance R2 and of the target resistance Rb, according to a voltage splitter configuration with resistors in series.

[0080] In an advantageous realization option of the fencing equipment 100 (in all the variants described above) the transmission means 27 are transmission means 27 of the wireless type.

[0081] According to different possible examples of implementation, the wireless transmission means 27 are transmitters based on Bluetooth technology, or HIPER-LAN technology, or IEEE 802.11 standard compliant Wi-Fi technology, or IEEE 802.15 standard compliant technology.

[0082] In an implementation example, the wireless transmission means 27 are configured to transmit on the ISM bandwidth between 2.4 and 2.5 GHz.

[0083] According to a further optional embodiment, the transmission means 27 are transceiver means 27, configured to transmit and to receive signals, and the control means 26 are further configured to operate according to a synchronization procedure, driven by a central control station 200 put in wireless communication with the control means 26 by means of such transceiver means 27.

[0084] According to an implementation example, the control means 26 are configured to sample the received electric signal Vm, of the analog type, and to process the signal samples through one or more algorithms, in order to determine the type of hit corresponding to the received signal.

[0085] For example, the control means 26 may be configured to sample the analog signal Vm with frequencies in the order of kHz for periods in the order of tens of milliseconds; furthermore, they are configured to extract from the sampled signal information concerning with amplitude and/or duration and/or frequency and/or spectrum content of the electrical signal Vm. In such a case, the aforesaid algorithms are configured to process information related to the amplitude and/or the duration and/or the frequency and/or the spectrum content to determine the hit type.

[0086] In accordance with a preferred option of implementation the detection apparatus 2 is integrated in a housing which can be worn by a fencer.

[0087] A fencer uniform is now described, which can be used jointly (and in a synergistic way) with the fencing equipment described above.

[0088] Such a uniform is characterized in that it comprises at least one uniform element having known and predetermined electrical properties of resistive type.

[0089] In particular, one or more uniform elements with resistive electrical properties (i.e., neither optimal/ideal

conductors nor optimal/ideal insulators, but such to have resistance electrical values that are intermediate between the very low ones, typical of conductors, and the very high ones, typical of insulators) can be profitably used to cover those parts of the body which are valid targets according to the rules of the considered fencing discipline. In contrast, invalid targets can be characterized by electrical properties of excellent conductor (e.g., the platform) or excellent insulator (e.g. "traditional" uniform parts made of insulating material, here used to cover parts of the body which are invalid targets). Considering this, it is apparent that a uniform characterized as indicated above - used in combination with the fencing equipment illustrated above - can allow to distinguish a valid touch from an invalid touch more effectively.

[0090] According to an embodiment, the uniform is provided for a sabre or kendo fencer, and comprises a mask provided with a structure made of resistive material and a mesh (i.e., grid) for the visor. The visor mesh is coated with a compound containing graphite powder and epoxy resin so as to also have resistive properties without damaging the wearability features of the mask.

[0091] In accordance with another embodiment provided for a sabre or kendo fencer, the uniform further comprises a jacket, made of resistive material, for the bust and those body parts corresponding to valid targets in the sabre or kendo; and finally further uniform elements, adapted to cover other body parts, corresponding to invalid targets in sabre or kendo, made of insulating material.

[0092] According to a further embodiment, the uniform is provided for a foil fencer, and comprises a jacket, made of resistive material, for the bust and for body parts corresponding to valid targets in foil, and further uniform elements made of insulating material, adapted to cover other body parts corresponding to targets which are invalid in foil.

[0093] In accordance with another embodiment, the uniform is provided for an épée fencer and comprises uniform elements made of resistive or insulating material.

[0094] With reference to the resistive material of which one or more elements of any one of the uniforms described above is made, an implementation option provides that portions of such resistive material, having dimensions comparable to those of the hit-detection element of the fencing weapon, have a resistance with a value comprised between 100 Ω and 1 M Ω .

[0095] Preferably, within the aforesaid range, such a resistance has a value comprised between 1 K Ω and several tens of K Ω .

[0096] The present description comprises a fencing kit for a fencer, comprising a fencing equipment 100, according to any one of the previously illustrated embodiments, and a fencer uniform in accordance with the corresponding embodiment.

[0097] A fencing system 1000 will now be described with reference to figure 9. Such a fencing system comprises two items of fencing equipment 100, each in ac-

cordance with any one of the previously illustrated embodiments and each associated to a respective fencer.

[0098] The system 1000 further comprises a central control station 200, operatively connected to each of the items of fencing equipment 100 to receive from them respective information messages M, representative of type C and of the timing T of the hits being detected; the central control station 200 is configured to decide a match score based on such information messages M.

[0099] In accordance with a preferred embodiment, the central control station 200 is configured to connect to each of the items of fencing equipment 100 in wireless manner.

[0100] According to an implementation option, the central control station 200 is configured to generate a time reference R_t and to send such a time reference R_t to each of the two items of fencing equipment 100. Each of two items of fencing equipment 100 comprises a high-precision local clock 28, and the two items of fencing equipment 100 are configured to synchronize the respective high-precision local clocks 28 based on the time reference R_t received.

[0101] In an example of implementation, the central control station 200 comprises a central clock.

[0102] In accordance with a realization option, the local clock 28 of each of the two items of fencer equipment 100, once synchronized, is configured to generate a time-stamp TS, upon the processing of the electrical signal V_m coming from the fencing weapon, as a time information T associated with a respective hit.

[0103] A method for detecting hits in fencing disciplines, according to the present invention, is described below.

[0104] Such a method comprises the steps of providing a fencing weapon 1, having a reference terminal T_r , a measuring terminal T_m and at least two contact terminals (T_{c1} , T_{c2}), suitable to be connected to each other in configurable manner, depending on whether the fencing weapon 1 touches a target X or not; then, connecting such a fencing weapon 1, through the reference terminal T_r and the measuring terminal T_m , to a detection apparatus 2, having electrical connections towards a power supply voltage V_{cc} and a ground, so as to form an electrical detection circuit, passing through the fencing weapon 1 and the detection apparatus 2, and adapted to take a signalling condition or a resting condition, depending whether the fencing weapon 1 delivers a hit on a target X or not.

