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(54) **Title**: ENGAGEMENT LOCK FOR A CONTAINER

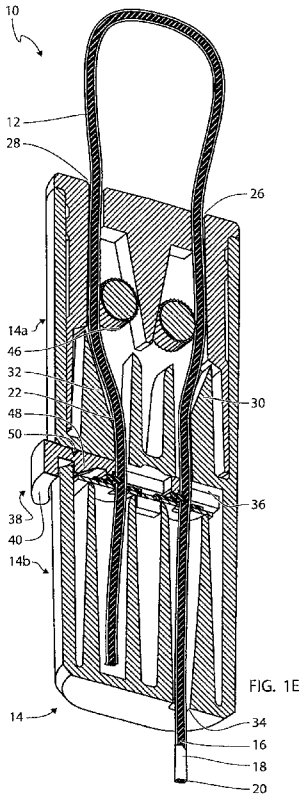

FIG. 1E

(57) **Abstract**: An engagement lock for a container, which engagement lock comprises a string which comprises a metal core such as a metal wire and where the metal core is coated by a flexible insulating material. The string defines a first end portion and a second end portion located opposite the first end portion, a housing which comprises a first opening for receiving the first end portion of the string and a second opening for receiving the second end portion of the string. The housing further includes a cavity for accessing the first end portion of the string within the housing, an arresting part for being received into the cavity of the housing, and a communication unit accommodated within the housing or on the arresting part. The arresting part includes a first element of electrically conductive material for penetrating the flexible insulating material of the first end portion of the string, arresting the first end portion of the string relative to the housing and establishing electrical connection between the communication unit and the metal core of the first end portion of the string.

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ENGAGEMENT LOCK FOR A CONTAINER

The present invention relates to an engagement lock for a container, a housing for an engagement lock for a container, an arresting part for being received in a cavity, a communication unit and a method of operating an engagement lock for a container.

Background

The present invention relates to an engagement lock for a container having a pair of locking rings or locking eyelets. Engagement locks are typically used in the shipping industry for preventing unauthorized opening of the container. One type of engagement lock is described in US 2003/0075933. This type of engagement locks has a housing and a pull absorbing string. The string is intended to form a loop through the locking rings and the opposing end portions of the string should subsequently be permanently arrested in the housing. Once locked, the locking rings are joined together and the container cannot be opened unless the engagement lock has been broken. Such engagement locks are also known as seals.

According to the authorised opening of the engagement lock known in the art, the engagement lock is opened by cutting the string by means of a wire cutter, strong pair of scissors or shears. The engagement lock is thereafter unusable. Since each engagement lock has a unique identification number, any attempt to open the engagement lock and thereafter replace the engagement lock with a new one will be detected.

A thief or a person having fraudulent thoughts, e.g. of transporting non legal goods in a container will not use the authorised opening referred to above, since this person does not want the opening and the subsequent closing of the container and the opening and the subsequent closing of the engagement lock to be revealed later on during inspection of the engagement lock. A thief or a fraudulent person attempting to transport non legal goods, e.g. drugs, etc in the container will attempt to break the engagement lock and store his "goods" in the container prior to - if at all possible - locking the container again. This person does not want the theft of goods or the addition or replacement of goods to be revealed later on by customs officers or other persons inspecting the engagement lock, e.g. by visible crack or other hammering or drilling traces. Any cracks or marks on the engagement lock which may indicate that an unauthorised opening

has taken place and may thus alert customs officers or other persons which may then perform a more in-depth analysis of the content of the container.

It may however be difficult for customs officers or other persons inspecting the engagement lock to determine whether the lock has been tampered with in case the engagement lock after tampering is left after without any major traces on the engagement lock. Any minor marks on the engagement lock may possibly be overlooked by customs officers or other persons inspecting the engagement lock. There is thus a need for technologies for technologies for providing additional indications that a tampering has taken place.

US 7 878 561 B2 shows a seal device having an attachment device which may be joined to a connection device and thereby provide an electrical contact.

WO2007/059161 A1 relates to an electronic tamper evident seal including an integrated circuit for impedance through a shackle.

WO 2009/048516 A2 relates to an electronic security bolt seal which transmits a tamper condition. The bolt is arranged for completing an electronic circuit.

WO 2011/008871 A1 relates to a security seal including an electrical circuit which is in electrical communication with a first shaft.

WO 03/042959 A1 relates to a method and apparatus for providing container security with a tag. The device includes a bolt which passes through spaced coils generating a magnetic field.

WO 2005/094172 A2 relates to a monitorable locking assembly. The assembly includes a sealing wire including a conductor forming an electrical circuit whose integrity is monitored.

WO 2006/095331 A2 relates to a smart container monitoring system. The system includes an electronic seal wire.

WO 2006/048872 A2 relates to a remotely monitorable electronic locking device including a locking element arranged to engage one end of a conductive loop.

WO 2004/021299 A1 relates to a smart container monitoring system including an electronic seal and a wireless communicator operable to wirelessly transmit information regarding the status of an electronic seal.

All of the above documents are hereby incorporated by reference.

It has recently been discovered that there is a risk that a skilled unauthorised person may be able to open the engagement lock and subsequently close it without the engagement lock breaking but while maintaining the integrity of the electrical circuit. It is therefore an object of the present invention to provide technologies for interrupting the electric circuit when the engagement lock has been broken.

It is a feature according to the present invention that the engagement lock is securely arrested and at the same time a well defined electronic circuit is established.

Summary of the invention

The above need and object together with numerous other needs and objects, which will be evident from the below detailed description of a preferred embodiment of the module according to the present invention, are according to a first aspect of the present invention obtained by an engagement lock for a container, the engagement lock comprising:

a string comprising a metal core such as a metal wire, the metal core being coated by a flexible insulating material, the string defining a first end portion and a second end portion located opposite the first end portion,

a housing comprising a first opening for receiving the first end portion of the string and a second opening for receiving the second end portion of the string, the housing further including a cavity for accessing the first end portion of the string within the housing,

an arresting part for being received into the cavity of the housing, and

a communication unit accommodated within the housing or on the arresting part,

the arresting part including a first element of electrically conductive material for penetrating the flexible insulating material of the first end portion of the string, arresting the first end portion of the string relative to the housing and establishing electrical connec-

tion between the communication unit and the metal core of the first end portion of the string.

The above engagement lock is intended to be used for locking the doors of containers by securing the locking rings of the container door by means of the string. The word container should however be construed broadly since it is evident that the present engagement lock may be used for other purposes than container doors such as e.g. for securing tank-truck valves, truck trailers, rail wagons, box doors, gates, money bags etc. By using strings of different lengths, a series of locking rings may be locked simultaneous and locking rings located at awkward positions may be reached.

The metal core of the string is preferably a flexible steel wire which should be sufficiently flexible for allowing the elements to engage and arrest the string. The wire is coated by a flexible insulating material which prevents any electrical conduction between the string and any conductive body outside the engagement lock. The flexible insulating material should however be sufficiently soft so that the first and second elements may pierce and penetrate the flexible insulation material and establish electrical connection with the metal core. The elements should define a needle or knife sufficiently rigid for both penetrating the flexible insulating material and arresting the string. The string has two ends, and the length of string adjacent the respective ends are respectively designated the first and second end parts. The cross section of the string is preferably square or alternatively another non-circular cross section such as elliptical in order for the first element to be able to penetrate the string at a well defined flat position of the string.

The housing is typically made of metal or rigid plastics. The first and second openings are typically located adjacent each other. The openings should have a circumference corresponding to the circumference of the string such that when the first and second end portions of the string are inserted into its respective opening, it should not be possible to manipulate the engagement lock by inserting a tool in-between the string and the opening. The first and second openings typically lead to respective channels within the housing. Further, by using a string having a non circular cross section (typically square) together with opening having a corresponding cross section (typically square), the string cannot be spun around its own axle as would be the case if the cross section of the string was circular. By spinning the string around its own axle, either as a delib-

erate attempt of tampering the engagement lock or as an occasional event during the transport or handling of the engagement lock, the arresting of the string may fail.

The cavity of the housing allows the first end portion of the string to be accessed once the first end portion of the string has been inserted into the first opening. The cavity typically intersects the channel corresponding with the first opening. The arresting part may be fitted into the cavity or the arresting part may be provided as a loose accessory for being fitted by the user. When the arresting part is inserted into the cavity, it establishes a first position in which the first end part of the string may be inserted into the first opening of the housing and pushed past the cavity. The arresting part may then establish a second position, typically by pushing the arresting part further into the cavity. In the second position, the first element penetrates the flexible insulation material of the string, thereby arresting the first end part of the string relative to the housing. The term arresting should be interpreted to mean that the string is permanently fixated relative to the housing in the sense that the release of the string, and thereby the opening of the container or the like, will require forceful actions against the engagement lock such as e.g. cutting the string by means of a wire cutter or the like.

The communication unit is typically located within the housing, but it may alternatively be located on the arresting part. When the arresting part is inserted into the cavity and the second position is established, i.e. when the string is permanently fixated relative to the housing by the first element, the communication unit establishes electrical connection via the first element to the metal core of the string and back to the communication unit. The communication unit is capable of monitoring whether or not the string is intact by sending an electrical current through the metal core of the string. In case the string has been tampered with, the electrical circuit through the string will be interrupted and the communication unit may establish that tampering has taken place. The communication unit may further be capable of communicating the information that tampering has taken place. The communication may in its simplest form be a visual indicator.

According to a further embodiment according to the first aspect, the arresting part including a handle having a predetermined breaking point adapted to break off when exposed to an excessive forces once the first end portion of the string has been arrested relative to the housing. When the user has placed the arresting part in the second position in the cavity, i.e. arrested the first end part of the string relative to the

housing, the user should not easily be able to move the arresting part back to the first position and thereby release the string again. In order to prevent this, the arresting part may include a handle which in the second position is visible outside the cavity, but which breaks off when an excessive force is applied. A fraudulent person trying to pull the arresting part away will just break off the handle. Thereafter, the remaining arresting part will be permanently hidden within the cavity and it will be evident that a tampering has taken place. The predetermined breaking point may be a portion of the arresting part which is deliberately weaker and which will withstand the forces applied during piercing when the arresting part is moved from the first position to the second position, but which will break when larger forces are applied, i.e. when leveraged tools such as screwdrivers or pliers are used to forcefully move the handle.

According to a further embodiment according to the first aspect, the second end portion of the string being electrically connected to the communication unit. The second end portion of the string may be permanently connected to the communication unit by means of e.g. soldering or welding. In this way, the string will be connected to the housing already when shipped to the user and there is thus no risk that the string will be lost.

According to a further embodiment according to the first aspect, the arresting part including a second element of electrically conductive material for penetrating the plastic coating of the second end portion of the string, arresting the second end portion within the housing and establishing electrical connection between the communication unit and the metal core of the second end portion of the string. Typically, however, the string is a loose accessory. In this way, the first end portion of the string is arrested as described above. Simultaneously, the second end portion of the string is arrested by a second element which is identical to the first end portion. The second element is in electrically connected to the communication unit in order to establish a closed circuit through the string when the arresting part is moved to the second position.

According to a further embodiment according to the first aspect, the housing comprising a third opening opposite the first opening for establishing a first pass through within the housing between the first opening and the third opening for allowing the first end portion of the string to at least partially extend outside the housing. In this way, the first end portion of the string may be adjusted according to the distance between the lock-

ing rings such that a close fit is achieved. Any excessive lengths of the first end portion may be cut off by using a wire cutter.

According to a further embodiment according to the first aspect, the second opening comprises a nipping area for securing the second end portion of the string. It may be difficult to keep the second end portion of the string in the correct position within the housing. In order to keep the second end portion at the correct position while inserting the first end portion and moving the arresting part from the second position to the first position, the second end portion may be held in place by a locking device such as a one way roller. In this way it may be avoided that the arresting part is moved to the second position while the second end portion of the string has not passed the cavity of the housing.

According to a further embodiment according to the first aspect, the housing comprising a fourth opening opposite the second opening for establishing a second pass through within the housing between the second opening and the fourth opening for allowing the second end portion of the string to at least partially extend outside the housing. Alternatively, both the first and second end portions may be allowed to extend through the housing such that by pulling both of the end portions, a close fit may be achieved.

According to a further embodiment according to the first aspect, the communication unit comprises a wireless communication unit, such as an RFID tag. Preferably, the communication unit may communicate with an external reader by wireless communication. Most preferably, a RFID tag is used. The RDIF tag may also be used for providing energy to the communication unit. In this way, the information whether the engagement lock has been tampered with or not may be further, additional data such as an identification number, may be transmitted by wireless communication.

According to a further embodiment according to the first aspect, the housing is at least partially made of a transparent plastic material. By using transparent plastic material at least adjacent the cavity, the integrity of the engagement lock may easily be inspected.

According to a further embodiment according to the first aspect, the arresting part being permanently fitted within the cavity or alternatively the arresting part is removable. In order to prevent loss of the arresting part, the arresting part may be permanently

fitted within the cavity. The arresting part is then provided to the user in the first position. Once the first and second end portions of the string have been inserted into the respective opening, the arresting part is moved to the second position. Alternatively, the arresting part is delivered separately. Then, the first position may be defined when the arresting part is located completely outside the cavity, i.e. first and second end portions of the string may be inserted into the respective opening before the arresting part is introduced into the cavity. Subsequently the arresting part is introduced into the cavity and moved to the second position in order to arrest the string relative to the housing.

According to a further embodiment according to the first aspect, the flexible insulating material comprises a polymeric material such as plastics. Preferably, a soft plastic material is used. In this way, the flexible insulating material may be easily penetrated by the piercing units while still allowing insulation capabilities to be maintained in the non penetrated areas of the string.

According to a further embodiment according to the first aspect, the arresting part includes an arresting section for interlocking with the cavity of the housing once the first end portion of the string has been arrested relative to the housing, the arresting section preferably comprising a snap-fit. A snap fit, such as a sloped section of the arresting part, may be used in order to prevent an easy removal of the arresting part once the second position has been established and the elements have arrested the string and established electrical connection with the metal core of the string.

According to a further embodiment according to the first aspect, the communication unit establishes a locked state when an electrical circuit is established from the communication unit via the first element of the arresting part and the metal core and back to the communication unit, and, a tampered state when the electrical circuit is or has been interrupted. The communication unit may include a memory which has two state, namely a locked state which is established once the second position has been established and the first element have arrested the string and established electrical connection with the metal core of the string, and, a tampered state which is established in case the electrical circuit from the communication unit via the first element of the arresting part and the metal core and back to the communication unit is broken for whatever reason. The state may be communicated to the user, customs officer or other

person by using a reader unit. A further non-enabled state may be established before the arresting part enters the second portion.

According to a further embodiment according to the first aspect, when in the tampered state, said communication unit is erased. In this way, it will be impossible to use or access the communication unit and it will thus be impossible even for a fraudulent person with computer skills to reprogram the communication unit. The memory in the communication unit may thus constitute an EROM (Erasable Read Only Memory) or EPROM (Erasable Programmable Read Only Memory).

According to a further embodiment according to the first aspect, the arresting part comprises an electrically conductive roller for arresting the first end portion of the string. The roller may be adapted such that when the string is being inserted into the housing, the roller allows the string to pass by rotation, however, when the user attempts to pull the string in the reverse direction in order to remove it from the housing, the string will be arrested relative to the housing.

According to a further embodiment according to the first aspect, the electrically conductive roller comprises metal piercing elements constituting the first element. In order to establish electrical connection between the metal core of the string and the communication unit via the roller, the roller may comprise metal piercing elements for piercing the flexible insulating material and contacting the metal core of the string.

According to a further embodiment according to the first aspect, the cavity defines an electrically conductive inner wall, the conductive inner wall being electrically connected with the communication unit. In this way, the electrically conductive roller may establish an electrical connection with the metal core of the string and at the same time establish electrical connection with the communication unit via the electrically conductive wall of the inner wall of the cavity. When the roller has arrested the string, the roller will be nipped between the string and the inner wall of the cavity, and in this way a good electrical contact between the roller and the inner wall of the cavity.

According to a further embodiment according to the first aspect, the cavity defines a tapering towards the first opening. When the user attempts to remove the string through the first opening, the roller will move and rotate with the string for a few millimeters and when be clamped in the tapering part of the inner wall of the cavity.

According to a further embodiment according to the first aspect, the arresting part comprises a further electrically conductive roller for arresting the second end portion of the string. The further roller may be located in a further cavity which may be located at the second opening and electrically connected to the communication unit, but which should be insulated from the (first) roller and cavity such that any electrical connection between the roller and the further roller is established via the metal core of the string only.

According to a further embodiment according to the first aspect, the housing comprises a spring for acting on the electrically conductive roller in a direction towards the first opening. In order to ensure that the roller is forced into the tapering part of the cavity at the first opening, the spring may act on the roller with a force towards the first opening.

The above need and object together with numerous other needs and objects, which will be evident from the below detailed description of a preferred embodiment of the module according to the present invention, are according to a second aspect of the present invention obtained by a housing for an engagement lock for a container, an arresting part arresting part for being received into a cavity, and a communication unit, the engagement lock further including a string comprising a metal core such as a metal wire, the metal core being coated by a flexible insulating material, the string defining a first end portion and a second end portion located opposite the first end portion, the housing comprising a first opening for receiving the first end portion of the string and a second opening for receiving the second end portion of the string, the communication unit being accommodated within the housing or on the arresting part, the arresting part including a first element of electrically conductive material for penetrating the flexible insulating material of the first end portion of the string, arresting the first end portion of the string relative to the housing and establishing electrical connection between the communication unit and the metal core of the first end portion of the string. It is evident that the housing according to the second aspect may be used together with the engagement lock according to the first aspect, or, as a retrofit for older engagement locks.

The above need and object together with numerous other needs and objects, which will be evident from the below detailed description of a preferred embodiment of the module according to the present invention, are according to a third aspect of the pre-

sent invention obtained by a method of operating an engagement lock for a container, the engagement lock comprising:

a string comprising a metal core such as a metal wire, the metal core being coated by a flexible insulating material, the string defining a first end portion and a second end portion located opposite the first end portion,

a housing comprising a first opening and a second opening, the housing further including a cavity for accessing the first end portion of the string within the housing,

an arresting part, the arresting part including a first element of electrically conductive material, and

a communication unit accommodated within the housing or on the arresting part,

the method comprising the steps of:

inserting the first end portion of the string into the first opening,

inserting the second end portion of the string into the second opening, and

inserting the arresting part into the cavity of the housing, thereby penetrating the flexible insulating material of the first end portion of the string, arresting the first end portion of the string relative to the housing and establishing electrical connection from the communication unit via first element to the metal core of the first end portion of the string.

It is evident that the method according to the second aspect may be used together with the engagement lock according to the first aspect or the housing according to the second aspect.

Brief description of the drawings:

Fig. 1A-F is a series of views illustrating the locking operation and functional principle of a first embodiment of an engagement lock according to the present invention.

Fig. 2A-F is a series of views illustrating the locking operation and functional principle of a second embodiment of an engagement lock according to the present invention.

Fig. 3A-F is a series of views illustrating the locking operation and functional principle of a third embodiment of an engagement lock according to the present invention.

Fig. 4A-D is a series of views illustrating the locking operation and functional principle of a fourth embodiment of an engagement lock according to the present invention.

Fig. 5A-F is a series of different views of the arresting part and RFID tag.

Fig. 6A-C is a series of views illustrating an alternative embodiment of an arresting part.

Fig. 7A-C is a series of views illustrating yet an alternative embodiment of an arresting part.

Fig. 8A-B is a series of views of an engagement lock having an arresting part in the form of a roller.

Fig. 9A-C is a series of views of a further engagement lock having an arresting part in the form of a roller.

Fig. 10A-C is a series of views describing the functional principle of the above engagement lock.

Fig. 11A-D is a series of views of an engagement lock in the form of a strap.

Fig. 12A-B is a series of views of the interior of the above engagement lock.

Detailed description of the drawings:

Fig. 1A shows a perspective view of an engagement lock 10 according to the present invention. The engagement lock comprises a string 12 and a housing 14. The string 12 define a first end portion 20 and an opposite second end portion 22. The string 12 comprises a core comprising a metal wire 16 and an insulating coating comprising a flexible plastic coating 18. The string 12 defines a square cross section for several which will be discussed below. It is contemplated that other non-circular cross sections, such as an elliptical cross section, of the string 12 may have similar advantages as a square cross section. The string 12 is inserted through a pair of locking rings 24 of a container (not shown), typically a freight container. The locking rings 24 are arranged such that the container cannot be opened when the locking rings 24 are adjacent each other, typically the locking rings 24 are each located on opposite double doors (not shown), or one of the locking rings may be located on an operating handle (not shown) of the container door and the other locking ring may be located on the container door (not shown).

The housing 14 is made of a rigid polymeric material such as plastic, alternative a metal material such as aluminum, iron, zinc or similar corrosion resistant metals. The housing 14 comprise a first opening 26 and an adjacent second opening 28 adapted for receiving the first end portion 20 and the second end portion 22, respectively, of the string 12. The openings 26 and 28 define a square cross section In this way the string

12, once the end portions 20 and 22 have been inserted into the respective opening 26 and 28 cannot be spun around its own axle as would be the case if the cross section of the string 12 was circular. Further, a square cross section forms a well defined flat surface for the arresting of the string which will be discussed in detail below. The first and second openings 26 and 28 communicate with respective first and second channels 30 and 32 within the housing 14. The first channel 30 further communicate with a third opening 34 opposite the first opening 26, whereas the second channel 32 defines a closed channel, i.e. ends in a wall. The upper housing part 14a located adjacent the first and second openings 26 and 28, is in the present embodiment opaque, whereas the lower housing part 14b located adjacent the third opening is transparent. This allows for a visual inspection of the lower housing part 14b.

The intersection between the upper housing part 14a and the lower housing part 14b defines a cavity 36 which allows access to the first and second channels 30 and 32. The cavity comprises an arresting part 38 which will be explained in more detail below. The arresting part 38 defines a handle 40. Adjacent the cavity 36, a wireless communication unit in the form of an RFID tag 42 is located.

Fig. 1B shows a perspective view of the engagement lock 10 according to the present invention before the engagement lock 10 has been arrested. The first end portion 20 of the string 12 has now been inserted into the first channel 30 via the first opening 26 and the second end portion 22 of the string 12 has been inserted into the second channel 32 via the second opening 28. The circumference of the first opening 26 and the second opening 28 should match the circumference of the string 12 in order to avoid any significant gap between the string 12 and the respective first and second openings 26 and 28. The first end portion 20 of the string 12 will extend through the third opening 34 such that the length of the part of the string 12 extending between the first and second openings 26 and 28 may be adjusted by simply pulling or pushing the first end portion 20 of the string 12.

Fig. 1C shows a perspective view of the engagement lock 10 according to the present invention after the engagement lock 10 has been arrested. The arresting part 38 has now been pushed in an inward direction as shown by the arrow by using the handle 40, from a first position in which the handle 40 of the arresting part 38 extends slightly outside the housing 12, to a second position in which the handle 40 of the arresting part 38 is located adjacent the housing 12. In this way, as will be explained further

below, the arresting part 38 will arrest the string 12 such that the string 12 cannot be moved in relation to the housing. In this way, the container (now shown) is sealed. In order to open the engagement lock 10, the string 12 must be cut by using a wire cutter or similar device (not shown). The arresting part 38 is permanently arrested in the second position, i.e. it cannot return to the first position without significantly damaging the engagement lock 10. The arresting part 38 further connects to the RFID tag 42 as will be described in more detail below.

Fig. 1D shows a perspective view of the engagement lock 10 according to the present invention when the RFID tag 42 is being read. By using an RFID reader 44, the information stored in the RFID tag 42 may be read by a customs officer or other person inspecting the engagement lock 10. The information stored in the RFID tag 42 may include basic data, such as an identification number or the like, which uniquely identifies the engagement lock. In this way the customs officer may determine whether the engagement lock 10 is authentic or has been replaced by a fraudulent person. Further, the RFID tag 42 may include information about whether the engagement lock 10 has been tampered with, e.g. whether or not the string 12 has been cut and replaced. Yet further, additional user specific information may be stored, such as the type of cargo transported, the weight of the cargo and similar information. All this information may be collected automatically, thus saving a lot of time otherwise spent on inspecting the engagement lock 10 and the container. It is evident that the information on the RFID tag 42 may be scrambled and/or read-only, such that any attempt to manipulate or misuse the information is prevented.

Fig. 1E shows a cross section view of the engagement lock 10 according to the present invention. The first and second channels 30 and 32 each include an optional locking device 46 in the form of a roller. The locking device 46 cooperates with the string 12 and the respective first and second channels 30 and 32 for preventing that the respective first and second end portions 20 and 22 of the string 12 may be pulled out of the respective first and second channels 30 and 32 before the arresting part 38 has arrested the respective first and second end portions 20 and 22 of the string 12. I this way the user may focus the attention to the first end portion 20 of the string 12 and by pulling the first end portion 20 through the third opening assuring that a snugly fit of the string 12 is achieved with respect to the locking rings of the container (not shown).

In the present situation, the arresting part 38 has been pushed into the cavity 36 to the second position in which the handle 40 of the arresting part 38 is located adjacent the housing 12. The arresting part 38 of the present embodiment includes an arresting section in the form of a wedge 48 which permanently arrests the arresting part 38 in the second position by acting against an inner wall of the housing 14. In this way, the arresting part 38 cannot again be pulled out of the cavity 36. To further complicate any attempt of removing the arresting part 38 once it has been arrested in the second position, a predetermined breaking point 40 is located between the handle 40 and the wedge 48 of the arresting part 38. In this way, the handle 40 will simply break off in case a fraudulent person attempts to use any forceful actions in order to remove the arresting part 38. The lack of a handle 40 on the engagement lock 10 will of course alert the customs officers.

Fig. 1F shows a detailed view of the arresting part 38 and the RFID tag 42 according to the present invention and as shown in fig 1. The RFID tag 38, which is here shown without antennas, includes a control unit 52 which is in electrical communication with a first sliding contact 54 and a separate second sliding contact 56. The first sliding contact 54 is contacting a first element 58 of the arresting part 38 and the second sliding contact 56 is contacting a second element 60 of the arresting part 38. There is no direct contact between the first element 58 and the second element 60. In the first position of the arresting part 38, the first element 58 and the second element 60 are both spaced apart from the string 12, whereas in the present second position of the arresting part 38, the first element 58 is penetrating the plastic coating 18 of the string 12 and thereby establishes an electrical contact with the metal wire 16 at the first end portion 20 of the string 12 and arrests the string 12 relative to the housing 12. At the same time, the second element 60 is penetrating the plastic coating 18 of the string 12 and thereby establishes an electrical contact with the metal wire 16 at the second end portion 22 of the string 12 and arrests the string 12 relative to the housing 14.

An electrical circuit may thereby be established from the control unit 52 of the RFID tag 42, via the first sliding contact 54 of the RFID tag 42, the first element 58 of the arresting part 38, the first and second end portions 20 and 22 of the string 12, the second element 60, the second sliding contact 56 to the control unit 52. In case a fraudulent person attempts to remove the string 12 from the housing 14 by e.g. forceful mechanical action, the first and second elements 54 and 56 will either cause significant damage to the string 12 and prevent a new string 12 from being inserted, or, alterna-

tively, the first and second elements 54 and 56 will bend in the direction of the force and make it impossible to arrest and electrically connect with a new string 12. Additionally, the removal, even for a very short time period, of the string 12 from the housing 14 will interrupt the electrical circuit. The interruption will be detected by the control unit 52 and even in case a skilled fraudulent person did replace the string 12 in such a skillful manner that a visual inspection would not reveal that the engagement lock has been opened, the control unit 52 of the RFID tag 42 would have detected the removal of the string 12 and consequently when the RFID tag 42 is read by the RFID reader, the customs officer will be notified of the fraud and a more thoroughly inspection of the engagement lock, container and cargo may be initiated.

Figs. 2A-D show a perspective view of an alternative embodiment of an engagement lock 10', which is identical to the previous engagement lock 10 as shown in connection with fig 1, except that the housing 12 is provided with a fourth opening 62 opposite the second opening 28. The fourth opening 62 allows the second end portion 22 of the string 12 to partially extend outside the housing 12. In this way both the first end portion 20 and the second end portion 22 of the string may be pulled in order to achieve a snugly fit of the string 12 in relation to the locking rings 24.

Fig. 2E shows a cross section view of the engagement lock 10'. The interior of the engagement lock 10' is identical to the previous engagement lock 10 except that the first and second channels 30 and 32 now lack any locking device for the reason that the second end part 22 of the string 12 should now extend outside the housing 14 and be adjustable together with the first end part 20 of the string 12.

Fig. 2F shows a detailed view of the arresting part 38 and the RFID tag 42 according to the present invention, which as such are identical to the arresting part and the RFID tag as shown in fig 1F.

Fig. 3A-D show a perspective view of yet an alternative embodiment of an engagement lock 10'' which is identical to the previous engagement lock 10' as shown in connection with fig 2 except that the housing 12 lacks a third opening 62 opposite the first opening 28. The fourth opening 62 allows the second end portion 22 of the string 12 to partially extend outside the housing 12, however, the first end portion 20 of the string 12 is permanently fixated inside the housing 14 as will be described in more detail below. In this way there is no risk of misplacing the string 12.

Fig. 3E shows a cross section view of the engagement lock 10''. The interior of the engagement lock 10'' is identical to the previous engagement lock 10' except that the first channel 32 now is closed off and the first end portion 20 of the string 12 is welded or soldered onto the first sliding contact 54' which now constitute a first contact connected to the control unit 52. The arresting part 38' now is shorter, includes only a second element 60 and no first element. The arresting part 38', which now optionally may be completely removed from the cavity 36 thus only extend into the cavity 36 as far as to reach the second channel 32.

Fig. 3F shows a detailed view of the arresting part 38 and the RFID tag 42 according to the present invention which as such are identical to the arresting part and the RFID tag except that the first element has been omitted and the first end portion 20 of the string 12 is directly welded or soldered onto the first contact 54'.

Fig. 4A-D show a perspective view of yet more an alternative embodiment of an engagement lock 10''' which as such is similar to the engagement lock 10''' of fig 1, however, the arresting part 38 and the cavity 36 have been shifted by 90°

Fig. 5A shows a side view of the RFID tag 42. The RFID tag 42 comprises an RFID antenna 64. The RFID antenna 64 is connected to the control unit 42. The RFID antenna 64 is used for the wireless communication with the RFID reader (not shown here) and may optionally be used for receiving power to the control unit 52. The control unit may also alternatively or in addition be powered by a battery (not shown).

Fig. 5B shows a side view of the arresting part 38. The first element 58 and the second element 60 are typically made of metal in order to be both rigid and electrically conductive. The wedge 48 has a sloped shape for being able to be inserted into the cavity of the housing, while preventing it to be removed, once it has achieved a snap fit interlock with the inner wall of the housing.

Fig. 5C shows a top view of the arresting part 38. The first element 58 and the second element 60 are adapted for sliding against and contacting the respective first sliding contact 54 and second sliding contact 56.

Fig. 5D shows a top view of the RFID tag 42 when produced. The first and second sliding contacts 54, 56 both exhibit holes for the string to pass through. Two opposite located RFID antennas 64, both electrically connected to the control unit 52, are provided.

Fig. 5E shows a perspective view of the RFID tag 42 when the RFID antennas are being bend in the direction of the arrows in order to allow the RFID tag 42 to fit into the housing.

Fig. 5E shows a perspective view of the final RFID tag 42 ready to be fitted into the housing.