[0105] The method then comprises applying a detection voltage ΔV to a target portion X, through the at least two contact terminals (T_{c1} , T_{c2}) - by means of said electrical detecting circuit when it takes the signalling condition; then the method provides detecting an electrical measurement potential V_m , present in the electrical detecting circuit at the measuring terminal T_m and depending on the detection voltage ΔV , in order to determine whether a hit was delivered or not, and in the affirmative case to discriminate on which type of target X the hit was

delivered.

[0106] In different possible implementation options, the aforesaid method employs a fencing weapon 1 according to any one of the embodiments described above.

[0107] In further possible implementation options, the aforesaid method employs a fencing equipment 100 according to any one of the embodiments described above.

[0108] A method for determining a score in a fencing competition is described below, which provides a step of detecting the hits delivered by each of the two competing fencers by means of fencing equipment 100 according to any one of the embodiments described above. It is worth noting that, according to an implementation option, such detecting step can be performed according to the previously described detection method. The method then includes the steps of associating with each hit being detected an information message M, representative of the type C and of the timing T of the hit being detected by an item of fencing equipment 100, provided to each fencer, comprising the fencing weapon 1 and the detection apparatus 2; then, transmitting such information message M, by each item of fencing equipment 100 of each of the two fencers, to a central control station 200; finally, processing the received information messages M by the central control system 200, in order to determine type and priority of the hits.

[0109] According to an implementation option, the step of transmitting is performed by means of wireless means.

[0110] In accordance with an implementation option, the fencing equipment 100 and the central control station 200 are configured to operate also in absence of a common ground.

[0111] According to an example of execution, the method comprises a further initial step of synchronization, which comprises the steps of providing a common time reference R_t , e.g., from the central control station 200, to each of the items of fencing equipment 100 of the two fencers; then, synchronizing, by each of the two items of fencing equipment 100, a respective high-precision local clock 28, based on such time reference R_t .

[0112] According to another example of execution, the method comprises the further steps of determining a detection instant for each detected hit on the basis of a time measurement of the synchronized local clock 28; and generating the hit time information T on the basis of the determined detection instant.

[0113] It is worth noting that the method and the system described above can be used to distinguish numerous targets, e.g. during a step of training, by using different resistive coatings. In such a case, after having detected different voltages on the different coatings with different properties, it is possible to distinguish a plurality of targets (e.g., 10), for example on a training dummy.

[0114] As apparent, the aimed objects are achieved by the fencing weapon and equipment previously described by virtue of the illustrated features.

[0115] Indeed, the described fencing equipment, comprising a respective fencing weapon, can determine a hit

on the basis of a circuit which does not require a common ground with the opponent's fencing equipment. *Inter alia*, this provides a basis to allow a wireless transmission of the signals representative of the hit type to a central detection station.

[0116] Furthermore, the detection system comprising the central station and the two items of fencing equipment allows to establish the priority of the detected hits, by virtue of the equipment features and system synchronization functions. This applies also when the communication between the central station and the equipment is wireless, which allows to make detection systems that are entirely wireless and to identify the hits with levels of accuracy compatible with those required for practical use.

[0117] Finally, effective strategies for recognizing and discriminating hits can be devised and implemented based on the use of the fencing equipment according to the invention, which in fact include the function of detecting an electrical resistance of the touched target, combined with the use of the fencing uniforms according to the invention, which have a known and discriminable electrical resistance (according to the body parts corresponding to valid or invalid targets, pursuant to the rules of the various disciplines).

[0118] Similar advantages can be identified in the methods of hit detection and score determination described above, which use the equipment and the system described above.

[0119] To the embodiments of the fencing weapon, of the fencing equipment, of the fencing uniform, of the hit detection and score determination systems and methods described above, a person skilled in art may make changes and adaptations or can replace elements with others which are functionally equivalent to satisfy contingent needs without departing from the scope of protection of the appended claims. All the features described above as belonging to one possible embodiment may be implemented independently from the other described embodiments. It is further worth noting that the term "comprising" does not exclude other elements or steps and that the term "one" or "a/an" does not exclude a plurality. Furthermore, the figures are not in scale; in contrast, relevance is generally provided to the illustration of the principles of the present invention.

Claims

1. A weapon for a fencing discipline (1), usable for sports or games, suitable to be connected to a detection apparatus (2) provided with at least a first (21) and a second (22) apparatus terminals, the weapon (1) comprising a percussion element (11), having a percussion portion (12) suitable to deliver a hit on a target (X), and an electrical device (10), incorporated in the weapon (1), wherein the electrical device (10) comprises:

- a reference terminal (Tr), adapted to be connected to the first apparatus terminal (21) to receive a reference electrical potential (Vr);
- a measuring terminal (Tm), adapted to be connected to the second apparatus terminal (22) to supply an electrical measuring potential (Vm);
- a first contact terminal (Tc1) and a second contact terminal (Tc2), which are arranged so as to come simultaneously into contact with the target (X) when the percussion portion (12) delivers a hit on the target (X);

wherein the electrical device (10) is configured to take a signalling condition when it is connected to the detection apparatus (2) and a hit has been delivered by the percussion portion (12) on the target (X), in which signalling condition:

- the reference terminal (Tr) is kept at the electrical reference potential (Vr) and is further electrically connected to the first contact terminal (Tc1);
- the first (Tc1) and the second (Tc2) contact terminals are adapted to be electrically connected by means of a target portion (X) comprised there between so as to apply a detection voltage (ΔV) to said target portion depending on the electrical reference potential (Vr);
- either the first (Tc1) or the second electrical contact (Tc2) is electrically connected to the measuring terminal (Tm) so that the electrical measuring potential (Vm) takes a signalling value (S), depending on said electrical reference potential (Vr) and detection voltage (ΔV).

2. Fencing weapon (1) according to claim 1, wherein the electrical device (10) is further configured to take a resting position, when it is connected to the detection apparatus (2) and when it is not in the signalling condition, wherein the first (Tc1) and the second (Tc2) contact terminals are not electrically connected to each other through the target (X) and wherein said electrical measuring potential (Vm) takes a resting value (N) distinguishable from the signalling value (S), wherein the resting value (N) of the electrical measuring potential (Vm) is representative of the resting condition of the electrical device (10) and the signalling value (S) of the electrical measuring potential (Vm) is representative of the signalling condition and is further indicative of at least one electrical property of the target (X).