Fig. 6A shows a alternative embodiment of an arresting part 38' when a first end portion 20 string 12 is pushed past the arresting part 38'. The alternative embodiment of the arresting part 38' may be fixedly installed into the cavity of the housing (not shown) and must not be pushed into the cavity, it is sufficient to push the string 12 into the opening of the housing (not shown). The present embodiment of the arresting part 38' comprises a first element 58' which is flexible. As shown in the figure, the string 12 may be pushed in a upward direction, i.e. inwardly from one of the first or second openings of the housing (not shown), and the first element 58' will flex in the same inwardly direction as the string 12 is moving. The string 12 will thereby not be penetrated.

Fig. 6B shows the alternative embodiment of the arresting part 38' when the string 12 is pulled in an outward direction, i.e. towards the first or second opening of the housing (not shown). The first element 58' will thereby flex back and penetrate the plastic coating 18 of the string 12, arrest the string 12 and establish a conductive path with the metal wire 16 of the string 12. The string 12 may thus not be removed from the housing (not shown). It is evident that the above arresting principle may be used in any of the embodiments shown in the previous figures 1-5.

Fig. 6C shows the alternative embodiment of the arresting part 38' when the first element 58' has penetrated the plastic coating 18 and established a conductive relationship with the metal wire 16 of the string 12.

Fig. 7A-C shows a alternative embodiment of an arresting part 38'' which is similar to the arresting part 38' shown in connection with fig 6A-C, except that the first element pierces the string 12 at four points of the string 12 instead of only one point of the string. This will allow a better arrestment of the string 12 and also a better conductive relationship with the metal wire 16 of the string 12.

Fig. 8A shows a cutout perspective view of an engagement lock 10^{V} according to a further embodiment of the present invention. The present engagement lock 10^{V} includes all of the features of the previous engagement lock 10 except that the arresting part has been omitted. In the present embodiment, the string is arrested in relation to the housing 14 by means of a pair of locking devices 46' and 46'', each located in the respective first and second channels 30 and 32. The locking devices 46' and 46'' are as described above in connection with fig. 1E provided in the form of a roller. The locking device 46 cooperates with the string 12 and the respective first and second channels 30 and 32 for preventing that the respective first and second end portions 20 and 22 of the string 12 may be pulled out of the respective first and second channels 30 and 32.

The rollers constituting the locking devices 46' and 46'' comprise metal piercing elements 66 which will penetrate the plastic coating 18 of the string and establish an electrical connection with the metal wire 16 of the string 12. The first and second channels 30 and 32 include a respective conductive path 68 and 68'. When the string 12 is inserted into the first and second channels 30 and 32, the string 12 will be arrested between the inner wall of the respective first or second channels 30 and 32 and the respective locking device 46' and 46''. The locking devices 46' and 46'' will in turn be arrested between the string 12 and the respective conductive path 68 and 68' of the first and second channels 30 and 32.

When the string 12 is moved into the respective first and second channels 30 and 32, the respective locking devices 46' and 46'' will pierce the string 12 and rotate together with the movement of the string 12 and no arresting will occur. When the string 12 is pulled out of the respective first and second channels 30 and 32, the respective locking devices 46' and 46'' will not rotate but move in a translator movement together with the sting 12 and arrest the string 12 at a location closer to the openings 26 and 28 at which location the cross section area of the respective first or second channels 30 and

32 are smaller. When the string 12 is arrested, the piercing elements of the string 12 will establish electrical connection to the conductive path 68.

Fig. 8B shows an interior perspective view of the engagement lock 10^{V} of fig 8A. As can be seen in the figure, an electrical connection is established as shown by the arrows from the control unit 52 via the first contact 54 to the conductive path 68', further to the locking device 46'', via the string 12 to the opposite locking device 46' and via the conductive path 68 and the second contact 56' to the control unit 52.

Fig. 9A shows a side view of a further embodiment of an engagement lock 10^{VI} according to the present invention. The engagement lock 10^{VI} comprises a housing 14' which in turn comprise a transparent housing part 14a' and an opaque housing part 14b'. The opaque housing part 14b' comprises a first opening 26 and a second opening 28 for receiving a string. The opaque housing part 14b' comprises a lid 70. The lid 70 covers an upper part of the housing 14b adjacent the first opening 26 and the second opening 28, which openings are not covered by the lid 70. The purpose of the lid 70 is to protect the opaque housing part 14b' in the vicinity of the first opening 26 and the second opening 28 while still allowing the openings to the accessed from the outside. The lid 70 may be made of metal in order to leave visible traces of any attempt of unauthorized opening of the engagement lock 10^{VI}. The opaque housing part 14b' may thus be made of plastics in order to reduce the overall weight of the opaque housing part 14b'.

The opaque housing part 14b' comprises two conductive housing parts 72 and 72b which are located within the opaque housing part 14b'. Each conductive housing part is located adjacent a corresponding opening 26 28 of the opaque housing part 14b'. Each of the conductive housing parts 72 and 72' includes a locking device 46' and 46'' of the same type as described in connection with fig 8. The locking devices 46' and 46'' are kept in place within the corresponding conductive housing parts 72 and 72' by a guide 74 having two springs 76. Each spring 76 and 76' contacts a corresponding locking device 46' and 46'' forcing it in the direction towards the corresponding opening of the opaque housing part 14b'.

The guide 74 includes two cylindrical portions, each adapted for guiding the string from the opaque housing part 14b' into a transparent housing part 14a'. The transparent housing part 14a' comprises an RFID tag 42. The RFID tag 42 is electrically connected

to each of the conductive housings 72 via leads 80 and 80'. The transparent housing part 14a' and the opaque housing part 14b' are interconnected at the guide 74.

Fig. 9B shows a cutout view of the engagement lock 10^{VI} according to the present invention. The transparent housing part 14a' further comprises an opening 34' for allowing the string to extend outside the transparent housing part 14a'. Each of the conductive housing parts 72 and 72' have an interior space which is narrowing towards the respective opening 26 and 28.

Fig. 9C shows a perspective view of the engagement lock 10^{VI}. The control unit 52 of the RFID tag is connected to the RFID antenna 64 and to the leads 80 and 80'.

Fig. 10A shows a side view of the engagement lock 10^{VI}. It is shown how the end of the string 12 is inserted into the second opening 28 of the opaque housing part 14b'. The other end of the string 12 has been inserted into the first opening 26 of the opaque housing part 14b' and further via the transparent housing part 14a' through the third opening 34. In this way the length of the string 12 extending between the first and second openings 26 and 28 may be determined by pulling the part of the string 12 extending through the third opening 34.

Fig. 10B a cutout view of the engagement lock 10^{VI} in which the working principle of the lock is further explained. When the end of the string 12 is inserted into either the first or the second opening 26 and 28, the string will contact the locking device 46' and 46'' which is supported on the spring 76 and 76'. The string 12 will cause the locking device 46' and 46'' to move, i.e. rotate and/or translate, towards the string 76 and 76'. The spring 76 and 76' will thereby bend towards the transparent housing part 14a allowing the string 12 to pass through into the transparent housing part 14a. Since the conductive housing part 72 and 72' exhibits a narrowing or tapering from the spring 76 towards the opening 26 and 28, the spacing in between the inner wall of the conductive housing 72 and the locking device 46' 46'' will be larger than the string 12 and allow the string 12 to pass when the string is pushed towards the transparent housing part 14a. However, when the user attempt to pull the string in the other direction, i.e. out of the opening 26 and 28, the spring 76 and 76' will act on the locking device 46' 46'' and push the locking device 46' and 46'' towards the opening 26 and 28. Since the inner wall of the conductive housing part 72 and 72' is narrowing or tapering from the spring 76 towards the opening 26 and 28, the string 12 will be clamped between the

locking device 46' and 46'' and the inner wall of the conductive housing part 72 and 72'. The movement of the string is thus only possible in the direction from the opaque housing part 14b towards the transparent housing part 14a, not the other way around.

Since the locking device 46' and 46'' comprise piercing elements 66, the plastic coating of the string 12 will be pierced by the piercing elements 66 such that and electrical connection is established between the electrically conductive locking device 46' and 46'' and the metal wire of the string 12. Further, an electrical connection is established between the locking device 46' and 46'' and the conductive housing part 72 and 72'. Thus, an electrical connection is established from the lead 80, via the conductive housing 72, the locking device 46', the metal wire of the string 12, the locking device 46'', the conductive housing 72' and to the lead 80'. The leads 80 and 80' are connected to the control unit 52. The control unit 52 may thus detect any interruption of the string 12 by monitoring the electrical connection.

Fig. 10C shows a perspective view of the engagement lock 10^{VI}. The lid 70 covers part of the opaque housing part 14b' while allowing the first and second openings 26 and 28 to be accessed by the string 12.

Fig. 11A shows a side view of an engagement lock 10^{VII} in the form of a plastic strap. The engagement lock 10^{VII} comprises an elongated section 82 and a locking section 84 attached to the elongated section 82. The locking section 84 is shorter but wider than the elongated section 82. The elongated section 82 comprise a predetermined breaking point 86 and a number of ridges 88, all adjacent the locking section 84. The locking section 84 comprises a locking housing 90 and an RFID tag 42'.

Fig. 11B shows a front view of an engagement lock 10^{VII}. The locking housing 90 comprise an aperture 92 which is adapted for receiving the elongated section 82. The elongated section comprises two conductive paths 94 and 94'.

Fig. 11C shows a perspective view of the engagement lock 10^{VII} in its unlocked state.

Fig. 11C shows a perspective view of the engagement lock 10^{VII} when locking a post bag 96. The elongated section 82 has been inserted through the aperture 92 of the locking housing 90 of the locking section 84 which arrests the elongated section 82

and forms a loop. The ridges 86 will grab the post bag 96 for avoiding the engagement lock 10^{VII} slipping off the bag 96.

Fig. 12A shows a sectional perspective view of the engagement lock 10^{VII} when in the open state. The conductive path 94 is here shown in more detail. The conductive path 94 may e.g. be a metal wire which is embedded in the plastic of the elongated section 82. The conductive path 94 comprise an elongated path 94' extending along one side of the elongated section 82 from the end of the elongated section 82 opposite the locking section 84 towards the locking section 84, a transverse path 94'' extending from the one side of the elongated section 82 to the opposite side of the elongated section 82 adjacent the locking section 84, and a further elongated path 94''' extending along the other side of the elongated section 82 from the transverse path 94'' to the end of the elongated section 82.

The locking section 84 comprises the locking housing 90. The aperture 92 of the locking housing 90 comprises two opposing metallic retro serrations or barbings 98, which allow the elongated section 82 to enter and pass through the aperture 92 while preventing the elongated section 82 to be removed from the locking housing 90. Each of the barbings 98 is connected to a control unit which in turn is connected to the RFID antenna 64.

Fig. 12A shows a sectional perspective view of the engagement lock 10^{VII} when in the closed state. The end of the elongated section has been inserted through the aperture 92. The retro serrations or barbings 98 will slide on top of the plastic elongated section 82. When the user attempts to pull the elongated section 82 in the reverse direction out of the locking housing 90, each of the retro serrations or barbings 98 will cut into the elongated section 82 and establish electrical contact with the conductive path 94, thereby establishing an electrical connection from the control unit 52, via the retro serrations or barbings 98 to the conductive paths 94', 94'' and 94''', the retro serrations or barbings 98' to the control unit 52.

When the user wished to open the engagement lock 10^{VII}, the user may tear the predetermined breaking point 86 in order to release the object which has been fastened. Any tampering will be evident since in case an unauthorized user manages to get the elongated section 82 out of the aperture92, the conductive path will be interrupted. The interruption will be detected by the control unit 52.

Although the engagement lock has been described above with reference to specific embodiments, it is evident to a skilled person that numerous modifications can be made, such as simple combinations of the presented embodiment. As an example, it is evident that the above described engagement lock for containers may be used for similar locking purposes such as locking of tank-truck valves, truck trailers, rail wagons, box doors, gates, money bags etc. The engagement lock for bags may consequently be used for containers.

List of parts with reference to the figures:

10. Engagement lock	54. First sliding contact
12. String	56. Second sliding contact
14. Housing	58. First element
14a. Transparent housing part	60. Second element
14b. Opaque housing part	62. Fourth opening
16. Metal wire	64. RFID antenna
18. Plastic coating	66. Piercing elements
20. First end portion	68. Conductive path
22. Second end portion	70. Lid
24. Locking rings	72. Conductive housing
26. First opening	74. Guide
28. Second opening	76. Spring
30. First channel	78. Cylindrical portion
32. Second channel	80. Leads
34. Third opening	82. Elongated section
36. Cavity	84. Locking section
38. Arresting part	86. Predetermined breaking point
40. Handle	88. Ridge
42. RFID tag	90. Locking housing
44. RFID reader	92. Aperture
46. Locking device	94. Conductive path
48. Wedge	96. Bag
50. Break point	98. Retro serration
52. Control unit	

CLAIMS

1. An engagement lock for a container, said engagement lock comprising:

a string comprising a metal core such as a metal wire, said metal core being coated by a flexible insulating material, said string defining a first end portion and a second end portion located opposite said first end portion,

a housing comprising a first opening for receiving said first end portion of said string and a second opening for receiving said second end portion of said string, said housing further including a cavity for accessing said first end portion of said string within said housing,

an arresting part for being received into said cavity of said housing, and

a communication unit accommodated within said housing or on said arresting part,

said arresting part including a first element of electrically conductive material for penetrating said flexible insulating material of said first end portion of said string, arresting said first end portion of said string relative to said housing and establishing electrical connection between said communication unit and said metal core of said first end portion of said string.

2. The engagement lock according to claim 1, wherein said arresting part including a handle having a predetermined breaking point adapted to break off when exposed to an excessive force once said first end portion of said string has been arrested relative to said housing.

3. The engagement lock according to any of the claims 1 or 2, wherein said second end portion of said string being electrically connected to said communication unit.

4. The engagement lock according to any of the claims 1 or 2, wherein said arresting part including a second element of electrically conductive material for penetrating said plastic coating of said second end portion of said string, arresting said second end portion within said housing and establishing electrical connection between said communication unit and said metal core of said second end portion of said string.

5. The engagement lock according to any of the preceding claims, wherein said housing comprising a third opening opposite said first opening for establishing a

first pass through within said housing between said first opening and said third opening for allowing said first end portion of said string to at least partially extend outside said housing.

6. The engagement lock according to any of the claim 1-2, wherein said housing comprising a fourth opening opposite said second opening for establishing a second pass through within said housing between said second opening and said fourth opening for allowing said second end portion of said string to at least partially extend outside said housing.

7. The engagement lock according to any of the preceding claims, wherein said second opening comprises a nipping area for securing said second end portion of said string.

8. The engagement lock according to any of the preceding claims, wherein said communication unit comprises a wireless communication unit, such as an RFID tag.

9. The engagement lock according to any of the preceding claims, wherein said housing is at least partially made of a transparent plastic material.

10. The engagement lock according to any of the preceding claims, wherein said arresting part is permanently fitted within said cavity or alternatively said arresting part being removable.

11. The engagement lock according to any of the preceding claims, wherein said flexible insulating material comprises a polymeric material such as plastics.

12. The engagement lock according to any of the preceding claims, wherein said arresting part includes an arresting section for interlocking with said cavity of said housing once said first end portion of said string has been arrested relative to said housing, said arresting section preferably comprising a snap-fit.

13. The engagement lock according to any of the preceding claims, wherein said communication unit establishes a locked state when an electrical circuit is established from said communication unit via said first element of said arresting part and

said metal core and back to said communication unit, and, a tampered state when said electrical circuit is or has been interrupted.

14. The engagement lock according to claim 13, wherein, when in said tampered state, said communication unit is erased.

15. The engagement lock according to any of the preceding claims, wherein said arresting part comprises an electrically conductive roller for arresting said first end portion of said string.

16. The engagement lock according to claim 15, wherein said electrically conductive roller comprises metal piercing elements constituting said first element

17. The engagement lock according to any of the claims 15-16, wherein said cavity defines an electrically conductive inner wall, said conductive inner wall being electrically connected with said communication unit.

18. The engagement lock according to claims 17, wherein said cavity defines a tapering towards said first opening.

19. The engagement lock according to any of the claims 15-18, wherein said arresting part comprises a further electrically conductive roller for arresting said second end portion of said string.

20. The engagement lock according to any of the claims 15-19, wherein said housing comprises a spring for acting on said electrically conductive roller in a direction towards said first opening.

21. A housing for an engagement lock for a container, an arresting part arresting part for being received into a cavity, and a communication unit, said engagement lock further including a string comprising a metal core such as a metal wire, said metal core being coated by a flexible insulating material, said string defining a first end portion and a second end portion located opposite said first end portion, said housing comprising a first opening for receiving said first end portion of said string and a second opening for receiving said second end portion of said string, said communication unit being accommodated within said housing or on said arresting part, said arresting

part including a first element of electrically conductive material for penetrating said flexible insulating material of said first end portion of said string, arresting said first end portion of said string relative to said housing and establishing electrical connection between said communication unit and said metal core of said first end portion of said string.

22. A method of operating an engagement lock for a container, said engagement lock comprising:

a string comprising a metal core such as a metal wire, said metal core being coated by a flexible insulating material, said string defining a first end portion and a second end portion located opposite said first end portion,

a housing comprising a first opening and a second opening, said housing further including a cavity for accessing said first end portion of said string within said housing,

an arresting part, said arresting part including a first element of electrically conductive material, and

a communication unit accommodated within said housing or on said arresting part,

said method comprising the steps of:

inserting said first end portion of said string into said first opening,

inserting said second end portion of said string into said second opening, and

inserting said arresting part into said cavity of said housing, thereby penetrating said flexible insulating material of said first end portion of said string, arresting said first end portion of said string relative to said housing and establishing electrical connection from said communication unit via first element to said metal core of said first end portion of said string.

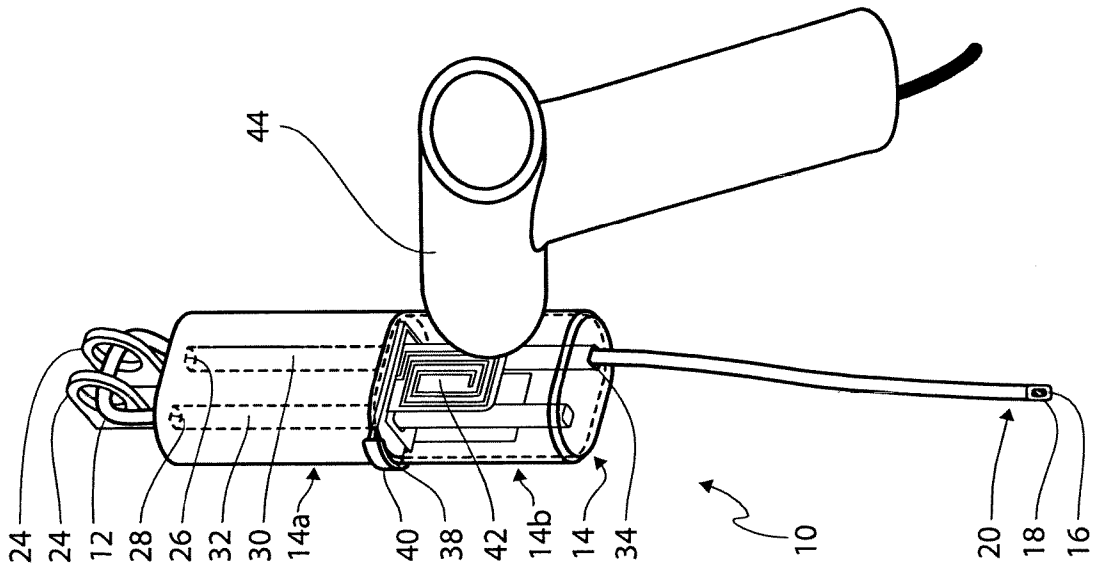


FIG. 1D

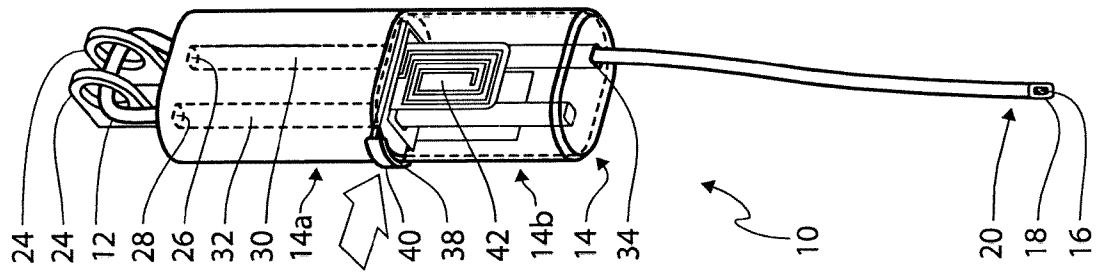


FIG. 1C

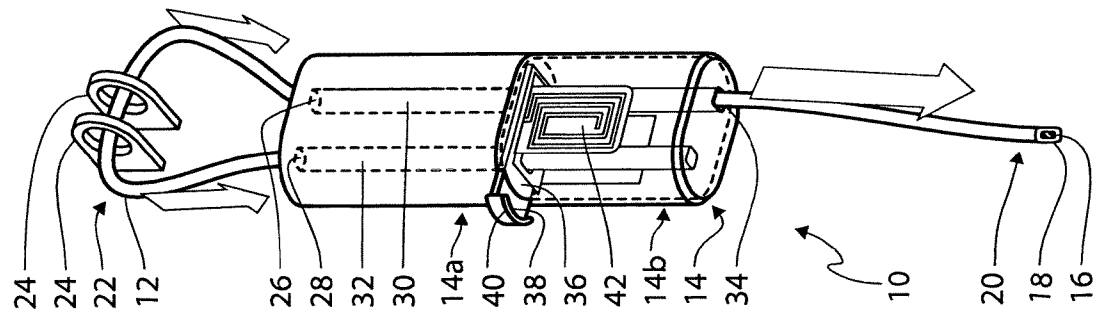


FIG. 1B

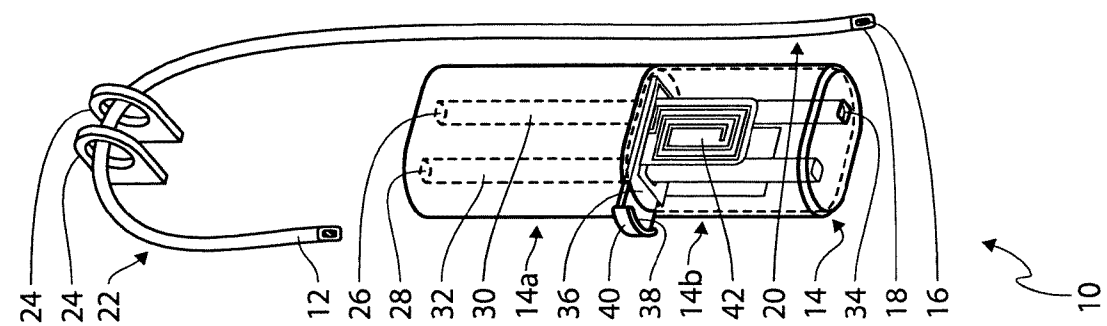
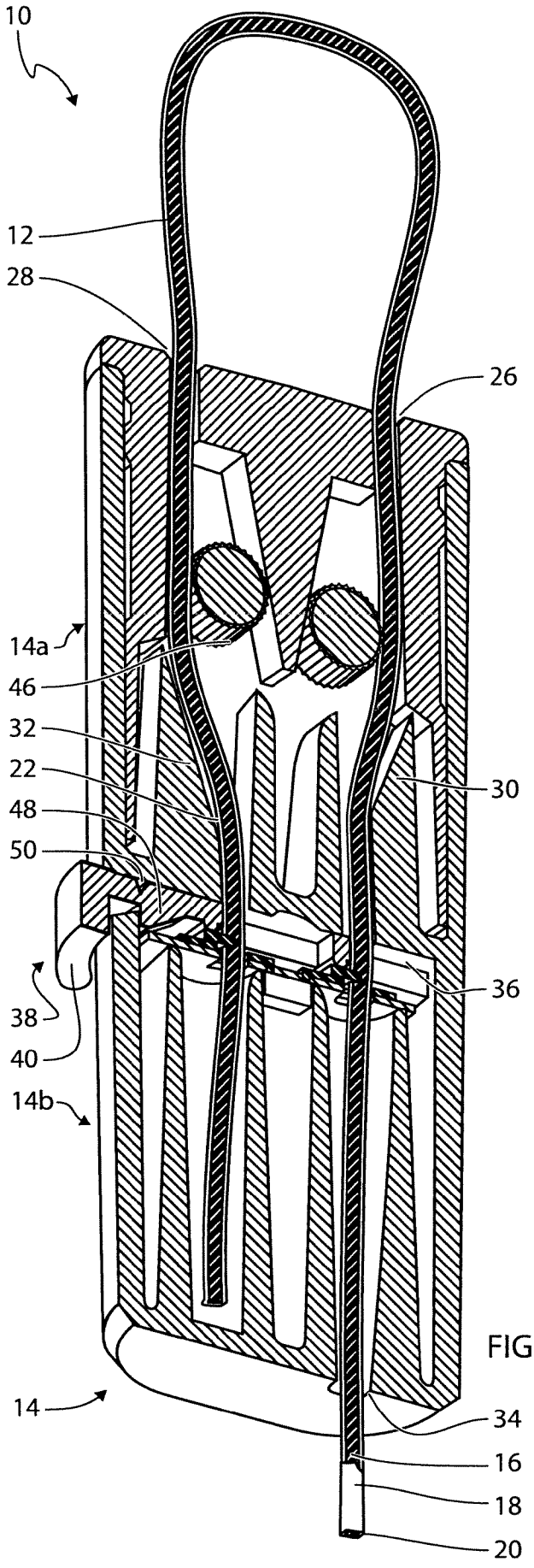


FIG. 1A


10
12
28
26
14a
46
32
22
48
50
30
36
38
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14b
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34
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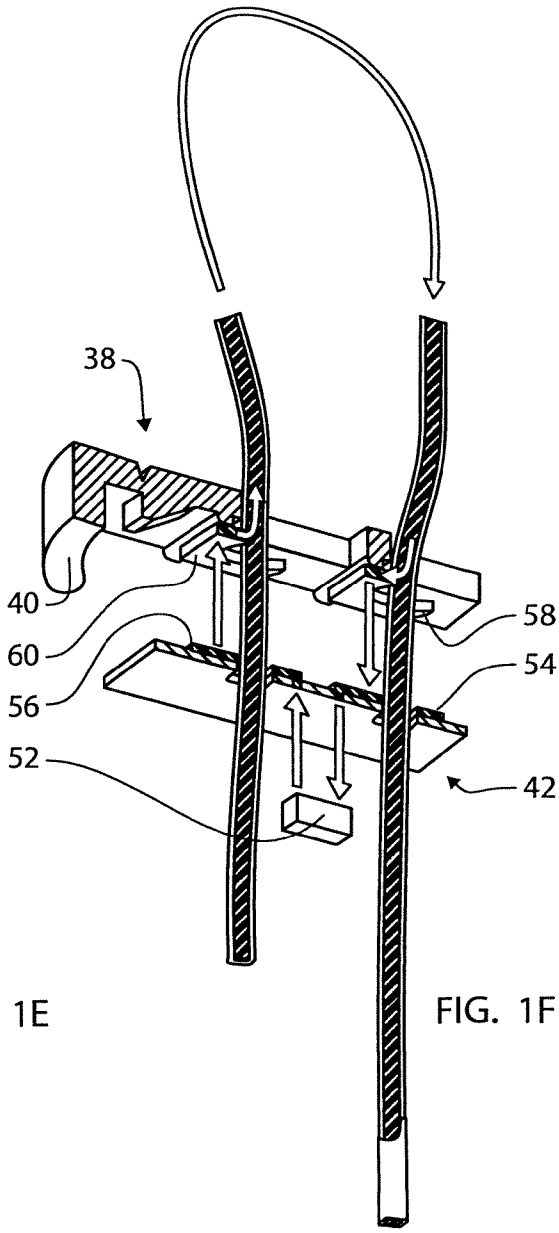
18
20

FIG. 1E


38
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52
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54
42