3. Fencing weapon (1) according to one of the claims 1-2, wherein:

- the weapon is a foil (1);
- the percussion element (11) is a foil blade (11)

and the percussion portion (12) is the blade tip (12), adapted to deliver a thrust as a hit;
 - the signalling condition corresponds to a situation in which the percussion portion (12) hits a target (X) and exerts against it a force higher than a predetermined threshold;

and the electrical device further comprises:

- a first conductive element (13), configured to electrically connect in permanent manner the reference terminal (Tr) to the first contact terminal (Tc1);
- a second conductive element (14), configured to electrically connect in permanent manner the measuring terminal (Vm) to the second contact terminal (Tc2);
- a switch element (15), configured to connect the first (13) and the second (14) conductive elements, when the device (1) is in resting condition, and to disconnect the first (13) and the second conductive element (14), when the device (1) is in signalling condition.

4. Fencing weapon (1) according to claim 3, further comprising a thrust detection element (16), in which the first (Tc1) and the second (Tc2) contact terminals are arranged, the detection element (16) being arranged at the tip (12) of the blade of the foil, the detection element (16) being slidingly connected to the percussion element (11) of the foil (1) so as to take, relative to the electrical device (10):

- a resting position, corresponding to the resting condition of the electrical device (10), in which the detection element (16) keeps the switch element (15) closed to connect the first (13) and the second (14) conductive elements;
- a signalling position, corresponding to the signalling condition of the electrical device (10), in which the detection element (16) keeps the switch element (15) open to disconnect the first (13) and the second (14) conductive elements.

5. Fencing weapon (1) according to one of the claims 1-2, wherein:

- the weapon is an épée (1);
- the percussion element (11) is a blade (11) of the épée (1) and the percussion portion (12) is the tip of the blade, adapted to deliver a thrust as a hit;
- the signalling condition corresponds to a situation in which the percussion portion (12) hits a target (X) and exerts against it a force higher than a predetermined threshold;

and the electrical device (10) further comprises:

- a switch element (17), connected to the reference terminal (Tr) by means of a conductive element (13), and configured to connect the reference terminal (Tr) to the first contact terminal (Tc1), when the electrical device (10) takes the signalling condition, and to disconnect the reference terminal (Tr) from the first contact terminal (Tc1), when the electrical device (10) takes the resting condition;
- a ground terminal (Tg), suitable to be connected to a third apparatus terminal (23) connected to ground;

and wherein the electrical device (10) is configured so that the first contact terminal (Tc1) is electrically connected in permanent manner to the measuring terminal (Tm), by means of a second conductive element (14), and the second contact terminal (Tc2) is electrically connected in permanent manner to the ground terminal (Tg), by means of a third conductive element (18).

6. Fencing weapon (1) according to claim 5, further comprising a thrust detection element (16), in which the first (Tc1) and the second (Tc2) contact terminals are arranged, the detection element (16) being arranged at the tip of the blade of the épée, the detection element (16) being slidingly connected to the percussion element (11) of the épée so as to take, relative to the electrical device:

- a resting position, corresponding to the resting position of the electrical device, in which the detection element (16) keeps the switch element (17) open to disconnect the reference terminal (Tr) and the first contact terminal (Tc1) from each other;
- a signalling position, corresponding to the signalling condition of the electrical device (10), wherein the detection element (16) keeps the switch element (17) closed to connect the reference terminal (Tr) and the first contact terminal (Tc1) to each other.

7. Fencing weapon (1) according to one of the claims 4 or 6, wherein the thrust detection element (16) comprises a button, arranged at the tip of the blade, and substantially shaped as a cylinder or truncated cone, and adapted to hit the target by means of a substantially planar contact surface thereof corresponding to a base of said cylinder and/or truncated cone;

- the first (Tc1) and the second (Tc2) contact terminals comprise respective portions of said button, mutually insulated and facing the contact surface, so that both contact terminals touch the target simultaneously when the contact surface hits the target.

8. Fencing weapon (1) according to one of the claims 1-2, wherein:

- the weapon is a sabre (1);
- the percussion element (11) is a blade (11) of the sabre and the percussion portion (12) is the blade itself adapted to deliver a cut as a hit;
- the signalling condition corresponds to a situation in which the percussion portion (12) touches a target, regardless of the force exerted against it;
- the first contact terminal (Tc1) comprises a threadlike conductive element (Tc1), electrically insulated with respect to the blade (11) of the sabre (1), and arranged on the blade (11) in a substantially coiled configuration;
- the second contact terminal (Tc2) comprises the blade of the sabre;
- the first contact terminal (Tc1) is electrically connected in permanent manner to the reference terminal (Tr), by means of a further conductive element, and the second contact terminal (Tc2) is electrically connected in permanent manner to the measuring terminal (Tm).

9. Fencing weapon (1) according to one of the claims 1-2, wherein:

- the gear is a kendo "shinai";
- the percussion element (11) is a stick comprised in the "shinai" and the percussion portion (12) is the stick itself, adapted to deliver a cut as a hit;
- the detection element (16) comprises a portion of the surface of the stick;
- the signalling condition corresponds to a situation in which the percussion portion (12) touches a target, (X) regardless of the force exerted against it;
- the first contact terminal (Tc1) comprises a first threadlike conductive element, arranged on the stick in a substantially coiled configuration;
- the second contact terminal (Tc2) comprises a second threadlike conductive element, arranged on the stick so as to be electrically insulated, in the resting condition, with respect to the first contact terminal (Tc1);
- the first contact terminal (Tc1) is electrically connected in permanent manner to the reference terminal (Tr) and the second contact terminal (Tc2) is electrically connected in permanent manner to the measuring terminal (Tm).