FIG. 1F

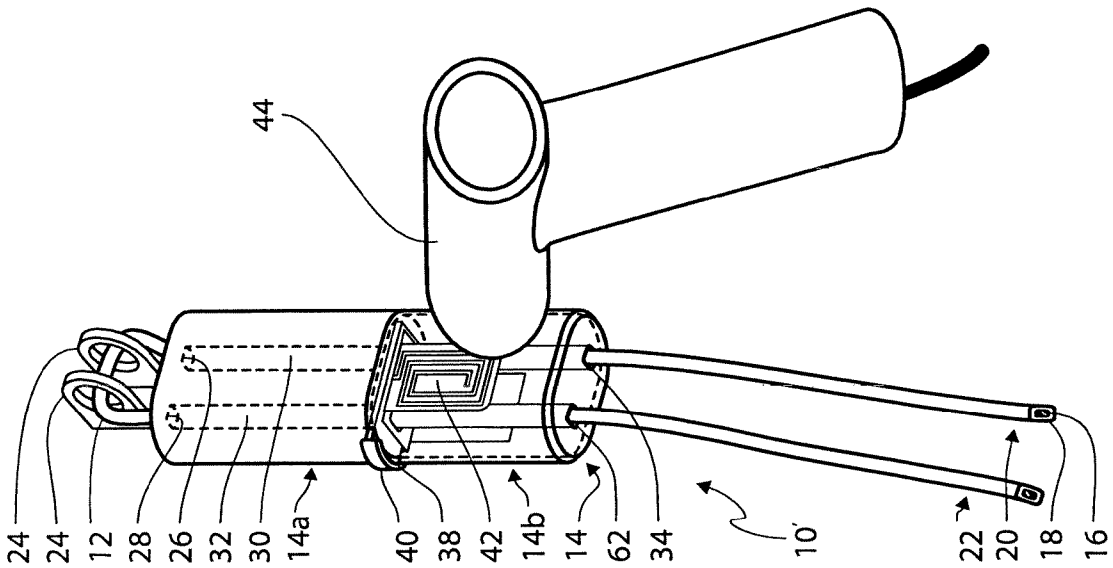

FIG. 2D

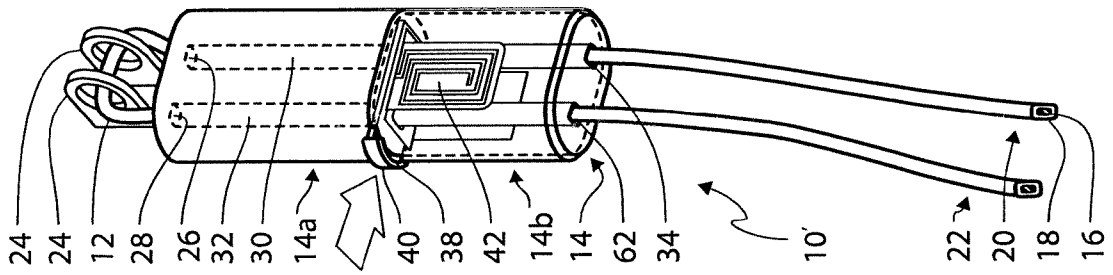

FIG. 2C

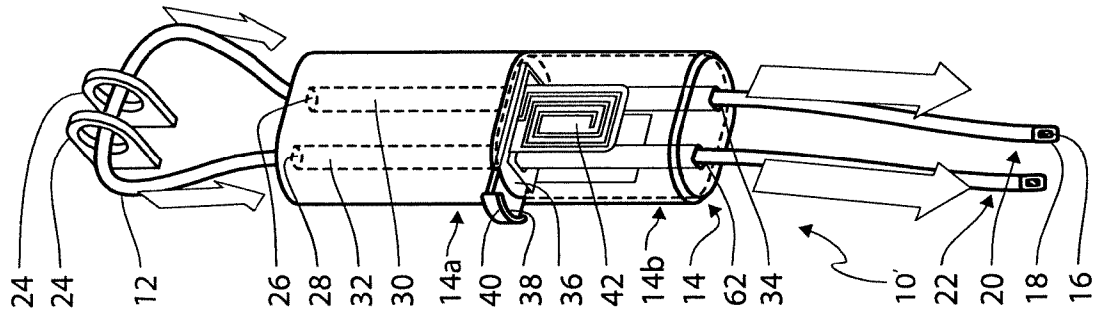

FIG. 2B

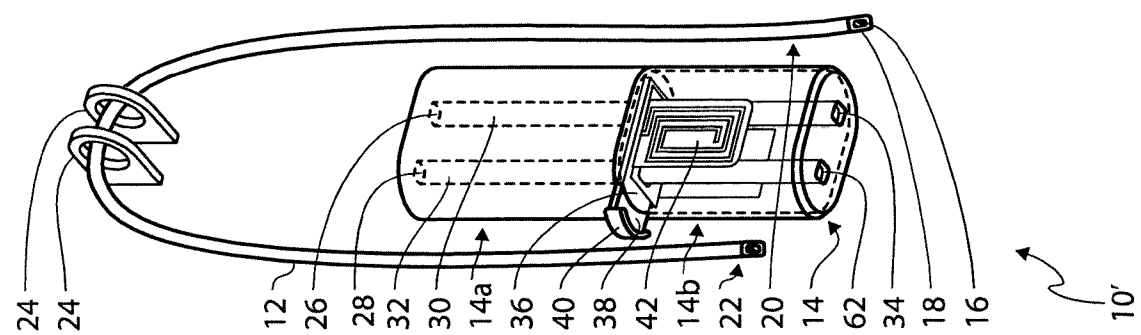

FIG. 2A

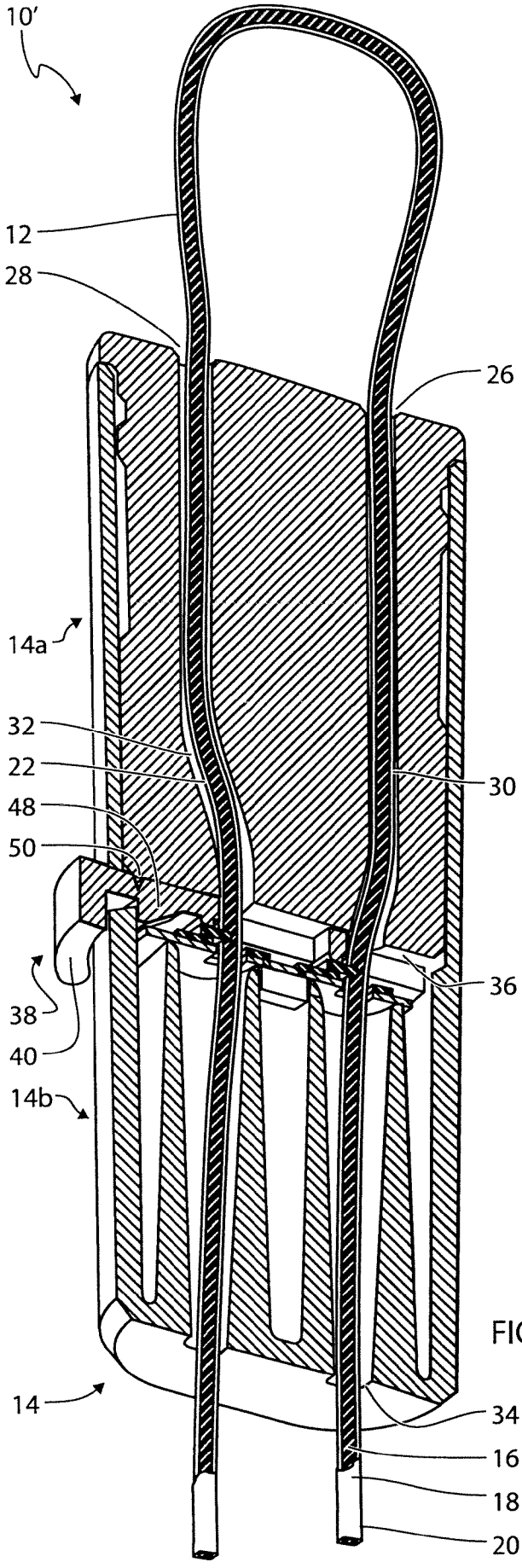
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FIG. 2E

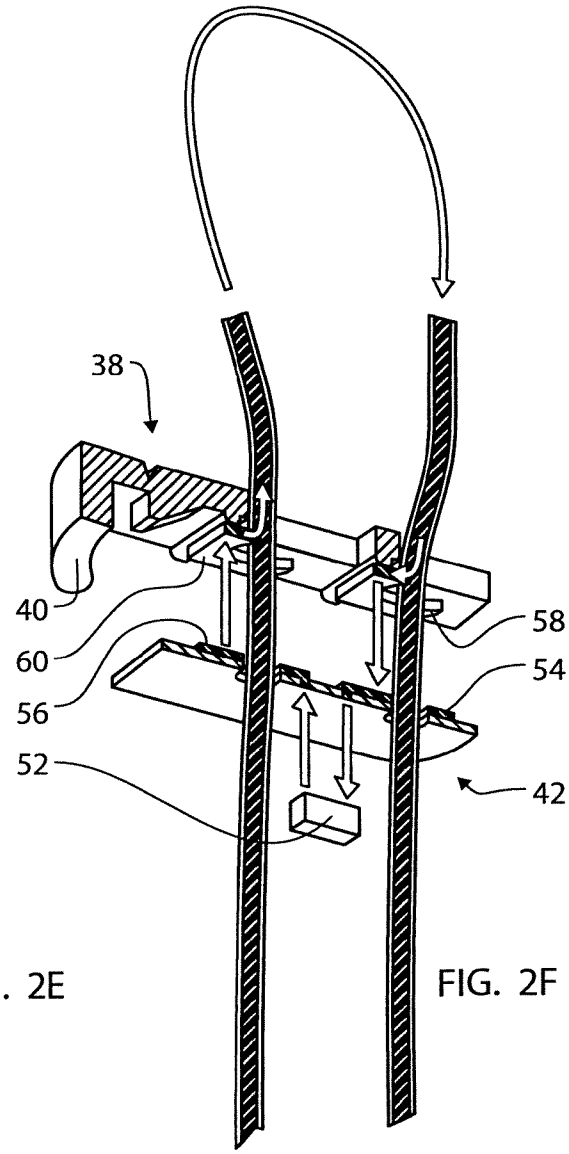
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FIG. 2F

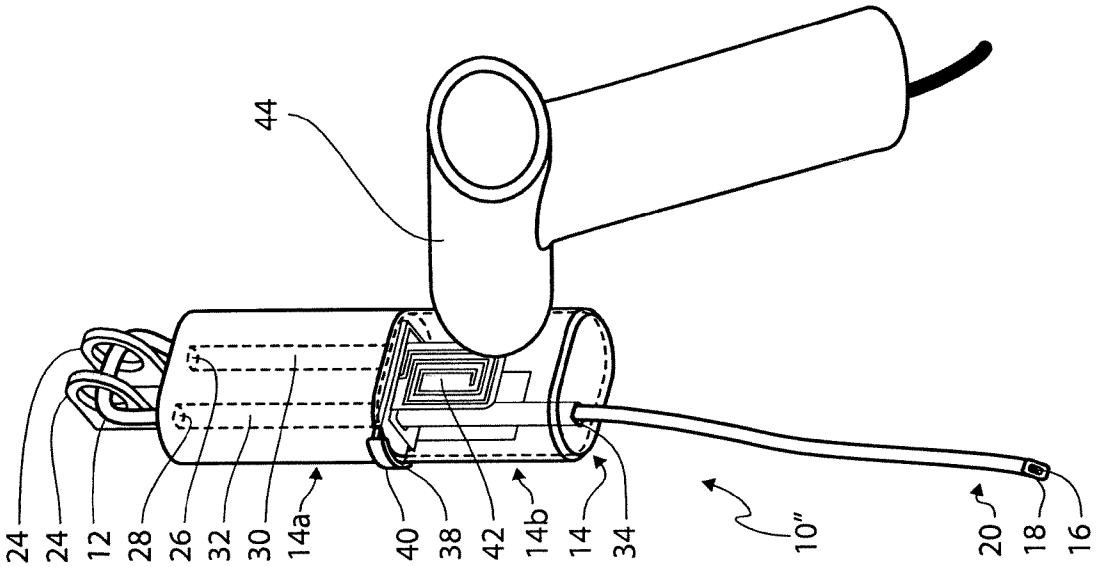


FIG. 3D

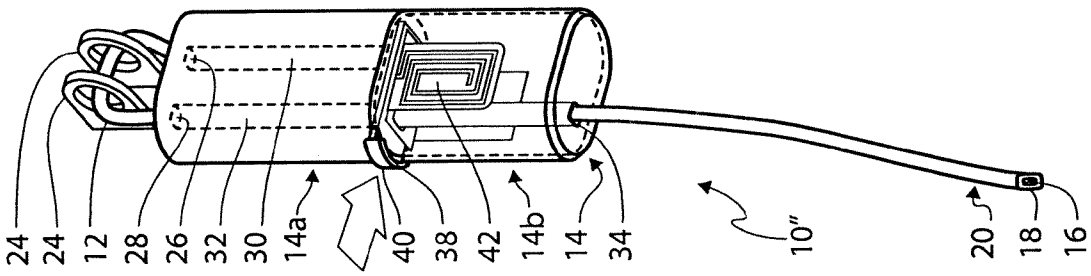


FIG. 3C

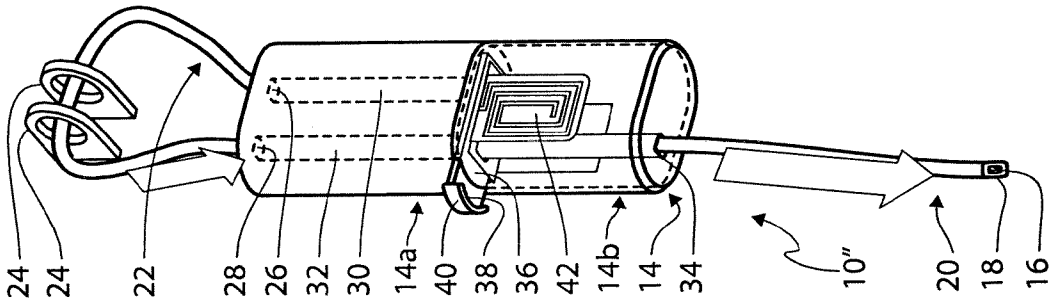
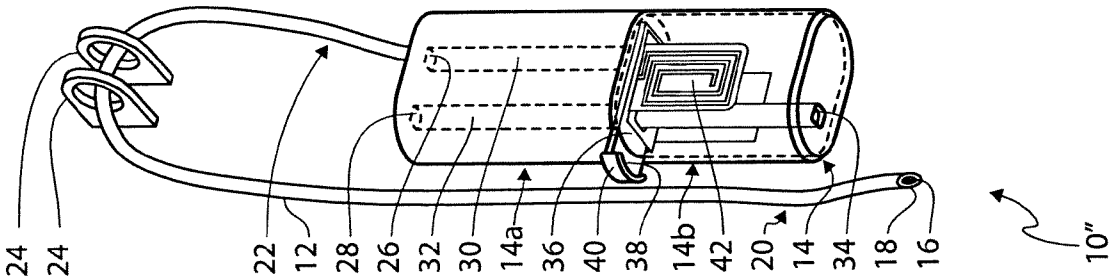


FIG. 3B



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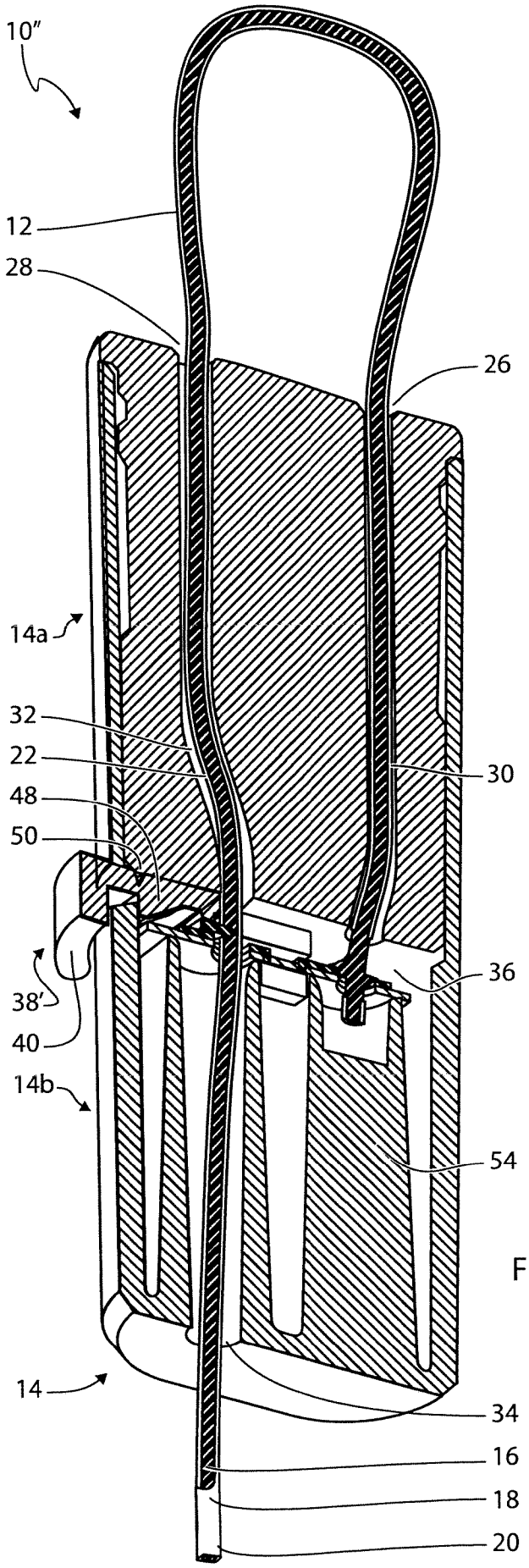
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FIG. 3E

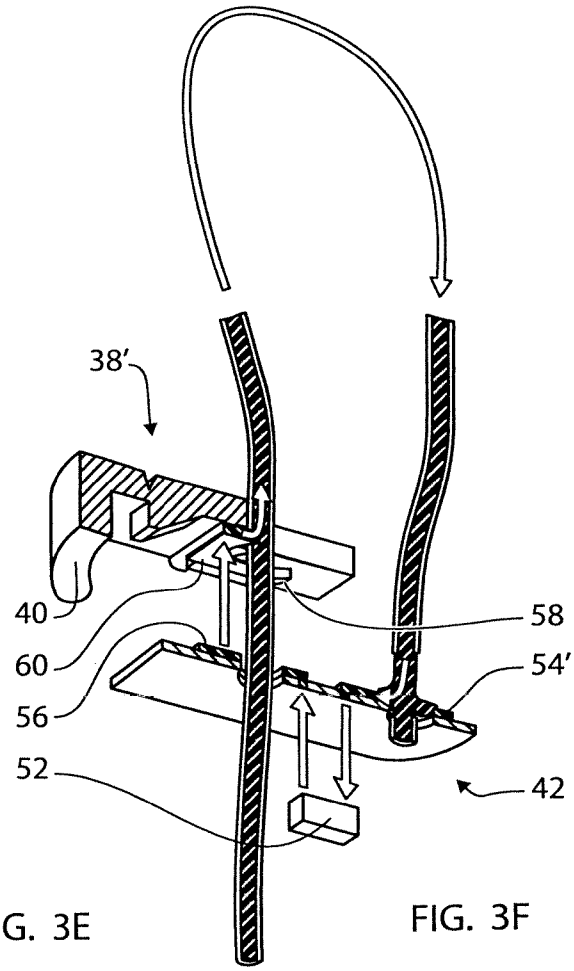
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FIG. 3F

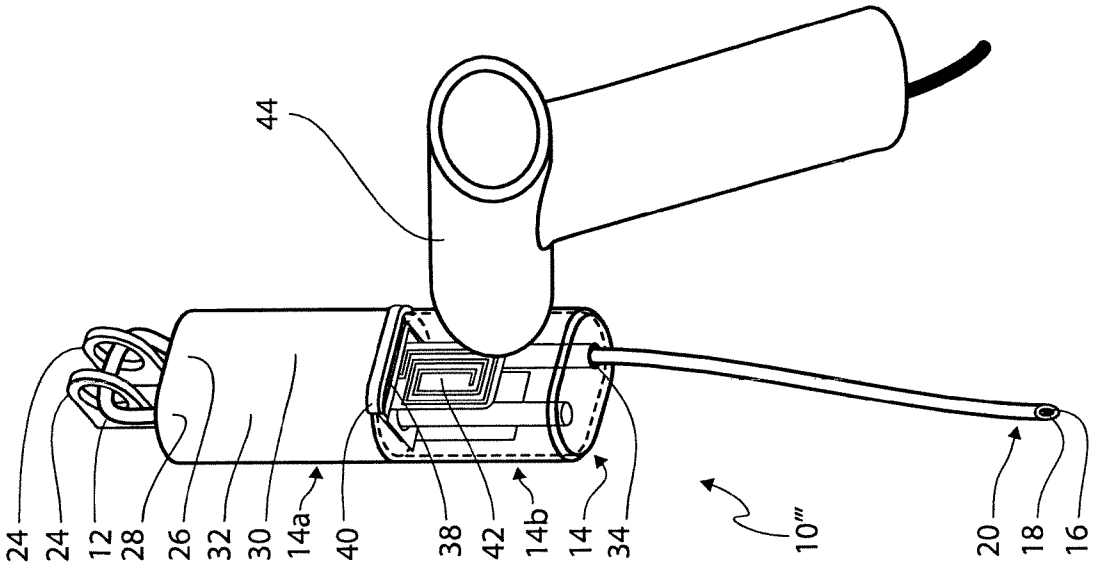


FIG. 4D

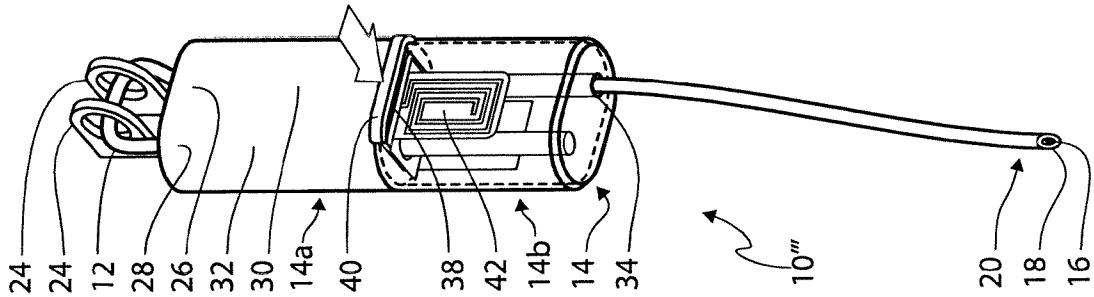
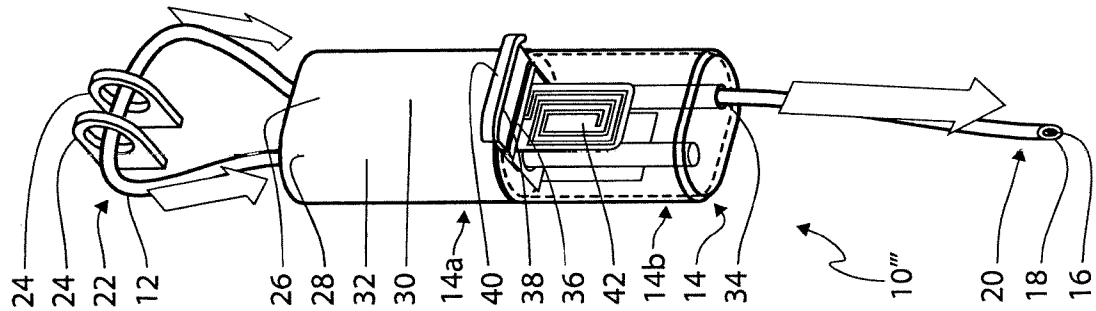


FIG. 4C



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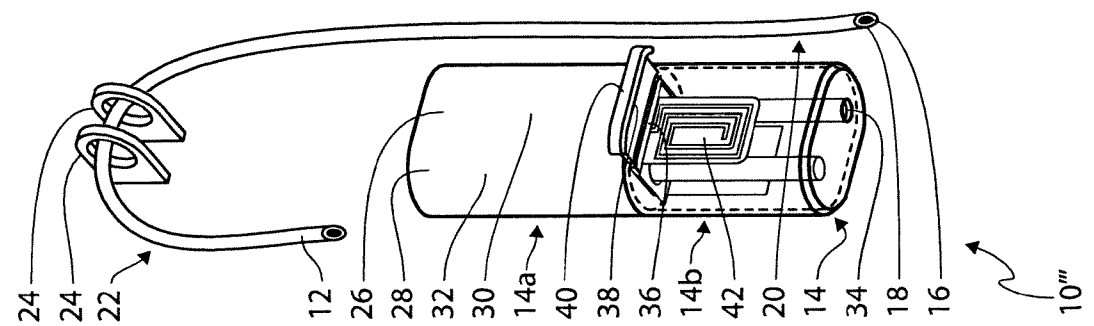


FIG. 4A

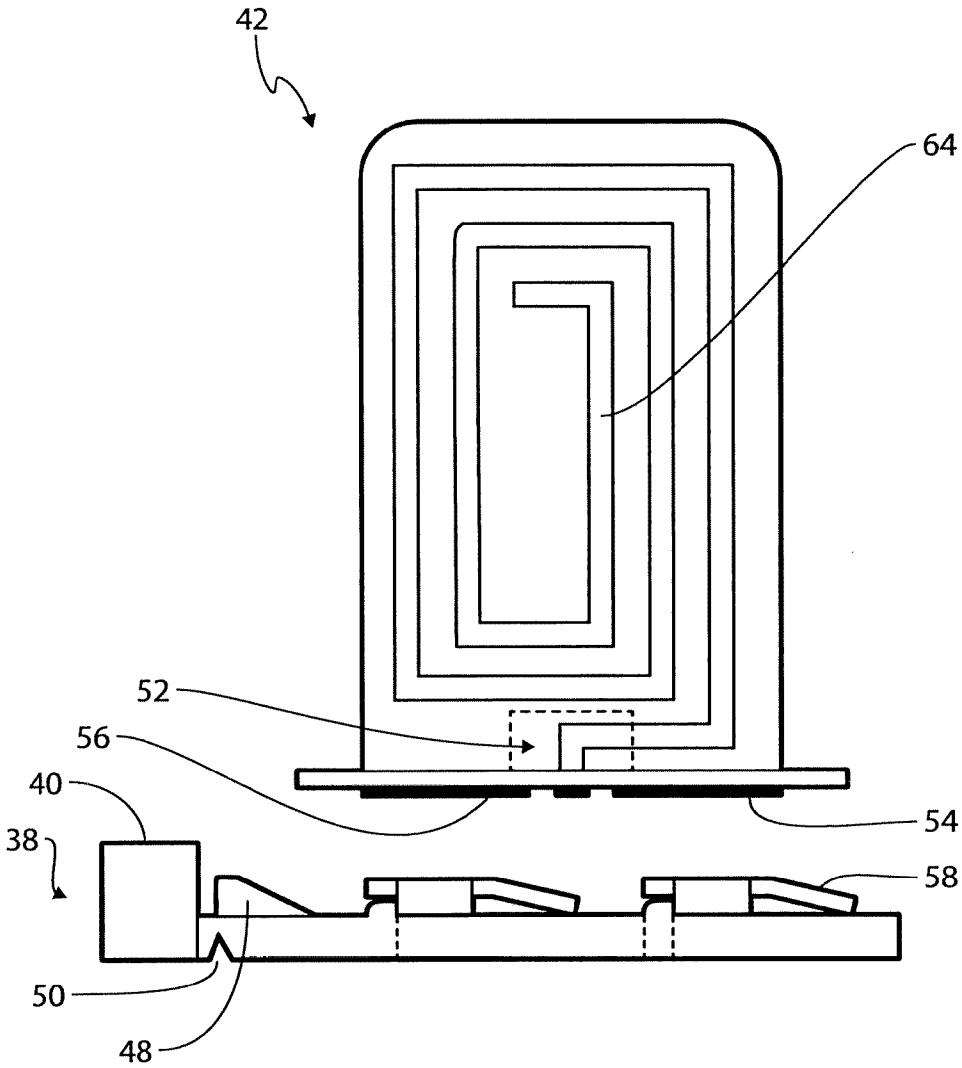


FIG. 5A

FIG. 5B

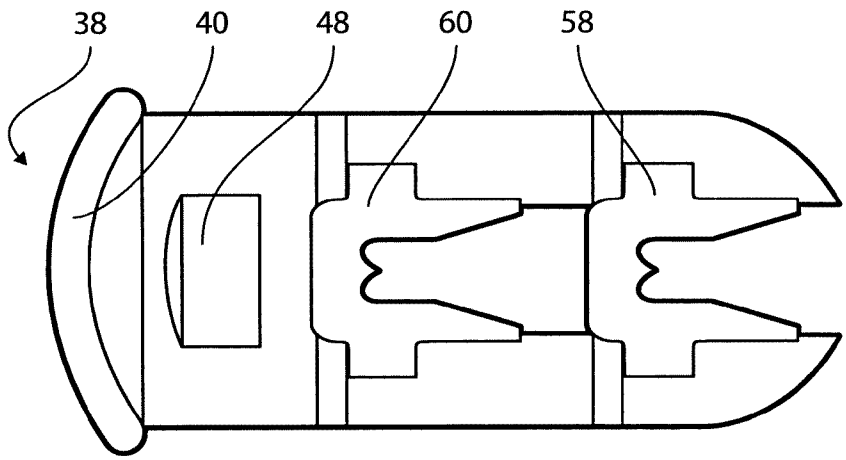
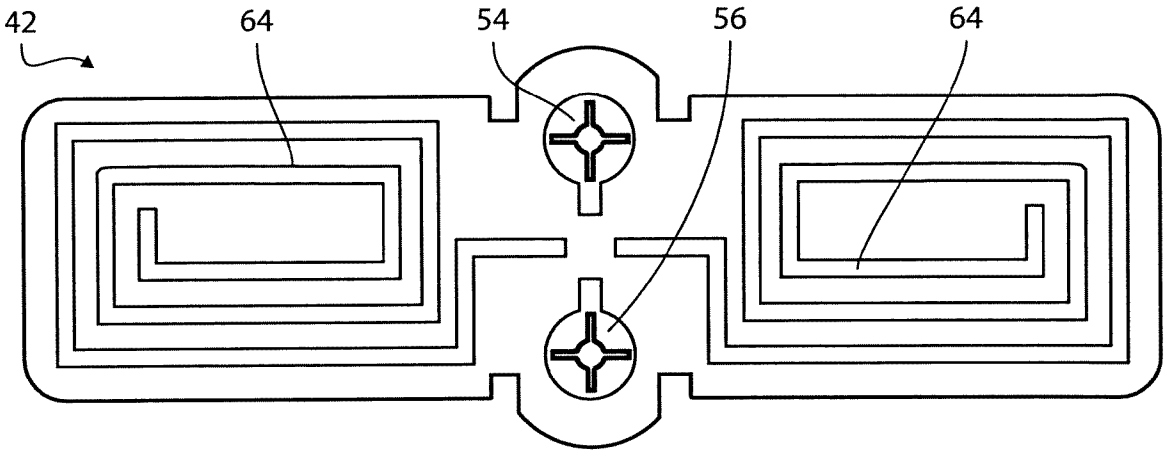


FIG. 5C



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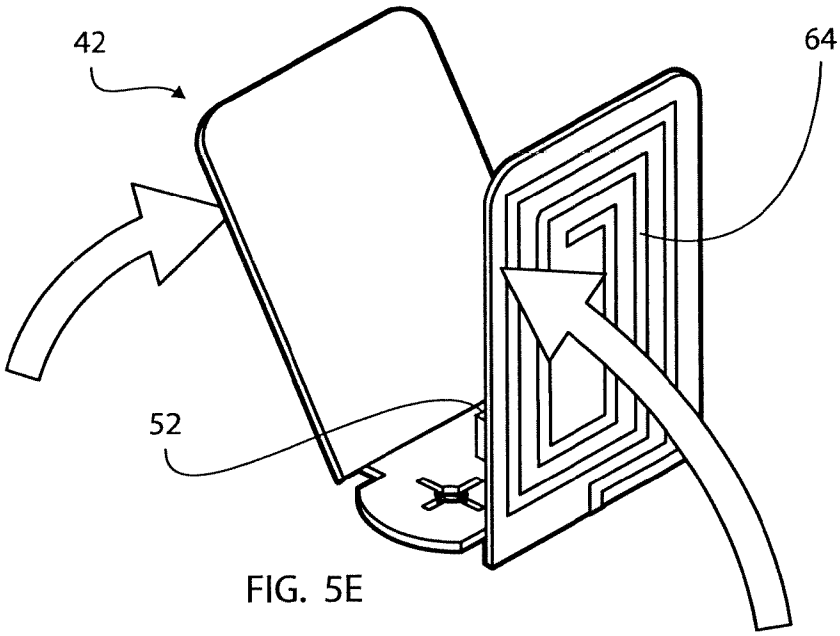