10. Fencing weapon (1) according to one of the claims 1-2, wherein:

- the weapon is a gear for games or for a toy;
- the percussion element (11) is a percussion

element made of plastic or wood or other synthetic material;

- the signalling condition corresponds to a situation in which the percussion portion (12) touches a target (X);
- the first contact terminal (Tc1) comprises a first conductive element arranged on the percussion element (11);
- the second contact terminal (Tc2) comprises a second conductive element arranged on the percussion element (11) so as to be electrically insulated, in the resting condition, with respect to the first contact terminal (Tc1).

11. Fencing equipment (100) for a fencer, comprising a fencing weapon (1), according to any of the claims 1-10, and an electrical detection apparatus (2), comprising:

- at least a first (21) and a second (22), apparatus terminals respectively connectable to a reference terminal (Tr) and to a measuring terminal (Tm) of the fencing weapon (1);
- power supplying means (25), operatively connected to the fencing weapon (1) to provide a power supply through the first apparatus terminal (21);
- control means (26), operatively connected to the fencing weapon (1) to receive, through the second apparatus terminal (22), an electrical signal (Vm) depending on the electrical measuring potential present at the measuring terminal (Tm) of the fencing weapon (1),

the control means (26) being configured to process said electrical signal (Vm) to recognize whether a hit was delivered and, in the affirmative case, discriminate whether the hit was delivered on a target (X) of insulating material or of resistive material or of conductive material,

the control means (26) being further configured to associate a time information (T) to each recognized hit and to generate, based on the processing of the electrical signal (Vm), an information message (M) representative of the type (C) of the hit being recognized and of the time information (T) associated thereto;

- transmission means (27), operatively connected with the control means (26) and configured to transmit said information message (M).

12. Fencing equipment (100) according to claim 11, wherein the fencing weapon (1) is according to one of the claims 4-5, and wherein the first apparatus terminal (21) is connected to a power supply voltage (Vcc) through a first resistor (R1) having a zero or positive resistance (R1) and the second apparatus

terminal (22) is connected to ground through a second resistor (R2) having a positive resistance (R2), so that:

- while the electrical device (10) takes the resting condition, the measuring potential (Vm) takes a resting value (N) equal to a maximum value, depending on the ratio between the second resistance (R2) and the sum of the first (R1) and the second resistance (R2), according to a voltage splitter configuration with resistors in series; 5
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target (X) of conductive material having substantially zero resistance, the measuring potential (Vm) takes a value substantially coinciding with said resting value (N); 10
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target (X) of insulating material having substantially infinite resistance, the measuring potential (Vm) takes a minimum value, which is substantially zero; 15
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target portion (X) of resistive material having an finite positive target resistance (Rb), the measuring potential (Vm) takes an intermediate value between said maximum and minimum values, according to the ratio between the second resistance (R2) and the sum of the first resistance (R1), second resistance (R2) and target resistance (Rb), according to a voltage splitter configuration with resistors in series; 20 25 30 35

or wherein the fencing weapon (1) is according to claims 6-7, and wherein the first apparatus terminal (21) is connected to a power supply voltage (Vcc) through a first resistor (R1) having a zero or positive resistance (R1) and the second apparatus terminal (22) is connected to ground by means of a second resistor (R2) having a positive resistance (R2), so that:

- while the electrical device (10) takes the resting condition, the measuring potential (Vm) takes a resting value (N) equal to a substantially zero minimum value; 45
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target (X) of conductive material having substantially zero resistance, the measuring potential (Vm) takes said value equal to a substantially zero minimum value; 50
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target (X) of insulating 55

material having substantially infinite resistance, the measuring potential (Vm) takes a maximum value, depending on the ratio between the second resistance (R2) and the sum of the first (R1) and the second resistance (R2), according to a voltage splitter configuration with resistors in series;

- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target portion (X) of resistive material, having a positive finite target resistance (Rb), the measuring potential (Vm) takes an intermediate value between said maximum and minimum values which is equal to the detection voltage (ΔV), said detection voltage (ΔV) depending on the ratio between the parallel of the target resistance (Rb) and of the second resistance (R2) and the sum of said parallel and the first resistance (R1);

or wherein the fencing weapon (1) is according to claims 9 or 10, and wherein the first apparatus terminal (21) is directly connected to a power supply voltage (Vcc) and the second apparatus terminal is connected to ground through a second resistor (R2) having a positive resistance (R2), so that:

- while the electrical device (10) takes a resting condition, the measuring potential (Vm) takes a resting value (N) equal to a substantially zero minimum value;
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target (X) of conductive material having substantially zero resistance, the measuring potential (Vm) takes a maximum value substantially equal to said power supply value (Vcc);
- when the electrical device (10) takes the signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target (X) of insulating material having substantially infinite resistance, the measuring potential (Vm) takes a value equal to said substantially zero minimum value;
- when the electrical device (10) takes a signalling condition and the contact terminals (Tc1, Tc2) are in contact with a target portion (X) of resistive material, having a finite target resistance (Rb), the measuring potential (Vm) takes an intermediate value between said maximum and minimum values, depending on the ratio between the second resistance (R2) and the sum of the second resistance (R2) and of the target resistance (Rb), in a voltage splitter configuration with resistors in series.

13. Fencing equipment (100) according to any one of the claims 11-12, wherein the transmission means

(27) are wireless transmission and/or transceiver means (27).

14. Fencing equipment (100) according to one of the claims 11-13, wherein the control means (26) are configured to sample the received electrical signal (V_m), of the analog type, and to process the signal samples through one or more algorithms, in order to determine the type of hit corresponding to the received signal and wherein said detection apparatus (2) is integrated in a housing which can be worn by a fencer.
15. A method for detecting hits in fencing disciplines, for sports or games, comprising the steps of:
- providing a fencing weapon (1), having a reference terminal (Tr), a measuring terminal (T_m) and at least two contact terminals ($Tc1$, $Tc2$), suitable to be connected to each other in configurable manner, depending on whether the fencing weapon (1) delivers a hit on a target (X) or not;
 - connecting said fencing weapon (1), through the reference terminal (Tr) and the measuring terminal (T_m), to a detection apparatus (2), having electrical connections towards a power supply voltage (V_{cc}) and a ground, so as to form an electrical detection circuit, passing through the fencing weapon (1) and the detection apparatus (2), and adapted to take a signalling condition or a resting condition, depending on whether the fencing weapon (1) delivers a hit on a target (X) or not;
 - by means of said electrical detection circuit, when it takes the signalling condition, applying a detection voltage (ΔV) to a target portion (X), through said at least two contact terminals ($Tc1$, $Tc2$);
 - detecting an electrical measurement potential (V_m), present in the electrical detection circuit at the measuring terminal (T_m), and depending on the detection voltage (ΔV), to determine whether a hit was delivered or not, and, in the affirmative case, to discriminate on which type of target (X) the hit was delivered.