FIG. 5E

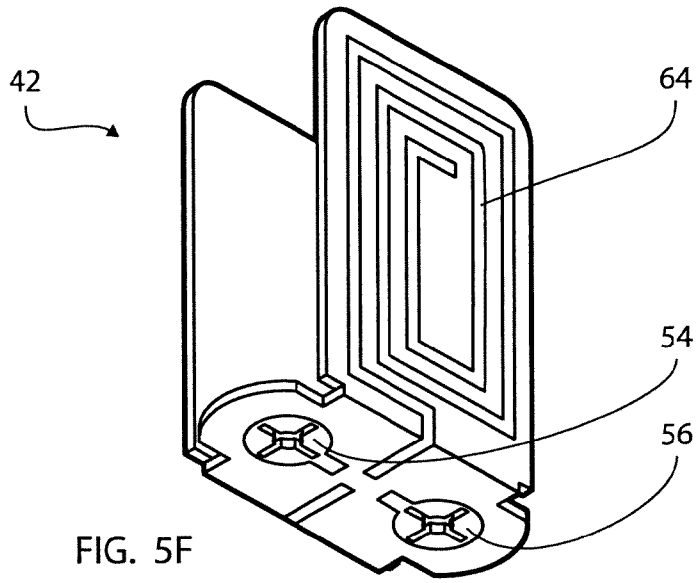

FIG. 5F

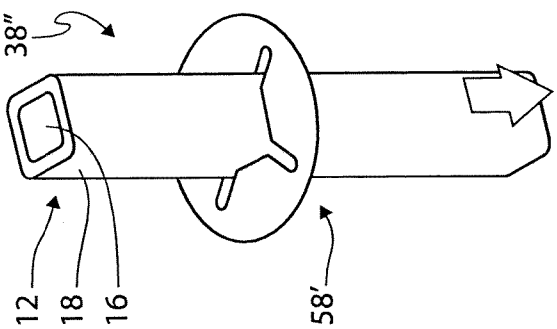

FIG. 7B

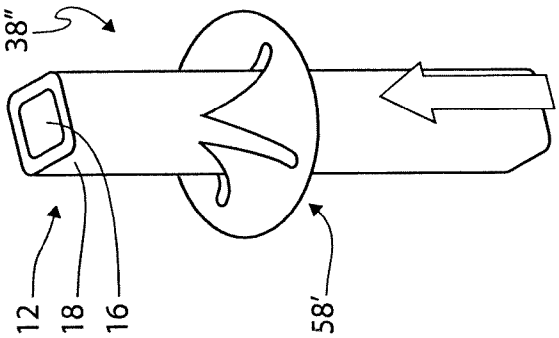

FIG. 7A

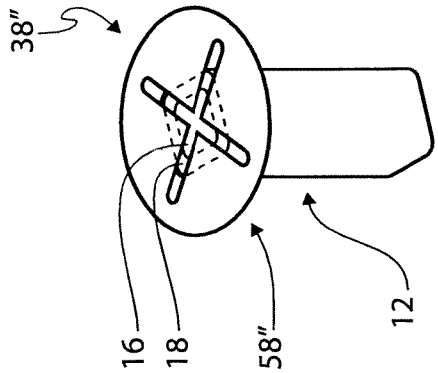

FIG. 7C

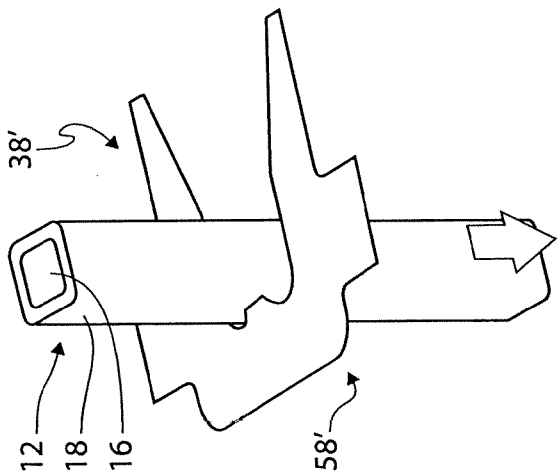

FIG. 6B

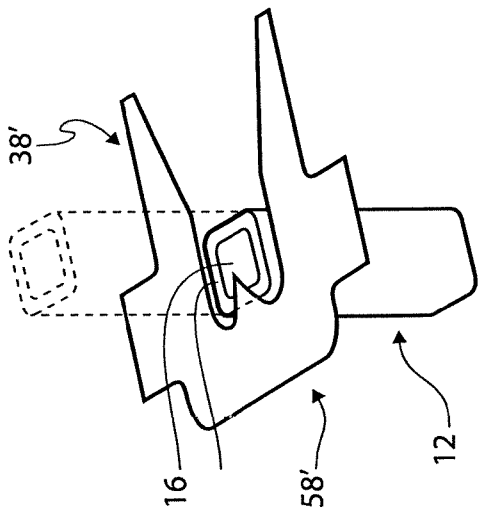

FIG. 6C

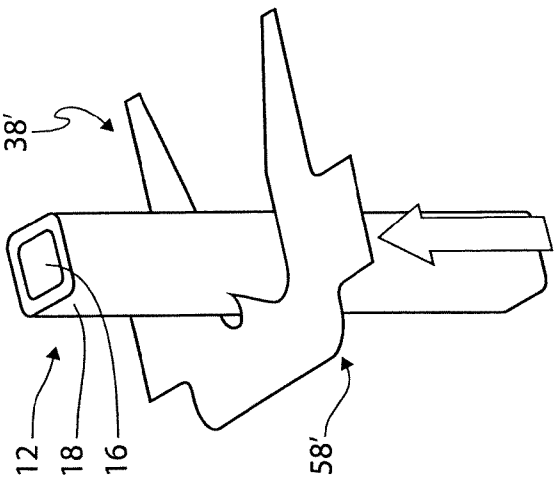

FIG. 6A

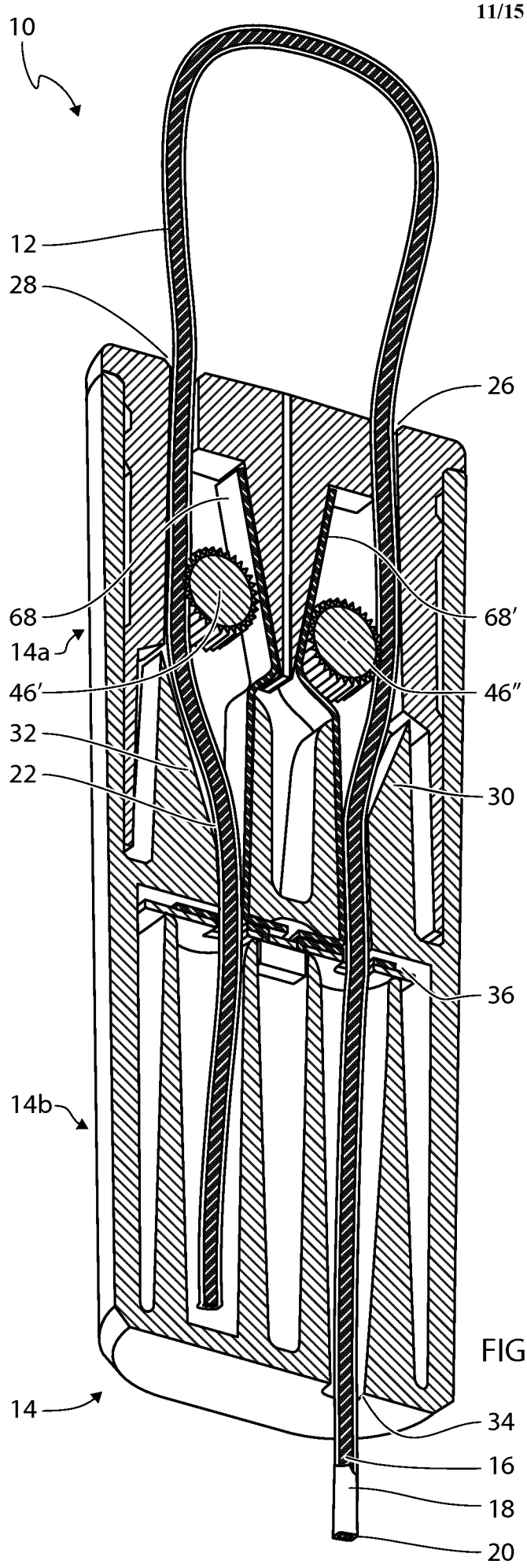
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FIG. 8A

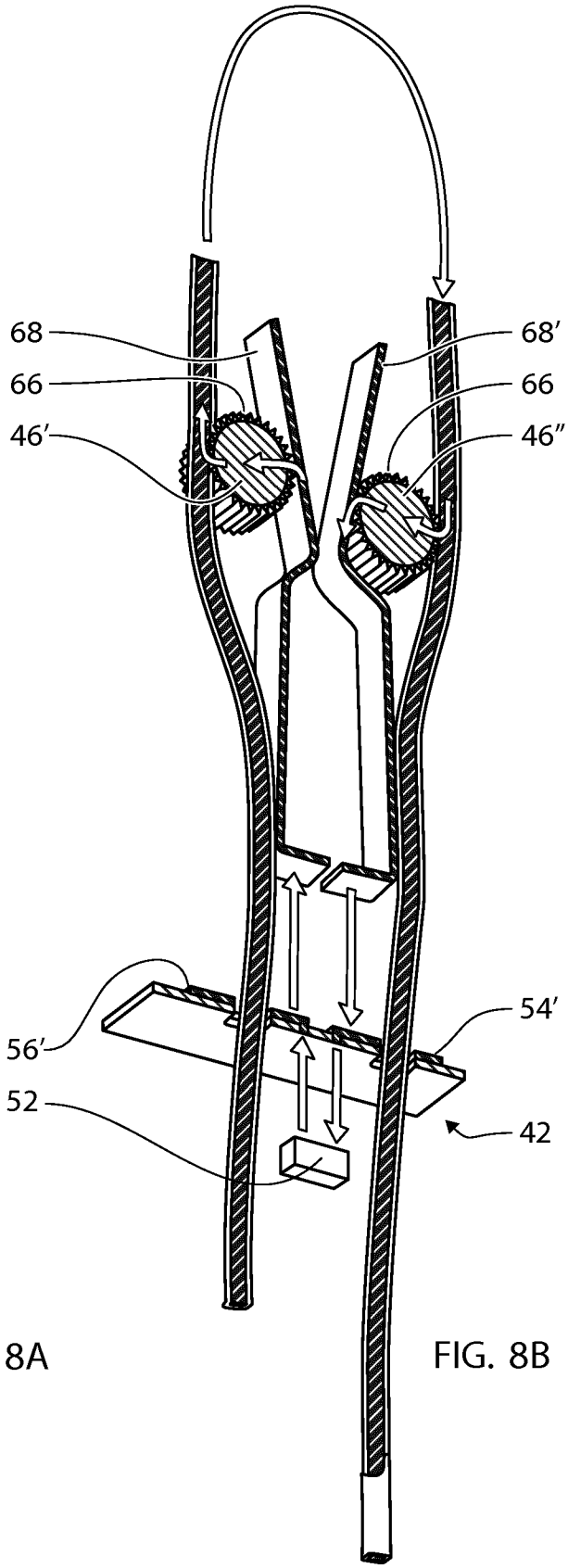
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FIG. 8B