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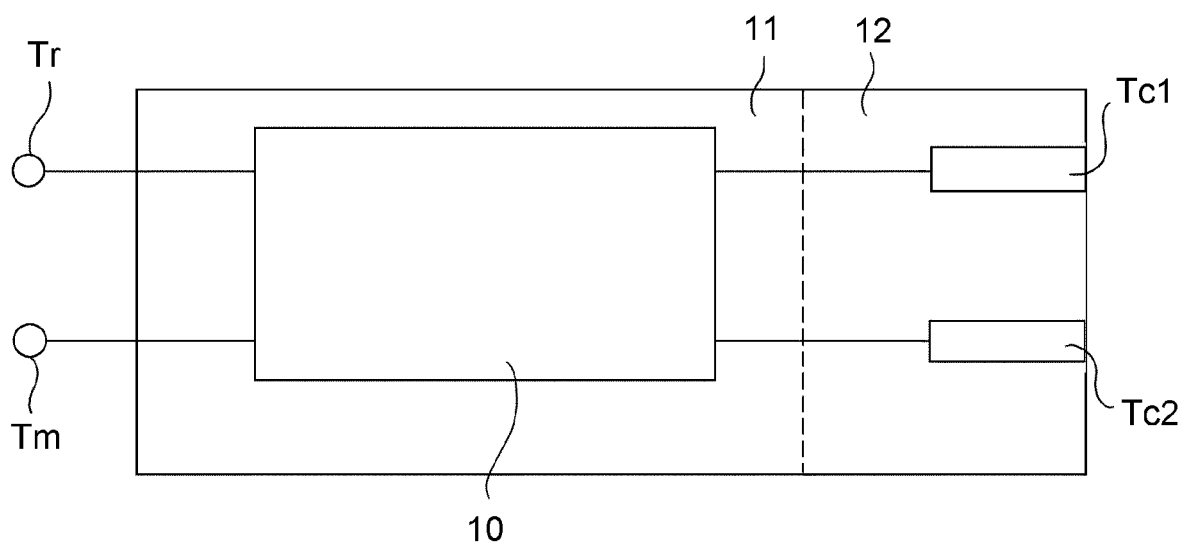


FIG. 1

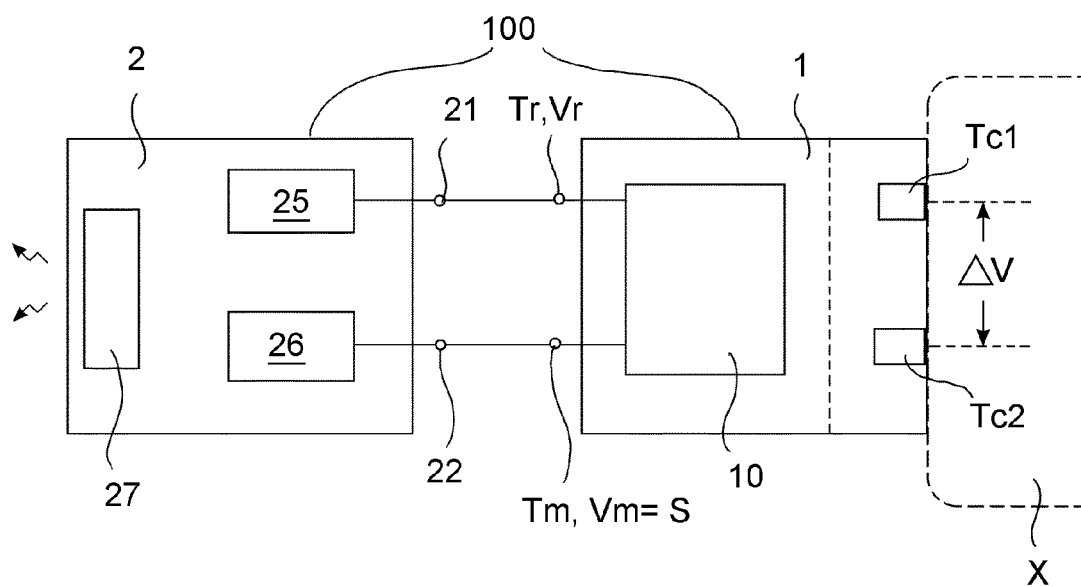


FIG. 2A

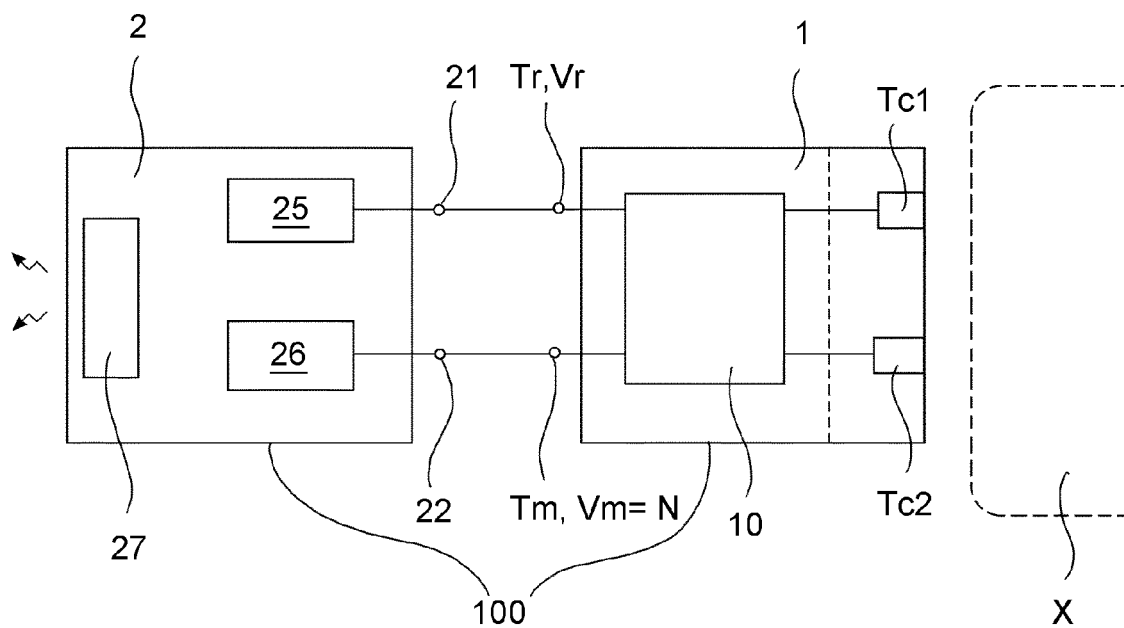


FIG. 2B

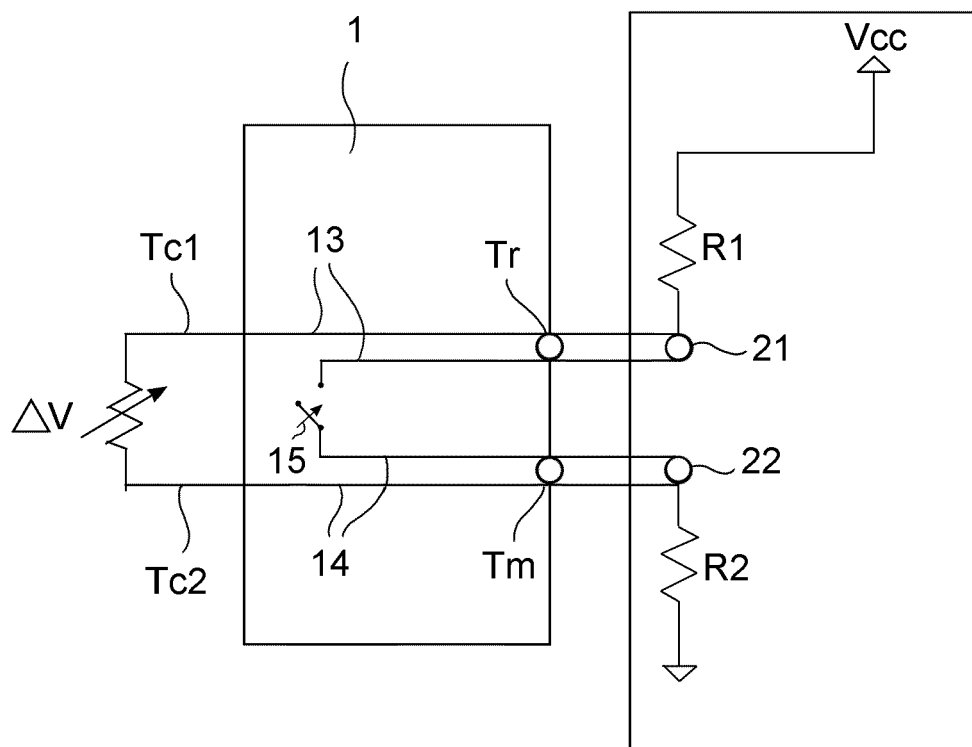


FIG. 3

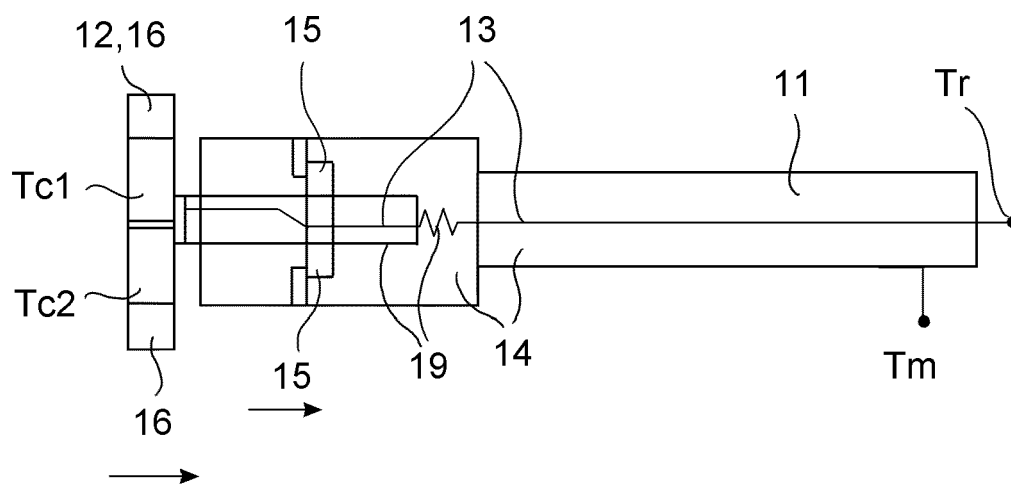


FIG. 4

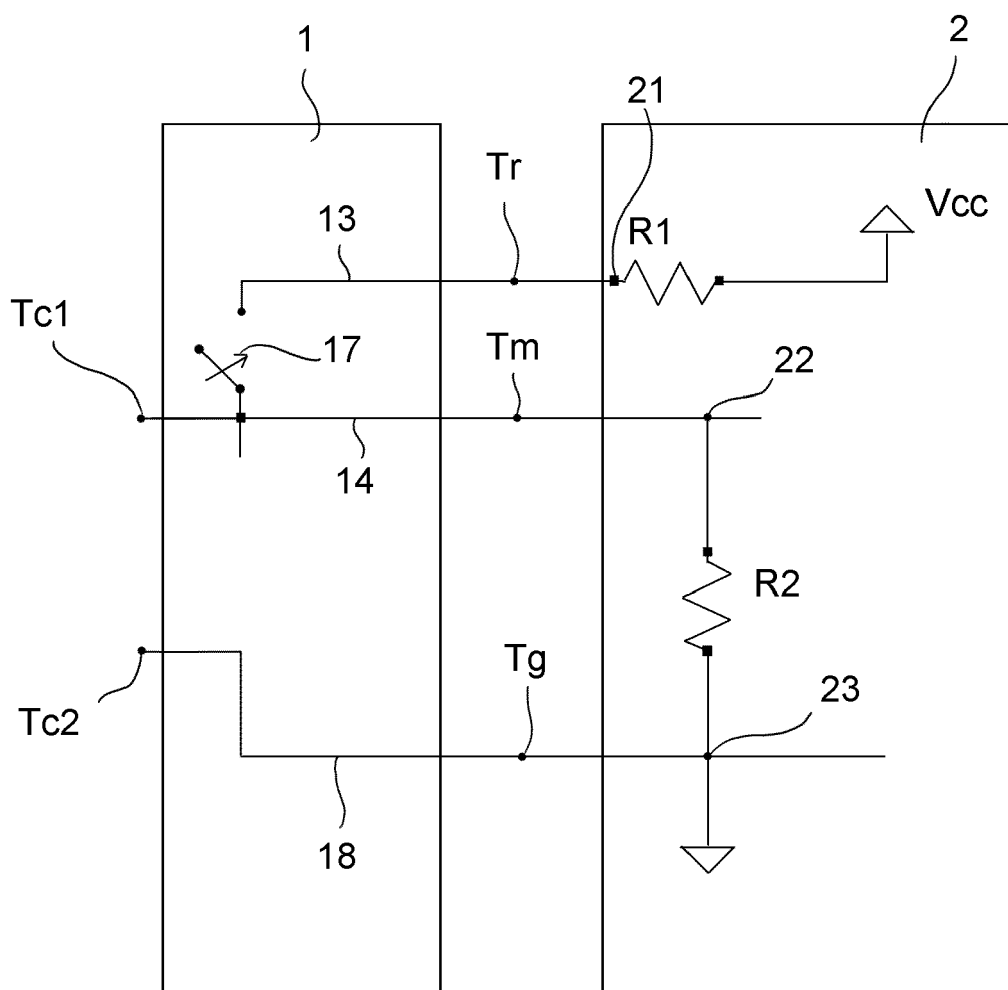