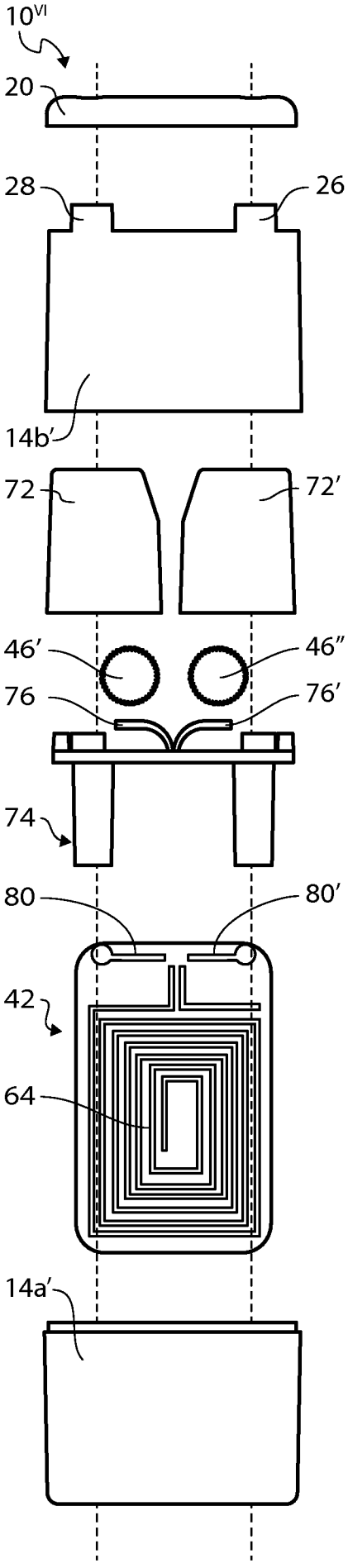

FIG. 9A

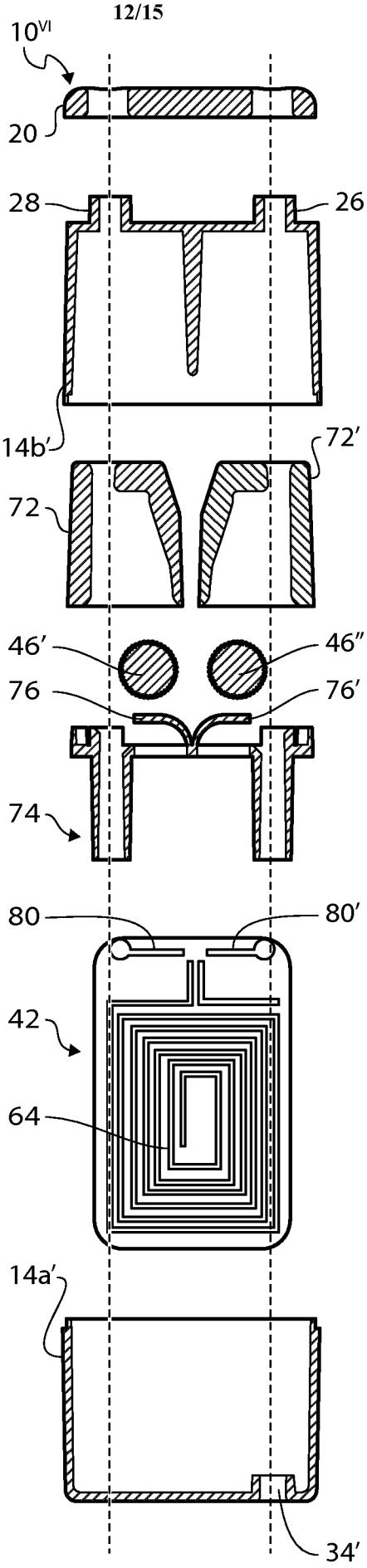

FIG. 9B

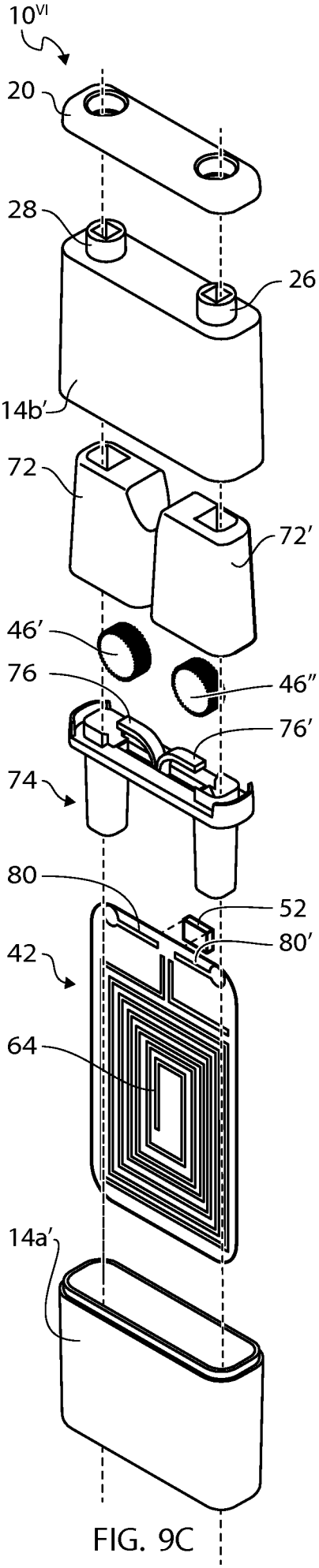

FIG. 9C

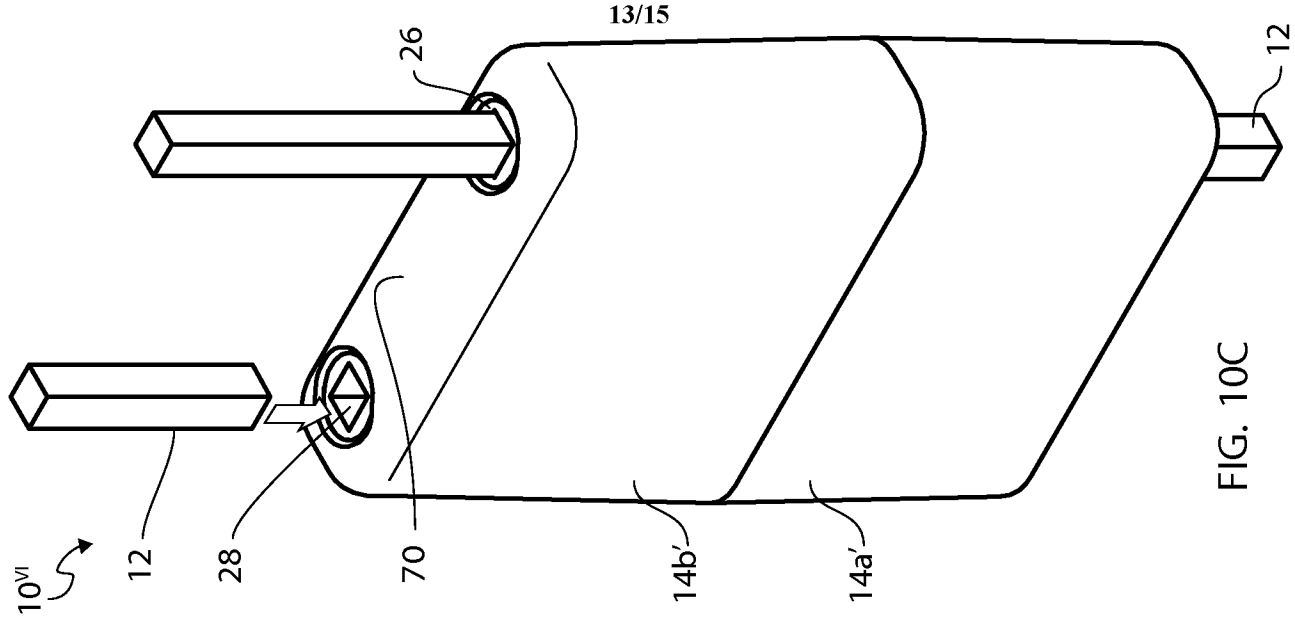

FIG. 10C

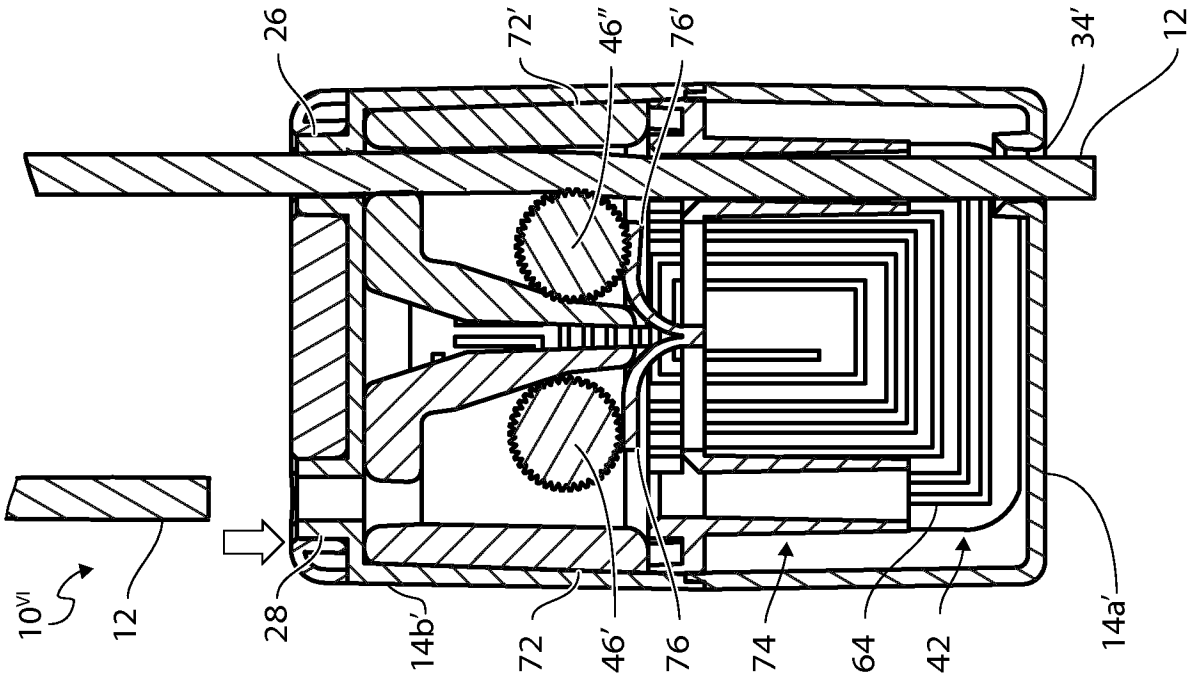

FIG. 10B

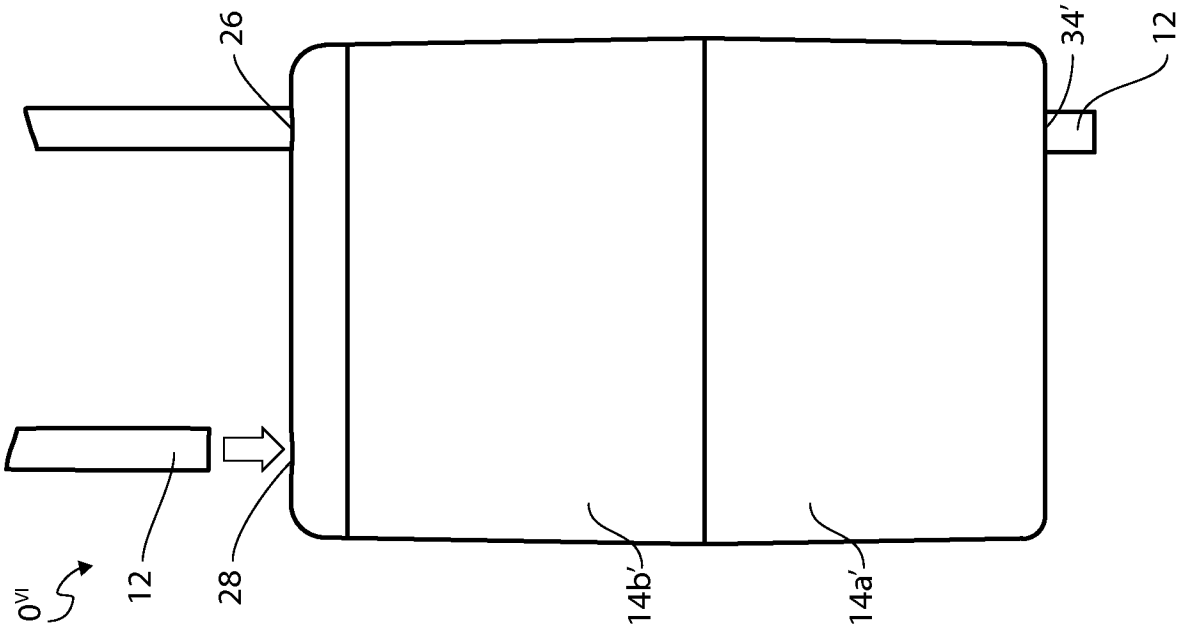

FIG. 10A

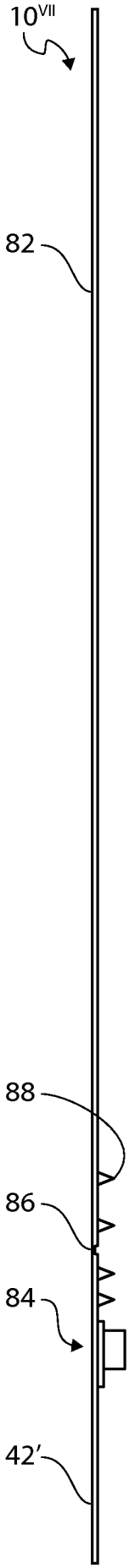

FIG. 11A

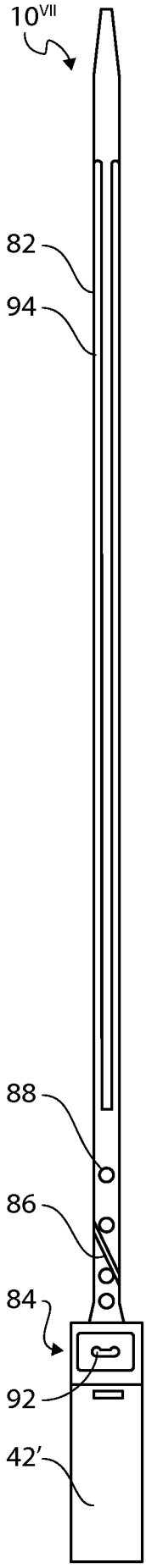

FIG. 11B

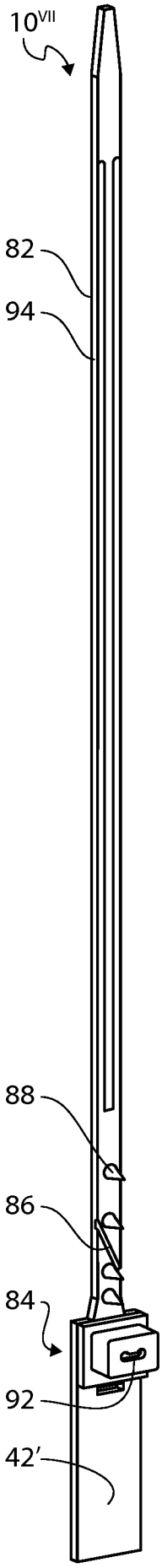

FIG. 11 C

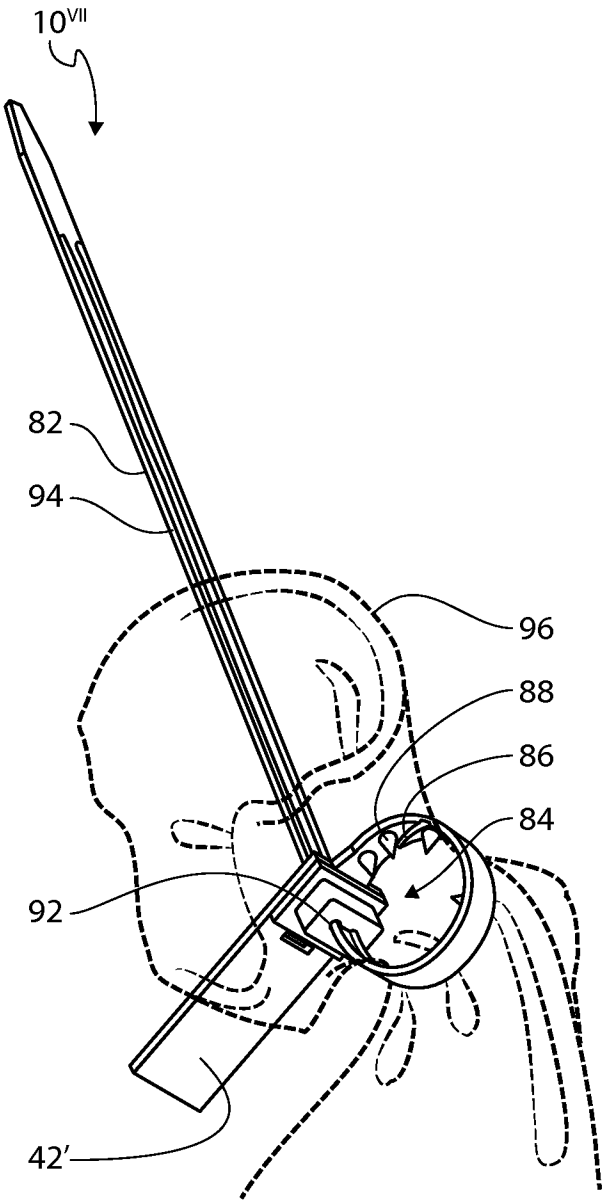

FIG. 11 D

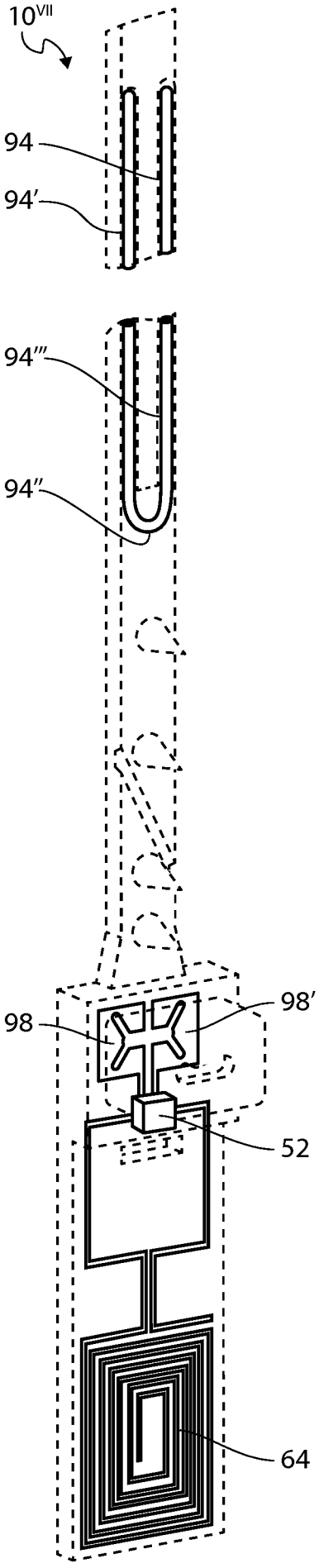

FIG. 12A

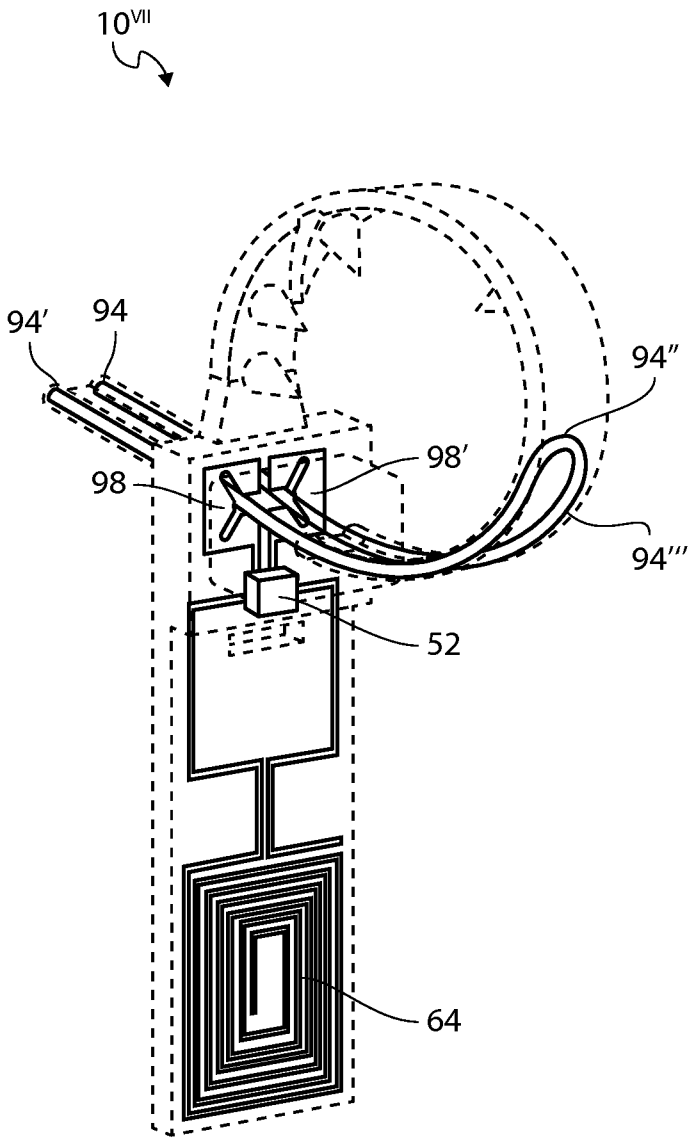

FIG. 12B

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/070555

A. CLASSIFICATION OF SUBJECT MATTER
INV. G09F3/03
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G09F G09B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2007/059161 A1 (BROOKS CO E J [US]) 24 May 2007 (2007-05-24) cited in the application the whole document	1-22
A	US 2003/075933 A1 (VELSCHOU JENS [DK] ET AL) 24 April 2003 (2003-04-24) cited in the application the whole document	1-22
A	US 7 878 561 B2 (RIETZLER MANFRED [DE]) 1 February 2011 (2011-02-01) cited in the application the whole document	1-22

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
17 December 2013	03/01/2014

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Demoor, Kristoffel

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2013/070555

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5 743 574 A (KOHN RAYMOND F [US]) 28 April 1998 (1998-04-28) abstract; figures 1-2a	1-22

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PCT/EP2013/070555

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Information on patent family members

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PCT/EP2013/070555

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