FIG. 5

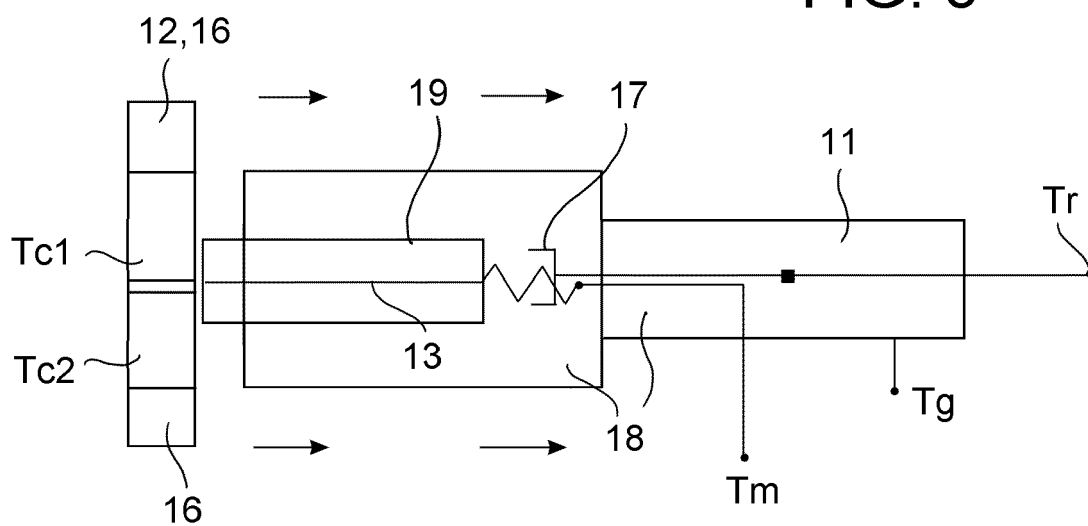


FIG. 6

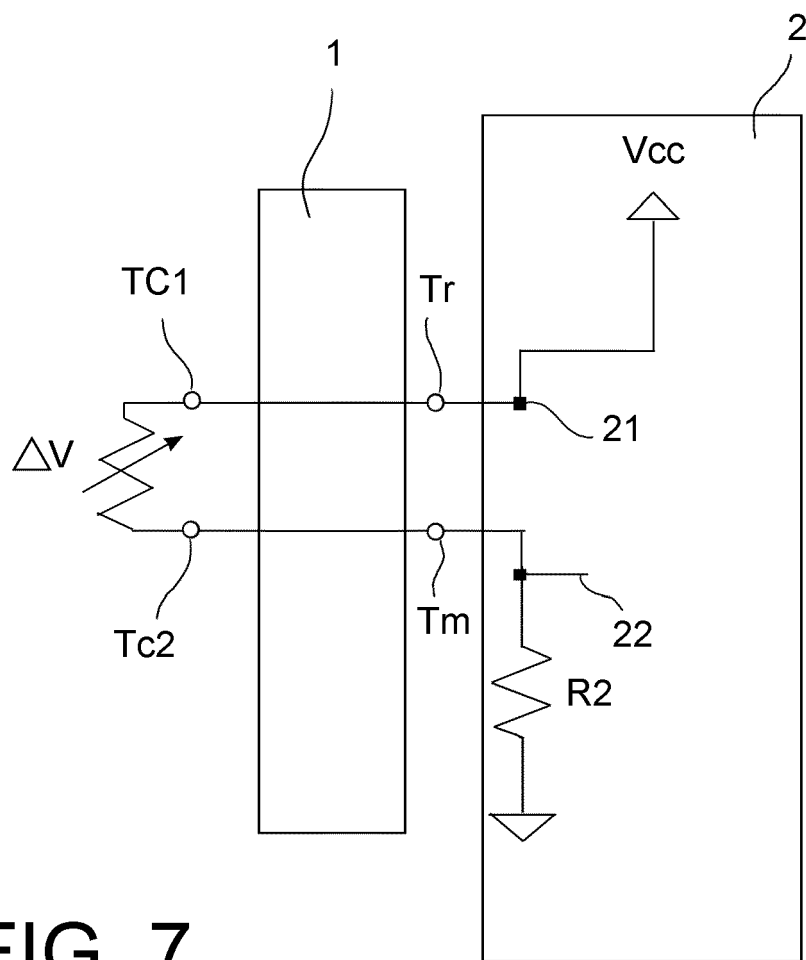


FIG. 7

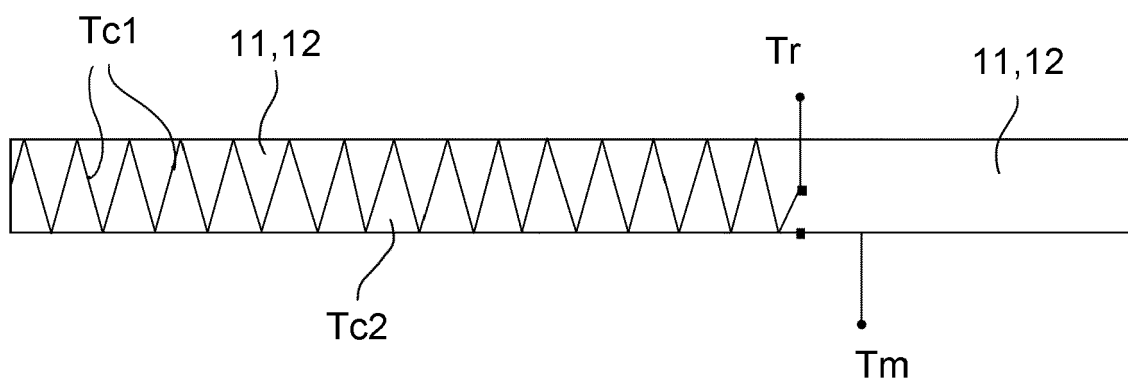


FIG. 8

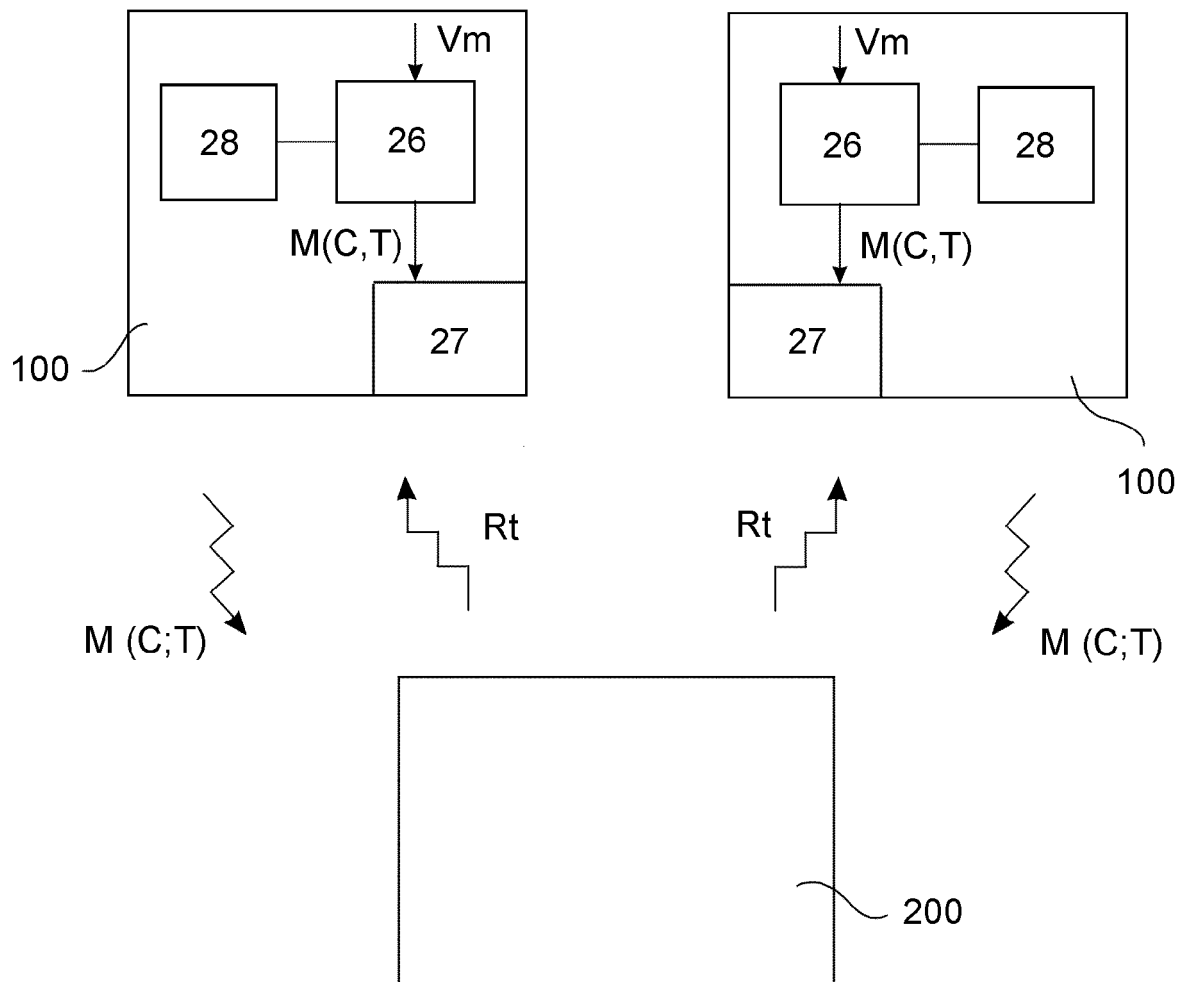


FIG. 9



EUROPEAN SEARCH REPORT

Application Number
EP 15 20 0835

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Place of search Munich		Date of completion of the search 1 April 2016	Examiner Haller, E
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82